IMPACT OF VAN HIELE'S GEOMETRIC MODEL ON PEDAGOGICAL ABILITIES OF NIGERIA CERTIFICATE IN EDUCATION MATHEMATICS STUDENTS IN NIGER STATE, NIGERIA.

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ABSTRACT

The purpose of this research, Impact of van Hiele's geometric model on pedagogical abilities of Nigeria Certificate in Education mathematics students in Niger State is to provide a better intervention programme oriented toward mathematics Teacher preparation and professional development in Colleges of Education. One hundred and twenty (60 males and 60 females), Nigeria Certificate in Education mathematics students were both conveniently and randomly sampled from two colleges of education in Niger State. Two instruments were used for the study, a geometric achievement test and geometry teaching practice assessment with reliability coefficients of r=0.72 and 0.78 respectively. Also 1,617 Junior Secondary III students were involved. Six hypotheses were formulated and tested. The t – test was used to test hypotheses one to five and F – test was used to test hypothesis six respectively. The study revealed that significant difference exists between the mean scores of NCE II mathematics students with geometric pedagogical abilities and those without. Also, significant difference exists between junior secondary students performance in geometry attributable, to NCE mathematics students pedagogical abilities. Similarly significant gender difference exists among male and female mathematics teachers with geometric pedagogical abilities. However, no significant difference was observed among junior secondary students performance in geometry that were taught by NCE mathematics students in respective of gender. Also, a significant difference exists between the urban and rural junior secondary students performance in geometry when taught by NCE II mathematics students with geometric pedagogical abilities. Finally, there was significant difference in the mean scores of students' performance in geometry by school type when taught by the NCE II mathematics students with geometric pedagogical abilities. The findings of this study confirmed that geometric pedagogical ability is linked to students' geometric learning. In the light of this, it is recommended among others that there should be an increased emphasis on continued training of NCE mathematics students on geometry pedagogy even, after graduation so as to keep them abreast of current researches in geometry teaching and learning practices.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Development in science, technology and mathematics is increasingly gaining recognition as one of the most reliable indicators for determining the socio-economic and technological development among nations (Atebe, 2008; Anne and Obinna,2010 and UNESCO, 2012). For example, Wasagu (2005) reported that, the impact of Science, Technology and Mathematics Education (STME) on the economy of Japan today has made it not only the second largest economy but a threat to even the world's strongest economy, the United States of America (USA) which has remained the most successful in harnessing scientific and technological development for the attainment of its national objectives. In modern societies world over, including Nigeria, there is strong emphasis on the need for the provision of good qualitative Science, Technology and Mathematics Education. It is in this regard that, Nigerian government in its National Policy on Education (FRN, 2004) made Mathematics a compulsory (core) subject of study at both primary and secondary school levels. Indeed, for a candidate to gain admission into science and science- related courses in tertiary institutions, he/she must have credit pass in Mathematics. This is because Mathematics plays a pivotal role in science and technology advancement. Musa (2006) buttressed this in his study that, Mathematics provides the laws, formula and the theories that empower the scientific and technological developments. Therefore, the study of Mathematics by individual is essential because it provides avenue for thinking, developing scientific structure, drawing conclusions as well as solving life problems. Thus, it has useful links to many other fields of human endeavor.

However, as useful as this subject is, there is ample evidence of continued low performance of students in both the standardized and teacher made examinations, (Benjamin and Agwagah, 2006). For example, both national and international evaluation shows that, on completion of basic education, many pupil's mathematics knowledge and competences fall short of the expected level. More over, the disparities observed between and within the countries give course for concern (UNESCO, 2012).Also in a related report a comparative study of Mathematics and Science performance of students around the world showed that United States students' mathematical achievement lagged behind those of several other countries. Specifically in geometry content area, United States students achievement was bottom third of all countries tested. 38 countries outperformed the US in geometry with Japan at the top with a score of 575 and international average of 473 in geometry, (Unal, 2005). Also in Nigeria, results from examination bodies like West African Examination Council (WAEC) and National Examinations Council (NECO) reports indicate students' low performance in Mathematics as contained in the chief examiner's report, (2000, 2002 and 2005). Going by the above reports, Pussey (2003) and Atebe, (2008) opined that, performance in Mathematics is a good indicator of performance in geometry specifically.

Many reasons have been advanced for this poor state of students' performance in Mathematics in general and geometry in particular. Some researchers viewed teachers' subject matter incompetence as a contributing factor, (Benjamin and Agwagah 2006; Unal, 2005). Others like Ishaku (2003); Tahir (2006) attributed this consistent poor performance in Mathematics by the students to Mathematics teachers' lack of necessary

skill and competence in both the content and delivery. Hence, findings have consistently shown 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 like discovery, laboratory activities, individual problem solving and other methods, Mathematics teachers still follow traditional pattern of teaching. In the same vain, Unal (2005) 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, from the research's experience a close look at the Mathematics education program in Nigerian Universities and colleges of education seems to show that geometry is not emphasized. In another related development, it is a common belief in society that, if a Mathematics teacher knows Mathematics very well, he/she can teach it very well. But research evidence showed that, knowing Mathematics is only an aspect of Mathematics teaching. There are other knowledge necessary for the Mathematics teaching and learning that go 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 terms of its precision, ubiquity of logical reasoning and its coherence nature) couple with geometry teaching which has very specific mathematical requirement, but NCE curriculum tends to show nothing about such requirement. Hence, it could be argued that for effective learning to take place, there must be effective teaching.

Therefore, for Mathematics teaching to be effective there must be an effective Mathematics teacher who must be competent in both content knowledge and knowledge of mathematical presentation. This is because Mathematics is a composition of a large set of highly related abstraction and Atebe (2008) opined that if teachers do not know how to translate these abstractions into forms that enable 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. Thus, Jones(2000) and Pussey (2003) reported that Mathematics teachers' level of geometry understanding is low. Indeed, the reasonable question to contemplate is the amount of exposure teachers have had on geometry as subject as well as the amount of training they have received in teaching geometry. Specifically, Ohakwe (2006) reported that NCE Students of Mathematics do not posses adequate knowledge of geometry and its pedagogy hence, the teaching and learning of geometry is seriously deficient. Another area of great concern for Mathematics teaching which requires urgent intervention is the ability of NCE Mathematics Students to be conversant with the knowledge of students' cognition. This weakness could be linked to Mathematics teachers' preparation. Research evidence shows that the Mathematics teachers' preparations with specific focus on developing a structure of pedagogical content in Mathematics in our colleges of education are grossly inadequate, (Ishaku, 2003; Odili, 2006 and Tahir, 2006). Indeed, it is said that, learning is based on what happens in the classroom and not only on what students do because teaching environment is important for learning. Psychologists and Educationists believed that learning makes sense only when the 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, Waris and Warmick, (2006) opined that teaching strategies should be appropriate for the context, age and developmental stages of the learners.

Therefore, Van Hiele's geometric Model can serve as guide to the Mathematics teacher in the geometry aspect of the Mathematics curriculum. Mathematics teacher with knowledge of Van Hiele's geometric model can provide appropriate lesson structure and other apparatus; devise activities and appropriate experience for the learner so that understanding would grow from within. This is because it describes cognitive development or reasoning in geometry and provides frame work for teaching geometry. Indeed, it implies providing awareness to Mathematics teaching of interrelating components inherent for teaching geometry. It is against this background that this study intended to use Van Hiele's geometric Model on Pedagogical Abilities of Nigeria Certificate in Education Mathematics Students. The model spelt-out how children develop geometric reasoning and how a Mathematics teacher can plan and execute his/her geometry lessons in the classroom. Van Hiele's geometric model as posited by Atebe (2008) is that, when assisted by appropriate instructional experiences, the child passes through these levels in a hierarchical order beginning with recognition of shapes as a whole, progressing to discovering about these shapes and continuing in a formal deductive and rigorous study of axiomatic geometry. Van Hiele's geometric model has proved to be a useful framework for accessing and unraveling students' difficulties with school geometry, (Wikipedia, 2010). Despite the wide application of Van Hiele's Geometric model in many countries such as USA, Netherlands and Japan to improve Mathematics curricula (geometry content area), only few studies have utilized the model in African context (Atebe, 2008). Specifically, in Nigeria, there seems to be no single study which has attempted to investigate the use of appropriate pedagogy for

specific form of knowledge such as Van Hiele's Geometric model at College of Education level. Hence the need for this study, the Impact of Van Hiele's Geometric Model on Pedagogical Abilities of Nigeria Certificate in Education Mathematics Students in Niger state of, Nigeria.

1.2 Statement of the Problem

The picture emerging from research reports shows that students have difficulty in solving Mathematics problems especially those that require mental manipulation, rearrangement of elements with a visual stimulus pattern, just as many teachers have problem teaching that area. The west African examination council(WAEC) chief Examiner's report (2000; 2002; 2005) revealed that students had problem with geometric branch of Mathematics and such problems have been traced to lack of essential knowledge of construction rubrics. According to reports 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 plane and 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 classroom communication is, the better the chances that learning will take place.

The establishment of Colleges of Education marked significant beginning of proper teacher Education in Nigeria. The essence of teacher training is to produce qualitative education. Consequently, the teacher issue is crucial if success is to be

achieved in any educational programmes. Indeed, the observed poor performance in Mathematics in general and geometry in particular is not limited to Primary school pupils and Secondary school students but also to Primary and Secondary schools Mathematics teachers as pointed by (Iji and Harbor-Peters, 2005; Ohakwe, 2006; Adolphus, 2011). Several factors are responsible for the poor performance of students in geometry. Such factors as reported in literatures include:

i. Students inability to solve geometric problems

ii. Deficiencies in verbal and visual skills.

iii. Inadequate skill for effective teaching and learning.

iv. Ineffective instructional practices by teachers.

These problems seem to emanate from teachers colleges, to student teachers, then to Primary school pupils and Secondary School students. So far, attempts to address the issue have been centered mainly on training, retraining, seminar, workshops for teachers and curriculum review in schools. Yet the state of Mathematics education still remains deplorable. Not much attention has been directed to pedagogical practices, teachers' knowledge of students' cognition in geometry and the impact of that knowledge on instructional practices. Therefore, the researcher decided to study the Impact of Van Hiele's Geometric Model on Pedagogical Abilities of Nigeria Certificate in Education Mathematics Students in Colleges of Education in Niger state, with a view to improving poor performance in geometry.

1.3 **Objectives of the Study**

The main objective of this study was to determine the Impact of Van Hiele's Geometric Model on Pedagogical Abilities of Nigeria Certificate in Education (NCE) Mathematics Students in Niger State. The specific objectives are;

i. To determine the Impact of Van Hiele's Geometric Model on the NCE Mathematics Students Pedagogical abilities in teaching Geometry.

ii. To develop instructional/learning materials to serve as a guide and awareness on Van Hiele's Geometric Model and Pedagogical Abilities for teaching geometry.

iii. To find-out if the NCE Mathematics students knowledge in Van Hiele's Geometric Model on Pedagogical Abilities of Nigerian Certificate in Education Mathematics students will improve the junior secondary school students' performance in geometry.

v. To determine the impact of Van Hiele's Geometric model on Junior Secondary Schools performance in Geometry when taught by NCE II mathematics students with the knowledge of Geometric model.

vi. To determine the Impact of Van Hiele's Geometric model on school type among Junior Secondary School Students performance in Geometry when thought by NCE II mathematics student with the knowledge of Van Hiele Geometric model.

vii. To highlight the contributions of the knowledge of Van Hiele's Geometric Model on Pedagogical Abilities of NCE Mathematics Students' professional training in Geometry Teaching and Learning.

viii. To recommend practical measures (in NCE Mathematics Curriculum) to enhance or improve NCE Mathematics Students' knowledge in both the students' cognition and performance in geometry at the junior secondary school levels of our educational system.

1.4 **Research Questions**

In an effort to access the quality of NCE Mathematics Students' Pedagogical Abilities in geometry teaching, the following research questions are raised.

1. Is there any difference in pedagogical abilities between the NCE II Mathematics Students with the knowledge of Van Hiele's Geometric Model and those not exposed to the model?
2. Is there any difference in junior secondary school students' performance in geometry when taught by NCE II Mathematics Students with knowledge of Van Hiele's Geometric Model and those without the knowledge of the model?
3 Is there any difference on the Impact of Van Hiele's Geometric Model on Pedagogical abilities of Male and Female NCE II Mathematics Student?
4. What is the Impact on junior secondary school students' performance in geometry when taught by males and females NCE II mathematics Students with the knowledge of Van Hiele's Geometric model.
5. Is there any difference in Geometry performance of urban and rural junior secondary school students when taught by the NCE II mathematics Students with the knowledge of Van Hiele's geometric model?
6. Is there any difference in geometry performance of junior secondary school students from boys' schools, girls' schools and mixed schools when taught by NCE II mathematics Students with the Knowledge of Van Hiele's geometric model?

1.5 Research Hypotheses

The following null hypotheses were formulated for the study.

1. There is no significant difference in geometric pedagogical ability between the NCE II Mathematics Students with geometric pedagogical abilities (knowledge of Van Hiele's geometric model) and those without the knowledge of Van Hiele's geometric model.

2. There is no significant difference between junior secondary school students performance in geometry attributable to NCE II Mathematics Students knowledge of Van Hiele's geometric model).
3. There is no significant gender difference in geometric pedagogical ability of NCE II Mathematics Students with the knowledge of Van Hiele's geometric models.
4. There is no significant difference in students' performance in geometry between those taught by males and those taught by females' NCE II Mathematics students with the knowledge of Van Hiele's geometric model.
5. There is no significant difference between Urban and Rural students' performance in geometry when taught by NCE II Mathematics Students with the knowledge of Van Hiele's geometric model.
6. There is no significant difference in the geometry performance among junior secondary school students from Boy's schools, Girl's schools, and mixed schools in geometry test when taught by NCE II Mathematics Students with the knowledge of Van Hiele's geometric model.

1.6 Basic Assumptions

The following assumptions have been made in this investigation.

1. NCE II Mathematics Students were exposed to the same content of MAT 114 (Basic Concepts in Mathematics) as contained in the NCE minimum standard.
2. NCE II Mathematics Students were exposed to training in general teaching methods in education.
3. NCE II Mathematics Students were never exposed to Van Hiele's Geometric Model theory of instruction in geometry.

1.7 Significance of the Study

This study is significant in several ways. First and foremost, it is hoped that this research effort will be of help to the Mathematics teachers. For instance, it will serve as a guide in his/her geometry teaching – given the continuous debate across the world about the difficulties encountered by both teachers and students in the teaching and learning of geometry. Hence, the findings of this study will help in contributing to understanding and interpreting, in depth, the teaching of geometry by analyzing classroom interaction. Also, it will provide Mathematics teachers with the knowledge on how to analyze the appropriateness of the Van Hiele Model of teaching phases, and to see how well the Model characterizes the observed teaching in order to explain how a successful teacher teaches based on the report that Mathematics is very difficult for many teachers to teach and students to learn, (Iji & Harbor-Peters, 2005 and Ohakwe 2006).

Similarly, it is hoped that this study would assist the stakeholders in curriculum development and decision making in the aspect of Mathematics curriculum development. In particular, the Nigerian Educational Research and Development Council (NERDC) who are in-charge of curriculum development in Nigeria as well as other teacher Education supervisory agencies like the National Commission for Colleges of Education (NCCE) who monitors and ensures that minimum standard is maintained by all Colleges of Education in its NCE Mathematics Education Programmes, the National Universities Commission(NUC) who serves the purpose of maintaining minimum standard at the Universities Undergraduate and Post-graduate Mathematics Teacher Education Programmes. Others are Institute of Education of Nigerian Universities and Faculties of Education of Nigerian Universities, Federal and State.

Furthermore, the National Examination bodies that conduct and award Secondary School Certificates in Mathematics such as the West African Examination

Council (WAEC), National Examinations Council (NECO), National Board for Technical Examinations (NABTEC), National Teachers Institute (NTI) would also find this study very beneficial in the aspect of test construction and validation. Also, others who will find this study useful include the National Mathematical Centre who is saddled with the responsibility of training and retraining of in-service Mathematics teachers to refresh and update their knowledge and skills in Mathematics teaching and learning.

Finally, the professional bodies such as the Mathematical Association of Nigeria (MAN) and Science Teachers Association of Nigeria (STAN) would also derive some benefits from this study as their members meet annually to review and update their members' knowledge in current researches in the field of Mathematics Education.

1.8 Scope of the Study

The scope of this study is focused on Mathematics teacher preparation in Colleges of Education. Precisely, geometric Pedagogical aspect of their training was looked into using the Van Hiele's Geometric Model "Teaching Phases" in geometry instruction at Junior Secondary School levels. The study covered the two Colleges of Education in Niger State, namely; Federal College of Education, Kontagora and College of Education, Minna. NCE II Mathematics Students who must have been taught MAT114 (basic concepts in Mathematics) and, general teaching methods in Education courses).Also, the study covered one thousand six hundred and seventeen junior secondary school students.

However, some of the delimitations of the study were; this study did not attempted to determine the level of geometry understanding of these NCE II students. This is because each NCE Student must have passed 'o' Mathematics at credit level. It only attempted to raise the level of awareness of NCE II Mathematics Students in their pedagogical knowledge in geometry teaching and learning precisely using Van Hiele's Model. The study likewise did not attempt to determine the areas of geometry which

should be included for teaching. Since the geometry achievement test was used to measure the extent of geometry understanding of the Junior Secondary School Students involved in the study. The basis for evaluation is therefore limited to the items within the Geometry Achievement Test (GAT 'A').

Lastly, the study did not in anyway consider the ability grouping of the NCE II Mathematics students in geometry. Rather, it considered the extent of his/her teaching ability/skills (on how to prepare and analyze the model as characterized in the observed teaching using Van Hiele's teaching phases) on the Junior Secondary School geometry content of the junior secondary Mathematics curriculum.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter contains a survey of relevant and related literature dealing with Impact of van Hiele's Geometric model on pedagogical abilities of NCE II Mathematics Students in Colleges of Education with the sole purpose of synthesizing previous studies about the topic under study. The review was carried out under the following sub-headings:

- Conceptual frame work.
- van Hiele's theory, Properties and Characteristics
- Behaviorists and Constructivist approaches to instruction
- Concept of Geometry
- Causes of learning difficulty in school geometry
- Mathematics Teacher Preparation in Colleges of Education and Students performance.
- Mathematics teacher preparation and Teaching practice.
- Gender and Mathematics performance.
- School location and Mathematics Achievement.
- School Types and Mathematics Achievement.
- Review of Empirical studies in geometry.
- Summary of Related Reviewed Literature in Geometry.

2.2 Conceptual/Theoretical Framework

The conceptual framework for this study is based on the assumptions that research and development efforts in Mathematics Education over the past few decades

have had little influence on Mathematics Teacher Preparation and the teaching of Mathematics as a subject. Even though, available literatures do not provide conclusive evidence on these assumptions but they do indicate some limitations of the previous studies on Mathematics Teacher Preparation and Pedagogy.

In Mathematics Education, teachers are powerful catalyst in the process of development. This is because no matter the calibre of infrastructure and facilities, curricular and instructional materials available in our classrooms without the Mathematics teacher playing a central role, it will be difficult to achieve our goals of advancement in science, technology and mathematics education. Indeed, learning experiences are framed by a teacher who selects, prepares, and presents a wide range of instructional activities. Obanya (2006) opined that, scientifically formulated educational theories make sense only to the extent to which they stand the litmus test of what teachers do in classrooms. In other words, conceptualization of Mathematics teacher education should focus on the nature of Mathematics teaching and learning.

Thus, effort towards this according to Van de walle (2004) should be influenced by Constructivist views on Mathematics learning, availability of new technologies and the learning of particular mathematical concepts. Hence, the need to carry out this study on geometry and NCE II Mathematics students' pedagogical abilities in geometry at College of Education level where initial teacher training begins.

Lassa (1996) stressed this when he posits that, the preparation of future teachers for Nigeria should recognize the distinction between "Curriculum knowledge and pedagogical content knowledge". The latter is needed by the NCE II Mathematics students in order to acquire the distinctive "bodies of knowledge for teaching". Lassa (1996) further supported this assertion by agreeing with the suggestion of Okebukola (1995) that;

> Training activities geared specifically to preparing teachers need to contemplate not only instruction on the curriculum and specific teaching procedures, but more importantly the development of the ability to reason "pedagogically on the part of student teachers in order to convert substantive knowledge into teachable knowledge and experiment with how this can be done,(Lassa,1996,pp2).

While the teaching and learning of Mathematics do face some problems, these problems in other sense are subsumed within more general consideration, concerning the nature and process of teaching and learning. Literatures have shown that, in general term, what constitutes the nature and process of teaching remains inconclusive, but the fact still remains that teaching or instructional practices is problematic and ephemeral. Similar remarks were made by (Monisola, 2000; Iji and Harbor-Peters, 2005).

Therefore, a central consideration for this study is on the situation whereby Mathematics teachers produced in Colleges of Education cannot provide any significant improvement, re-orientation and shift from the old and out-dated but also ineffective and unrealistic instructional practices in the teaching and learning of geometry in our school as observed from 10years teaching experience of the researcher in a College of Education. Hence it has become very necessary to examine the state of Mathematics teacher preparation in Colleges of Education with special focus on or pre-service NCE Mathematics Teachers' Pedagogical ability in geometry and on enhancing his/her students performance at the levels they are expected to function after graduation.

This study is focused on Van Hiele's theory and instruction. The theory of instruction is prescriptive in nature. It is prescriptive because it contains principles for the most effective procedure for teaching and learning facts, skills, concepts and principles.

Indeed within Van Hiele theory of instruction there are prescribed processes and strategies for the achievement of the objectives of instruction. Van Hiele's theory of instruction is in line with constructivism as a theory of instruction in education. Constructivism developed from one of the fundamental assumption of cognitive learning psychology, which is that new knowledge is for the most part constructed by the learner, (Orton 2004). Thus, van Hiele's geometric model of teaching is outlined in the following steps.

1. Information phase
2. Guided orientation phase
3. Explicitation phase
4. Free orientation phase
5. Integration phase

The point stressed by the van Hiele theory on instruction for level attainment is that each unit of teachers' geometry classroom instructional delivery should be organized in accord with the sequence of the phases.

The early constructivists believed that knowledge is an individual's construction and each learner must construct knowledge for himself. According to Pollard et al (2006), effective learning takes place only when learners have ownership of the body of knowledge being learned. Indeed Pollard et al (2006) opined that in teaching, knowledge cannot simply be transferred by means of word without first being subjected to some form of agreement about meaning pertaining to some shared experiential bases. In other words, teacher should determine learner's prior knowledge and lead him, through negotiation, to construct his own meaning and understanding of subject matter

being taught. It was this view that made Van Hiele to propose five (5) phases in the learning process that promotes students progress from one level to the next in geometry

classroom instruction. Equally Van Hiele recommends five phases for guiding students from one level to another on a given topic in geometry.

Phase 1. Information: Through discussion the teacher leads the learners to become acquainted with the domain of investigation. Here the teacher is expected to show a picture / diagram and the class is asked to identify the diagram. Students should be allowed to use their own language (or imprecise terminology) with minimum interference from the teacher. Thus, this paves way to identify background knowledge of the pupils in the topic or concept.

Phase 2: Guided orientation: The teacher guides the students explore the object of instruction by assigning carefully structured but simple tasks that invite or permit only one solution. Example of such activities include folding, reflecting and measuring a shape such as in Rhombus were students can observe things like angle, side and diagonals. The teacher allows students to use their own language but occasionally injecting the right terminology.

Phase 3: Explicitation: Here the students describe what they have learned about the topic using their own language. Example, discuss what they found as properties of a rhombus. The teacher introduces technical terms associated with the subject matter in order to promote accurate communication among the students.

Phase 4: Free orientation: Activities at this stage are designed to provide the

students with problems that have multi – path solution in the network of relation. Exercise such as constructing a Rhombus given some vertices and sides. Tasks are open – ended ones.

Phase 5: Integration: The students are conversant with the field of study and have arrived at an overview of the topics. Thus, students have a clear sense of purpose with regard to the object of study, having developed a new network of relations pertaining to it and are able to summarize and integrate what they have learned. According to Van Hiele (1986), students who have attained the next level indicate that "problems set which integration must be simple" for example asking the students to "summarize and memorize the properties of the Rhombus.

The major significance of the Van Hiele learning phases is their link into the level descriptions. The phase move hand – in – hand with the van Hiele levels of geometric thought. Hence, offers teachers a chance to identify clearly the starting and ending points in their effort to raise students' thought at any given level to the next higher level during instruction in geometry. Also, another advantage to the teachers is the opportunity to compare their current instructional practice with a model of teaching that places "introduction, discussion, straight forward exercise, language development, multi – path solution exercise, and topic overview in a sequence (Pusey, 2003; Atebe, 2008). The development of van Hiele's model in geometry is a specific constructivist approach (theory) which shed more light on how individuals developed geometric thinking.

Van Hiele Theory

Pierre van Hiele and Dina van Hiele – Geldof were husband – and – wife team of Dutch Mathematics educators who did research in the late 1950s on thought and concept development in geometry among school children. As a result of many years of

teaching experience, they noticed with disappointment the difficulties that their students had in learning geometry as a result of classroom observations, van Hiele asserted that students pass through several levels of reasoning about geometric concept. Hence, they developed Van Hiele model, a theory that describes how students learn geometry. The theory first appeared in 1957 in the doctoral dissertation of Dina Van Hiele Geldof and Pierre Van Hiele (wife and husband) at Utrecht University in the Netherlands. The soviet did research on the theory in the 1960s and integrated their findings into their curricula. American researchers did several large studies on the Van Hiele theory in the late 1970s and early 1980s and Pierre Van Hiele published structure and insight in 1986, further describing his theory. The model has greatly influenced geometry curricula through out the world (Wikipedia, 2010). The best known part of the theory is the five levels which Van Hiele postulated to describe how children learn to reason in geometry. These levels are often used to describe students 'progress in geometrical reasoning. Pierre Van Hiele noticed that his students tended to "plateau" at certain point in their understanding of geometry and he identified these plateau points as levels. These levels are attained as a result of experience and instruction rather then age. This is in contrast to Piaget's theory of cognitive development which goes with age. Therefore a child must have enough experience (classroom or otherwise) with these geometric ideas to move to a higher level of sophistication. The levels are as follows.

Level 0 – Recognition and Visualization

Geometric figures are viewed as a whole. Students can name and identify common geometric figures, and compare shapes such as triangles, squares and rectangles but figures are recognized by their shapes, not their parts or attributes. Figures are recognized by appearance i.e. it looks

like a square. Students can learn geometric vocabulary and if given a figure can reproduce it.

Level 1 - Analysis or Descriptive level

Students are able to perceive or identify attributes of a figure, but they are isolated and unrelated. Since each property is seen separately, no relationship between properties is noticed and relationships between different figures are not perceived. They judge a shape to be a type of figure based on the attributes it possesses. They have not yet mastered which properties are necessary and which are sufficient to describe a geometric shape. Class inclusion is not yet understood.

Level 2 Informal Deductions or ordering level.

At this level, deduction is meaningful. Logically students can order the property of figures previously identified and begin to perceive the relationships between these properties and between different figures. The student can construct proofs, understand the roles of axioms and definitions and know the meaning of necessary and sufficient conditions. Students are able to understand hierarchies of geometric figure. However, the role and importance of formal deductions is not yet understood.

Level 3 Deduction:

The role of axioms, undefined terms, and theorems are understood. Students comprehend the significance of proofs; they also understand that a proof may be done in more than one way. Students should be able to supply the reasons for steps in a proof and also construct their own proofs, while the need for rote learning is minimized.

Level 4 Rigor;

Students can study non-Euclidean geometries. Different axiomatic system can be compared. Students are able to analyze various systems like establishing theorems in different axiomatic system. E.g. a locus of a prior from a fixed point to a fixed distance is a circle.

Properties of Van Hiele levels.

The Van Hieles made certain observations about the nature of the level of thinking in geometry and their relationship to classroom instruction. It was Lenhart (2010) who reported that Van Hiele have five properties which helped in understanding how an individual student progresses from one Van Hiele level to the next. These properties are:-

1. Fixed sequence: The levels are hierarchical. Students cannot skip levels. The Van Hiele claimed that much of the difficulty experienced by geometry students is due to being taught at the deduction level when they have not yet reach the abstraction level
2. Linguistic character: one of the most important results of Van Hiele theory is its pedagogical relevance to instruction in geometry. Each level has its own language and network of relationship. People reasoning at different level speak different language and the same term is interpreted differently. The mismatch

between instruction and students cognitive level in geometry is caused largely by teacher's failure to deliver instruction to the pupils in a language that is appropriate to the students thinking levels. Van Hiele (1986) sees this property as the must critical in the learning process. Therefore, this stage means that teachers should use level – appropriate terminology, symbols or general language in their geometry instruction.

3. Adjacency: concepts that were implicitly understood at level N became explicitly understood at level N+1. The properties are there at visualization level, but the student is not yet consciously aware of them until the analysis level. Students at the analysis level may be vaguely aware that certain properties are related, but do not use such reasoning explicitly.
4. Discontinuously: Van Hiele (1986) said, the most distinctive property of the levels of thinking is their discontinuity, the lack of coherence between the network of relations. In other words, learning of geometry is a discontinuous process characterized by qualitatively distinct levels in thinking. Two persons who reason at different levels would not understand each other. A student having attained a given level remains at that level for a while as if "maturing". Attempt to force him to the next level will not succeed until this maturation process has occurred.
5. Retention: research evidence indicates that students can be on different Van Hiele levels for different concepts. Some students oscillate between levels). However, once a student is raised to a certain level in one concept, it becomes easier for the students to think at that level in other concepts, (Wikipedia 2010).

Characteristics of the Van Hiele theory.

Van Hiele theory is unique. It is unique in the sense that it presents the quality of being both a theory of learning and a theory of instruction. The distinction between theory of learning and theory of instruction is that, theories of learning are descriptive in nature. This is because theory of learning (intellectual development) describes what has happened and what can reasonably expected to happen. It describes that mental activity which children can do at certain stage of their development as in the case of Piaget but it

does not prescribe procedure for teaching. Therefore, Atebe (2008) opined that the Van Hiele theory's ability to describe and predict behaviour and to prescribe procedure for the attainment of level of thinking is an important attribute for any scientific theory. Hence, three appealing characteristics of van Hiele's theory were identified. These are

1. **Elegance:** This refers to simple structure of the theory element from one level to the next following the same principles. Example, the figures of level 1 is the foundation for properties at level 2.
2. **Comprehension:** This refers to the descriptive and prescriptive attributes of Van Hiele theory. In other word, a theory which covers the whole of learning of geometry, and which seeks to explain not only why students have trouble in learning but also what could be done to remove these stumbling block, reason why it must be called comprehension.
3. **Wide application:** Van Hiele theory has influenced major reforms in geometry curricula in Netherlands, Soviet, and United states. The model has greatly influenced geometry curricula throughout the world, (Wikipedia, 2010). Indeed, this showed that the Van Hiele theory should obviously be seen as both widely and easily applicable. Therefore, Atebe (2008) reported that despite this

wide applicability only a few studies have utilized the Van Hiele model to explain students' geometry thinking level in an African context. There appears to be a particular dearth of research in the available literature concerning the use of the Van Hiele theory on instruction to explicate geometry classroom instructional practice. This makes this study worthy of investigation at college of education level.

2.3 Behaviorist and Constructivist Approach to Instruction.

For many years, there has been a debate in education on the advantages and disadvantages of socio-constructivism and behaviorism. These two theories of teaching and learning Mathematics can be seen as two contrasting views and both have influenced the way Mathematics is being taught in schools,(Anderson,Reder and Simon,2006).

Behaviorist models of teaching and learning claims that knowledge should be transferred from one individual to another in educational environments. For constructivist educationist, knowledge must be actively constructed as the learner is an entity with previous experiences that must be considered as a "knowing being". Learning is therefore seen as an adaptive and experienced process rather than a knowledge transference activity. As learners encounter new situations, they look for similarity and differences against their own cognitive schemata.

In constructivist terms, learning depends on the way each individual learner looks at a particular situation and draws his/her conclusions. Therefore, students determine their own knowledge based on their own way of processing information and in accordance with beliefs and attitudes towards learning. Constructivism therefore

gives recognition and value instructional strategies in which students are able to learn Mathematics by personally and socially constructing knowledge. Hence, constructivist learning strategies which are more reflective oriented activities include problem solving, group learning, discussions, and situated learning. In a behaviorist's oriented environment, completion of tasks is seen as ideal learning behaviour and mastering basic skills require students to move from basic tasks to more advanced tasks. In addition, learning is considered a function of rewarding and reinforcing student learning.

Teaching and learning in behaviorists term is a matter of optimizing and manipulating the instructional environment towards the fulfillment of rigidly and specifically designed educational objectives. A behaviorist teaching style in Mathematics education tends to rely on practices that emphasize rote learning and memorization of formulas, one way to solve problems, and adherence to procedures and drills. Repetition is seen as one of the greatest means to skill acquisition. Teaching is therefore a matter of enunciating objectives and providing the means to reach those objectives.

It is worthy to add that most of the literatures on Mathematics education revolve around a dialog between the constructivist and the behaviouralist movements. However, this two opposing psychological theories have influenced the way students, teachers and school system in general have taught about what Mathematics is and how it should be taught and learned. In addition, each group often appeals to the writing of the other for support, Anderson et al (2006).

2.4 Concept of Geometry

For this study to take a proper shape or sharp focus and to provide common ground for a better understanding to the readers there is the need to look at the concept of geometry. Thus, few definitions sufficed. Atebe (2008) define geometry as "the elementary study of the properties and relations of CONSTRUCTIBLE plane figures". It is the specific mathematical axiomatization of the properties and relations of plane shapes as studied, for example, under Euclidean Geometry. The emphasis is the notion of geometry by explaining, through geometrical construction, students understanding of

the properties and relations of simple geometrical shapes such as triangles, squares, rhombuses, trapeziums and circles.

Also Van Hiele (1986) describes geometry as a science, as a form of study, in which teachers have no concern for space, or geometric figures in space, but rather only for the relations between properties of these figures. Hence, he emphasized on the "intuition introduction" to the study of geometry in which learners are given the opportunities for direct observation/manipulations of geometric figures. This enables them to abstract the relations between the properties of these shapes. This is the practice expected of mathematics teachers in geometry teaching and learning in Nigeria Primary and secondary schools. This approach enables the learners the ability to recognize, describe, classify and abstract the properties of triangle, quadrilaterals using cardboard cut-outs.

In a related development, geometry could be defined as the study of spatial objects, relationships, and transformation that have been formalized and the axiomatic mathematical systems that have been constructed to represent them. Also linking geometry with spatial reasoning, they described spatial reasoning to consist of the

set of intellectual process through which mental representations of spatial objects and the relationships between the properties of those objects are constructed and manipulated. Hence, these indicate that geometry and spatial reasoning are interrelated mathematical concept. Therefore, spatial reasoning is a tool used to explore learner's understanding of geometry.

Similarly, Farlex The Free Dictionary(2014) defines geometry as that part of that mathematics which deals with the properties of points, lines, surfaces, and solids either under the classical Euclidean assumption, or (in the case of elliptic,

hyperbolic etc geometry) involving postulates that are not identical with Euclid's geometry.

The word geometry is derived from the Greek geo meaning earth and metric meaning measure. This arose as the field of knowledge dealing with spatial relationships. Geometry was one of two fields of pre modern mathematics, the other being the study of numbers (arithmetic). Classic geometry focused on compass and straight edge constructions. Later, Euclid added the mathematical rigor and the axiomatic method.

Early geometry focused on the measurement of length, angles, areas, and volumes which are developed to meet some practical needs in surveying, constructions, astronomy, and various crafts. Thus Jones(2002) said geometry involves the study of spatial relationships (positions, shape and size). Its study is carried on through observations, constructions and description of shapes; and location of points in one, two or three dimensional space. Hence, the knowledge of geometry is basic to understanding the environment in which people live. This can be ascertained by observing the arts; architecture, clothing and other aspects of the socio-cultural surroundings. Therefore, it seems that ability to represent and interpret 3 dimensional geometric relationships is valuable skill for many secondary schools subjects and technical occupations. Furthermore, majority of mathematics teachers trained in Nigeria universities and colleges of education did not study geometry beyond secondary school level. Thus it follows that, if teachers of mathematics do not possess adequate knowledge of geometry, the teaching and learning is likely to be serious deficient. Hence the need for this study, Impact of Van Hiele's geometric model on Pedagogical abilities of Nigeria certificate in Education mathematics students in Niger state.

To sum it up, Geometry is one of the most interesting areas of mathematics to teach. It has a host of interesting problems and beautiful theorems that are open to many different approaches. Geometry has along history, intimately connected with development of mathematics. It is an integral part of our cultural experience, being a vital component of numerous aspect of life from architecture to design (in all its manifestation). What is more, geometry appeals to our visual, aesthetic and intuitive senses. These aspects and considerations also tend to make geometry a demanding part of mathematics to teach well, (Jones, 2000). Therefore the transition from practical subject to a theoretical subject made the subject becomes an area of mathematics which needs to be given desired attention. It is in this regard that, the current study did investigate Impact of Van Heile's geometric model on pedagogical abilities of Nigeria certificate in education mathematics students in Niger state.

2.5 Causes of learning difficulty in school Geometry

Most of the available literature continued to reveal that there is low performance in Mathematics among Nigeria students, Harbor–Peters and Iji (2005) Ohakwe (2006), Atebe (2008). Consequently, Atebe (2008) opined that performances in Mathematics are low and as a whole could be taken as good indicator of performance in geometry. By way of extension, it also means that Nigeria students' knowledge of geometry could be said to have fallen below expectations as supported by the WAEC chief examiner's report (2000; 2002; 2005) which states that candidates were observed to be generally weak in the area of geometry, as a result many students dislike geometry. Unal(2005), Atebe (2008) and Adolphus, (2011) also reported similar observations among the Nigeria and South Africa high school students. Most of the literatures reported the area

of difficulties to include, misconception about geometrical shapes and relationship between their proportion, imprecise terminology, identification and classification of shapes, proof writing in geometry. Geometry stresses the use of language more than any course both inside and outside the classroom. In addition, most literatures indicate that source of learning difficulties in school geometry cut – across the globe and have been attributed to several factors. These factors have been categorized into student-factor, teachers factor, curriculum text and instructional/ pedagogical factor etc Ali (2000); Aburime (2003); Agwagah (2005); Unal (2005); Odili (2006); Ohakwe (2006); Mahwah (2007); Olaoye (2007); Adedibu and Olayiwola (2007); and Atebe (2008). Since these factors mention above are not the only critical influence on students learning of geometry, they do have a major impact and their evaluation does give insight into the roles they play among the expected, implemented and attained educational objectives, (Fujita and Jones,2002).

Therefore, for the purpose of this investigation, the instructional/pedagogical factor is relevant to this study. This is because the teacher and what he does at the classroom that is, transforming curriculum (geometry content) intentions into potential learning experience matters a lot. Hence, Ishaku (2003) supported this and said the most important people in any educational system are the teacher in the classroom. Tahir (2006) and Obanya (2006) believe that "learning is strongly and necessarily linked to teaching. This means that the amount of learning that takes place in the classroom depends, for the most part, on teachers' knowledge of the subject matter learned. Indeed, available literatures suggest that teachers' behaviors are often influenced by their knowledge of the subject and subject matter specific pedagogy, Jones (2000), Thus, teachers are expected to teach geometry when they are likely to have done little geometry themselves since they were in secondary school, and possible haste even then,

In this circumstance, it might be right to say that, a teacher with good content knowledge of geometry added with a good knowledge of teaching strategy make learning much easier for the students.

However, Jones (2000) identified differences in the categories of knowledge that a teacher should have in order to teach effectively. These include content knowledge i.e. knowledge of the subject matter to be taught, pedagogy of content knowledge and curriculum knowledge i.e. knowledge of subject matter programme and by means of which instruction and assessment are to be carried out. These according to literatures cited above, opined that, pedagogical content knowledge is perhaps the most important because it brings out clearly the different types of knowledge and teaching strategies for teaching and learning to take place.

Also, other literatures indicate that much of the difficulties that students faced with Mathematics in general and geometry in particular is due to teachers' lack of appropriate pedagogical contents in this subject, van Hiele (1986), Jones (2000), Ohakwe (2006), and Mahwah (2007).These literatures cited confirmed that children's knowledge and teachers understanding of that knowledge are the major determinants to instructional decision making. Therefore, it seems many traditional methods of teaching do little to help the Mathematics teachers to raise the level of his/her understanding of the learners mathematical thought. As a result of this, van Hiele (1986) asserts that the inability of many teachers to match instruction with their pupil's level of understanding in geometry more than anything else contributed to their failure to promote students conceptual understanding in the subject. Similar remarks were reported and supported by Atebe (2008) in his study on students' Van Hiele level of geometry thought and conception in plane geometry; A collective case study of Nigeria and South Africa.

Atebe ((2008) reported that, grade 7 teachers and prospective teachers lacked the geometry content knowledge requisite for them to be successful teachers. The implication is that inadequate geometry content knowledge by the teacher tends to exacerbate the problem that students experience in learning the subject.

In Nigeria several factors were identified in the literatures as the causes of student's poor performance in Mathematics with emphasis on instructional method as the most critical factor. Others are teachers' qualification, students' family background, school environment and curriculum. It is in the light of these that most literatures seem to agree that all is not well with the teaching and learning of Mathematics generally and geometry in particular,(Iji and Habor- Peters ,2005; Inekwe 2005; Putten 2008; Adolphus,2011). However, it is assumed that, an improvement in students learning

assumes an improvement in the pedagogy enabling the learning. Related to the causes of difficulty in school geometry are the all important issue of teachers' reluctance to 'change' for new and progressive methods of teaching. Probably the reason for this is that, it seems it will require teachers to adapt radically to different teaching styles (Mary and Lourdes, 2005). Hence, this is true with many teachers who use the traditional method which is characterized by teacher centered method of instruction. This is contrary to the world acclaimed learner centered, the social constructivist approach, (Pollard et al, 2006). Teachers should target the approaches that will raise students' mathematical thinking and the learner centered is the most appropriate in geometry instruction, Van Hiele (1986). Therefore, Impact of Van Hiele's geometric model on teachers Pedagogical abilities and junior secondary school students' performance in geometry are the central focus of this study at Colleges of Education in Nigeria.

2.6 Mathematics Teacher Preparation in Colleges of Education and Students Performance

In 1960 when Nigeria gained her independent, one of the major problems was how to accelerate the pace of educational development with a view to meeting up with other developing nations. To achieve this, Ashby Commission on Education recommended a scientific rationale to adapt to the rate of expansion envisaged at other levels i.e. massive expansion of intermediate Education aimed at upgrading the existing teaching force in primary schools and the supply of trained teachers for the expansion of secondary education (Isyaku, 2000).

Consequently, four advanced Teachers college were established in the country to produce holders of the Nigeria Certificate in Education (NCE), a Non-degree but higher Qualitative Diploma in Education. The Advanced teachers Colleges thus become originators of the current Colleges of Education. Thus, teachers in Nigeria are trained and produced by these recognized institutions namely; Colleges of Education, National Teachers Institute (NTI), Faculties of Education, and Institutes of Education in the Universities. However, the focus of this research is mainly on the Colleges of Education which awards NCE, the minimum teaching qualification allowed in the country.

Courses run in these Colleges of Education include Sciences, Arts/Social Science, Vocational and Technical Education – all at NCE level. Many argued that, Colleges of Education are better suited than the Universities for the preparation of teachers particularly those that would function at the Pre-Primary, Primary and Secondary levels. This is because at this level, the NCEII students are exposed to pedagogic content knowledge using varied approaches to teaching and learning at the primary and junior secondary school levels. Therefore, it is argued that graduates of colleges of education are to emulate the approaches of their masters who produce them after graduation. However, this turned out not to be so and became a source of concern

to all stake holders due to the calibre of teachers produced by these teacher training colleges as expressed by (Ali 2000, and Junaid ,2008).

Ali (2000) reported that, there is considerable concern about certain issues which affect the calibre of such teachers produced in Colleges of Education. Such issues include deteriorating quality of candidates admitted to train as teachers, identifying major and appropriate skills, competencies and teaching styles for training purposes which match the need of the prospective teacher after graduation. Others include, identifying the appropriate and relevant pedagogical concepts so that the contexts learnt during training are matched with appropriate teacher methodology etc all in the hope that these will enhance and predispose effective teaching and preparing teachers in the subject matter content. Thus, professional teacher training expose prospective teachers in Colleges of Education to Psychology, Philosophy, Micro-teaching, teaching practice, General Education (Use of English, Computer Education etc) and Content Preparation (Mathematics, Physics, Chemistry etc) as teaching subjects after graduation.

Therefore, Mathematics as the bed-rock in the advancement of science and technology is equally given its due recognition as a course / subject in Colleges of Education. It is in the light of the above that the review of the literature will take a closer look at the Mathematics teacher preparation at NCE level. NCE Mathematics Education requires the NCE II Mathematics students' courses to expose its members or students trainees to three major components. Courses of Professional teacher preparation include psychology, philosophy, micro-teaching, teaching practice, general Education (Use of English, Computer Education, etc) and Content Preparations (i.e. Mathematics – Geometry, Trigonometry, and Calculus etc).

Ali (2000) opined that equal weighing most be given to the three components of teacher training which form the typical structure of a teacher Education courses/programme. These are delicate and influence the quality of a teacher finally

produced. Ali (2000) said something that calls for a fair balancing within and among the three in the prospective teacher preparation. Against this background, there has been consistent outcry from all stakeholders over a general decline in the teachers' ability to deliver to the learners (Bolaji, 2000; Unal, 2005; Tahir, 2006; Junaid, 2008).

Similarly, it seems from a closer look at development of Mathematics Education in Nigeria, revealed that no Mathematics educator minimizes the complex problem of preparing teachers, who do not teach Mathematics well. This is applicable to the Nigerian Situation that probably teachers of Mathematics teach "better" Mathematics but still do not teach Mathematics better. For instance, it seems that geometry is the last branch of Mathematics to be taught to Secondary School Students. Also, it was assumed that the logical science of geometry was very difficult for non-University students to understand. However, geometry had been made available in both the primary and secondary school curricula. The teaching of geometry at secondary school level requires that Mathematics teachers are well equipped to deliver. Thus, the problem of students' poor performance in geometry could be critically view from the perspectives of teacher preparation. Geometry being an essential branch of Mathematics has received the attention it deserves by its inclusion in Primary and Secondary School curricula. Then why is the persistence decline in the students' performance in this area which is said to be on the increase as reported by, (Iji & Harbor-Peters, 2005; Ohakwe, 2006; Adolphus, 2011).

This problem of students' poor performance in geometry has been linked to the teachers' pedagogy of the subject matter. The available literatures show that teacher's knowledge of subject matter and pedagogical theories learned during the course of training remain questionable. Thus, Jones (2000) and Ali (2000) emphasized the maintenance of a balance between the subject matter knowledge and pedagogical theories in terms of teacher competencies. For instance, subject matter knowledge is

another variable that one might think could be related to teacher effectiveness. While from the available literatures there is some support for this assumption, even though the findings are not as strong and consistent as one might suppose. Hammond (2000) report that studies of teachers' scores on the subject matter tests of the National Teacher Examination (NTE) have found no consistent relationship between this measure of

Subject matter knowledge and teacher performance as measured by students' outcome or supervisory rating, as more studies show small, statistically insignificant relationships which are both positive and negative. Such studies reviewed, which were either standardized or researcher constructed test, were mixed with 17 showing a positive relationship and 14 showing no relationship. These studies with no relationship according to Hammond (2000) had little variability in the teacher knowledge measure that insignificant findings were almost inevitable. Hill, Rowan and Ball (2005) investigated effect of Teacher 'Mathematical Knowledge for Teaching on Students Achievement. The study explored whether as how Teachers' Mathematical Knowledge for teaching contributes to gains in Students Mathematical achievement. The study used a linear- mixed model methodology in which first and third graders' mathematical achievement gains over a year were rested within teachers, who In turn were nested within school. They found that teachers' mathematical knowledge was significantly related to students' achievement gains in both first and third grades after controlling students as leader level covariates. The result was obtain via a measure treating on specializes mathematical knowledge and skills used in teaching mathematics. This finding provides support for policy initiatives designed to improve students' mathematics achievement by improving teachers' mathematical knowledge.

However, the current study intends to examine the Impact of Van Hiele's geometric models on the geometry teacher pedagogical preparation and his/her students' performance in the geometry. Also, performance test in geometry and instructional units in geometry was used to find-out if any difference between the junior secondary students' subject matter content knowledge and NCEII Mathematics students' Preparation in Geometry pedagogy exists. However, the current study will not look at the NCEII Mathematics Students' competence in terms of their pedagogical ability grouping, but the study will examine them on the basis of their competences in geometry teaching and its Impact on school location, school type and gender.

In a related studies, in the area of teachers' knowledge of teaching and learning, studies have shown that, there was a stronger and more consistent positive influence of education course work on teachers' effectiveness. For instance, Lenhart (2010). Study on the Effect of Teacher Pedagogical content Knowledge and the Instruction of Middle school Geometry. The purpose of the study was to s determine the relationship between middle school mathematics teacher Pedagogical Content Knowledge and Instruction of Middle School Geometry. Data were collected through Teacher Assessment and Students Learning Score. Nine Middle School Mathematics Teachers at two rural schools were assessed for their pedagogical content knowledge in Geometry. A Pearson Product Moment Coefficient Statistical test was used to compare teacher Assessment score of each pedagogical content knowledge level with student standard of learning mathematics score. The result showed that there is a relationship between teacher pedagogical content knowledge and students' standard of learning scores in geometry. However, the focus of the current study is on geometrical pedagogical ability of NCE II mathematics students and it's Impact on JSS students. The difference between the study by Lenhart (2010) and current study is in terms of sample size and statistical test used. With this limited sampled size, the findings of the study need to be revisited.

In another related report by Jones (2000), on Teacher Knowledge and professional development, it opined that, the successful teaching of geometry depends on teachers knowing a good ideal of geometry and how to teach it effectively. The report provides a review of what is known about teacher knowledge in geometry, how the knowledge development can be supported by professional development. The available evidence suggests that attention could usefully be paid both to the initial and continuing education of teachers of mathematics in terms of their background and understanding of geometry. Therefore, the current study is linked with that of Jones (2000) in terms of the purpose that focus on NCE II mathematics students pedagogical knowledge on Geometry and the Impact on their Instructional practice at the initial level of teacher preparation.

Judging from the literatures reviewed, it seems that, the maximum and equal benefits to be derived by the NCE II Mathematics students from the three major domains of their teacher preparation has not been adequately demonstrated in their instructional practices as reflected in the students poor performance in geometry examinations. It is in the light of this that the present study intends to obtain empirical data on how van Hiele's geometric model in geometry influence the NCE II Mathematics students pedagogical abilities in geometry and its impact on junior secondary school students performance.

2.7 Mathematics Teacher Preparation and Teaching Practice

Teaching Practice exercise is considered to be an important aspect of teacher Education Preparation in Colleges of Education. Hence, the most important crucial factors in the teaching practice exercise for the prospective teacher is the preparation. Preparation include the practicalities of classroom, performance standards, personal ideals and other educational concerns, hence the job of reconciling the numerous

requirement and possible conflict seem to be overwhelming. In this era, where science, technology and Mathematics are basic and fundamentally important to human live and existence, the training of teacher that impact the requisite knowledge in the teaching activity particularly at preparatory stage (Teaching Practice) must be equally regarded as very important matter that deserves every attention. Adedibu and Olayiwola (2007) reported that the preparation of qualified, competent and committed STM teachers which ought to have dominated the education scene was neglected and was not given the right attention. Hence, the emphasis on the FRN (2004) which identified the needs to accords teacher education its rightful position in the scheme of things.

Teaching Practice could be define as that period of practical experience in which the teacher trainee is exposed to understanding students, teaching techniques and procedures carefully concerned and directed to develop a degree of expertness. Student teaching practice exercise is to the Prospective Teachers what internship is to Medical Doctors. Thus, it gives the Teacher trainee an opportunity under guidance and supervision, to put into practice the theories and principles of Education that has been learnt to teach the core leading subjects. Also, it is the bedrock on which foundation of the Professional training of teachers is built (Landu, 2002).

Therefore, the objectives of teaching practice as identified by Sule and Chatta (2007) include:

i. Inculcating in the student teachers the basic teaching skills and ethics which facilitate the teaching and learning process.

ii. Provide the student teacher an opportunity, to imbibe practical classroom life experience.

iii. Identify their strength and weakness in lesson preservation while thinking of

iv. possible means to improve their teaching capacities.

v. Facilitate the exchange of innovative educational ideas between student-teachers and educators from participating teacher training institutions, and co-operating schools.

vi. Provide an avenue for the student-teachers and their supervisors to translate theory into practice.

vii. Expose the weakness in teacher-training programmes to the educators for prompt correctness and improvement.

Though, several researchers and from the researcher's experience in College of Education, it could be argued that the organization and conduct in the standards of practical experience acquired by the prospective teachers in general and Mathematics Education in particular are inadequate. Research findings have identified the following

i. Period of Teaching Practice: Six weeks period of teaching practice is grossly inadequate for any meaningful exposure to practical aspects, that a great majority of teacher trainees does not have the rudimentary skills to effectively impart knowledge to the learner.(Ali, 2000. Akinsola,2002; Landu ,2002;, Tahir 2006; Sule and Chata,2007)

ii. period of teaching practice as grossly inadequate for any meaningful exposure to practical aspects and supervision of teaching practice students carried out.

It seems that, the method courses used to contain both theory of instruction and practical in terms of micro teaching and teaching practice. The activities that could be packaged for 3-4 hours methods course cannot be satisfactorily completed because of time frame factor. Time is linear and is never adequate. Also, time frame factor is a proximal factor that is very close to instruction. This implies that the needed pre-service experiences will not be adequate. Teachers' knowledge of the subject matter content of a discipline has influence on students' achievements (Hill, Rowan and Ball, 2005). However, this is a necessary aspect of teacher education, but not sufficient component

of the programme. Mathematics teachers could be good solvers of problems in Mathematics, but the same teachers may not know how or when to engage their students in problem solving or able to design or select appropriate problems. The transition from the learner of Mathematics to a teacher of Mathematics is complex and deserves more attention than it presently receives in Mathematics teacher education.

In a related study by Ding and Jones (2007), using van Hiele theory to analyze the teaching of geometrical proof at Grade 8 in Shangai reported the appropriateness of the Van Hiele Model of teaching 'phases' within Chinese context. The analysis indicated that though the second and third van Hiele teaching phases could be identified in the Chinese lessons, the instructional complexity of, for example, the guided orientation phase means that more research is needed into the validity of the van Hiele phases of teaching. However, the purpose of their studies is, to analyze the appropriateness of van Hiele Model of 'teaching phases' within Chinese context, and to see how well the model characterizes the observed' teaching in order to explain how a successful teacher teaches what is by all accounts, an aspect of Mathematics that is very difficult for many students at schools. Therefore, in relation to the current study, the purpose is to determine the influence of van Hiele phases on NCE II Mathematics students' pedagogical abilities and determine its outcome from junior secondary school students' performance in geometry using Nigeria's context.

A related study of Olaoye (2007) investigated the extent to which students of Mathematics Education in Colleges of Education are skilled in Mathematics and its pedagogy. The study revealed that, students mean score of 44% fell below credit level that could be judged skilled in the subject. This he said could be traced back to the training level and lack of the topic pedagogy. Therefore, these showed the need to investigate the NCE II Mathematics students understanding of concepts, principles and

skills in geometry using van Hiele Model at Colleges of education and relating them to their pedagogy so as to influence students' performance in geometry.

2.8 Gender and Mathematics Achievement

What has continued to receive attention in recent times in education industry is the issue of gender especially in science, Mathematics and technology. The debate of gender performance in Mathematics and sciences is inconclusive. The term gender is important in STM because it describes the social definition of sex roles rather than distinct biological distinction itself, STM is seen as subject of the male and for the female. Wasagu and Rabi (2007), rationalizes the need to have women in the field of science. Indeed, they said in the ultimate and programmed society of the future, special talent and abilities of the women will be very necessary in order to carry out highly skilled jobs requiring advanced level of education in Mathematics, science and technology. Where women are denied this, they will loose out in the labour market. Further more, if developing countries are to continue to advance in the area of science and technology through increase of personnel in science based occupation, women need to be there, contributing their own quota. In addition, the trends towards social, ethical and humanistic values of science demand that more women enter science-based occupation so that they can inject their caring nature into scientific practices. Consequently, they will help to alter the image of science from an impersonal call pursuit to sciences that focuses on men. So far, men seem to have pursuit science for power and conquest. With women in science based occupation, science would be more useful and interesting.

Thus, teaching in Nigeria cannot be completely described without mentioning gender. In Nigeria, teaching is classified as faminine profession. From the National Commission for Colleges of Education (NCCE) Digest of Statistics on Colleges of Education (2009). One may deduce two trends. NCCE (2009) Statistical Digest showed

two important trends in female enrolment at the tertiary education level. The study revealed that females are not up to half of the beneficiaries of higher education in any of the three kinds of tertiary institutions and indeed, there is a high proportion of female in colleges of education (a teaching oriented institution) than in either polytechnics or universities. The consequences of these are low participation in high education position and wider gender gap which slows growth for females. This has limited their employment opportunities and access to position of influence and limit their participation in, and their ability to shape Mathematics, science and technology. Similarly, Ocholi (2000) reported that, the low proportion of female in the study of science courses and science-based occupations and abandonment of teaching career by women has caused serious concern to science educators-in particular.

The role of females cannot be ignored in the current dispensation of attaining improved standards in scientific and technological development. Thus, Ekuri and Windapo (2000) reported that, statistical figures and students' enrolment in science, Mathematics and technology subjects from the secondary school level to Colleges of Education show a wide difference. For instance, the proportion of women enrolment in Mathematics and science in College of Education as at 1990/91 session stood at 32.8% and 37.9% respectively. Similarly, in the statistics for 1990/91 session, female graduates output in College of Education in science and Mathematics stood at 31.2% and 33.9% respectively. This result indicates females are under represented in science and Mathematics which confirmed the wide difference between male and female participation which seems to be lower than that of the males.

Similarly, in terms of school Mathematics performances, Olaoye (2007) reported the extent to which students in Mathematics education in College of Education claimed to be skilled in Mathematics and its pedagogy. His findings revealed that several Mathematics concepts was lacking among the students teacher in training but majority

saw teaching as a calling, an attribute of a profession. Also, comparing grades of males and females scores in their teaching practice, which are 59.73% and 56.56% respectively, shows a significant difference in gender performance in teaching practice. Thus, the multiply effect on the students handled by these teachers after training is the immediate implication. The current study intends to investigate the effect of gender performance in geometry and the extent to which effects of Van Hiele model in geometry pedagogy and NCE II Mathematics students influence their students' performance which has not been reported in any literature reviewed.

A related study by Daniel and Moses (2008) investigated gender difference in integrated science achievement among the pre-service teachers in Nigeria. It was a longitudinal study of integrated science achievement of graduating pre-services teachers over three years. Data were drawn from students consisting of 126 males and 127 females final year result from the college of education in Nigeria. The findings revealed that the gender gap in integrated science achievement among the sampled data could be disappearing. Thus, this finding was seen as a source of hope since the findings contradict the general Nigerian stereotype belief about males and females performance in integrated science. However, the difference between this study by Daniel and Moses (2008) and the current study is in data generated. The earlier study generated secondary data while the current study intends to generate primary data from specific area of Mathematics (Geometry performance) and teachers' pedagogical abilities. The similarity between the two studies is that, the same pre-services teachers in colleges of education were used. A related study by Chukwume and Modupe (2000) reported that apparent abandonment of teaching career by men for women calls for critical examination of gender disposition in Colleges of Education. In Nigeria, this study revealed that, women appear to be out numbering men in the teaching profession. There is gender streaming or sex separation by field of study especially in the sciences and

vocational/technical subjects. The suspicion of this disparity forces the study of this nature as the consequences has not been investigated in the study involving geometry and its Teachers Pedagogical ability in Colleges of Education.

Also, a study by Heather, Ozken and Serkan (2012), on the Effect of Teacher Gender on Student Achievement in Primary School; Evidence from a Randomized Experiment. Show that the Purpose of the study was to reconcile the Contradictory result found in the economic literature and the educational psychology with respect to the academic Impact of gender dynamic classroom. Specifically using data from a randomized experiment, looking at the effects of having a female teacher on mathematics test score of student, in Primary School. Findings showed that female students who were assigned to a male teacher without strong mathematics background suffered from lower mathematics test sore at the end of the academic year. This negative effect however not only seem to disappear becomes (negatively) positive for female students who were assigned to a female Teacher with a strong mathematics background. Finally, there was no effect of having a female teacher on male students test scores (math or reading) or female students reading test scores. To sum up, these findings tentatively suggested that in these two streams of the literature are intact consistent if one takes into account a teachers academic background in mathematics.

2.9 School Location and Mathematics Achievement

The issue of students' achievement in mathematics being influenced by school location is a controversial one. There is a substantial debate in literature about the positive and negative effects of school location as it affects achievement in mathematics. Specifically, according to Asim, Joshua and Bassey (2009) school location is a variable in achievement and rural students, who constitute the majority group in Nigeria tend to manifest more simple relationships than their urban counterparts, probably due to greater interpersonal ties in rural settings. Furthermore,

the popular culture views rural education as a deficit model while others hold the view that there is no difference between urban and rural education. The purpose of their (Asim et al, 2009) study was to verify the existence of or otherwise of gender inequality in the mathematics achievement of rural male and female students in Cross-River State, Nigeria. By stratified and random sampling, 2000 students were selected (50% male; 50% female) and a 30 item, four option multiple choice mathematics achievement test (MAT) was constructed with reliability coefficient using KR20 r= 0.87 and item difficult, $0.40 \leq p \leq 0.82$) and administered. The t- test analysis of significance revealed gender achievement gap in favour of the rural males.

In a study by Ibu, Ngban and Maliki (2009) reported that, mathematics is said to be a difficult subject. Also, students' performance in mathematics test has been observed to vary from person to person and from school to school. Therefore, the study sought to provide data on the performance of students in mathematics test as it relates to sex, school location (urban and rural) and school type (private and public). Inferential survey design was adopted for the study. The data used was junior secondary school examination test items in mathematics for the year 2006. The sample size of 600 randomly selected students of JSS3 in Bayelsa State, Nigeria was involved in the study. The state was stratified into 3 zones and four (4) schools were randomly selected from each of the zones making a total of 12 schools. Mean standard deviation and t-test for one sample mean was used as the statistical tool. The result shows that, students from rural school against all odds perform higher than those from urban schools. This revelation is in support of the argument that, urban schools shared common features of learning impediments such as reading retardation, high absenteeism, drug abuse, students, vandalism, apathy and over-crowding which have manifested in their poor performance. Their findings contradict the other side of the argument which says that urban schools are better staffed, with better facilities; students are exposed to good

study habits and are highly motivated to study with conducive learning environment. Consequently, these factors encourage the students from urban schools to perform better than those from rural schools. However, the current study intends to find out the effect of Geometrical Pedagogical Abilities of NCE 2 mathematics students in junior secondary school achievement.

Similarly, Reeves (2005) reported that the effect of school location on mathematics and science learning is currently an important policy issue in the United States and in the countries, such as Australia. Therefore, the goal of their study was to determine the effects of school location on learning in those subject areas. The study uses a 5 year series of mathematics and science achievement data from the state of Kentucky. An organizational approach was adopted to show how growth models may be used to estimate achievement trends. Also, the study demonstrates methods for discovering two important sources of invalidity in growth models: regression artifacts and spuriousness. Failure to account for these sources of invalidity may lead to erroneous policy conclusions. Two examples of growth models are provided, linear model and non-linear model. The result of these analyses does not support the popular view that there is a rural achievement gap in mathematics and science. The implication of the study is that, if policy makes wish to enhance mathematics learning, they will accomplish this more effectively by interventions and programmes that increase the motivation and opportunity to learn among low-income students, regardless of school location.

Also, Enukoha and Meremikwu (2010) in their study opined that, instructional aids, school variables aid pupil's achievement in primary schools in Cross-River State, Nigeria. The aim of their study was to determine the effects of the use of instructional aids, and school variables on pupils' achievement in both public and private schools. The study adopted quasi-experimental research design involving pretest – posttest

design. A random sample of 600 pupils was involved. The experiment groups were subjected to the treatment (teach with instructional aids). A 20 item multiple choice mathematics test designed by the researcher with reliability coefficient, 0.67(using split half method technique) was used to collect data. Data collected were analyzed using analysis of covariance (ANCOVA). The result showed that school was statistically significant in explaining pupils' mathematics achievement. Infact, in the urban areas, pupils' in the experimental group in private schools achieved significantly higher than their counterparts in the public schools. However, in the rural areas, the difference between mean mathematics achievement of the pupils in private and public schools was not statistically significant. However, the current study aimed at finding out the effects of van Hiele's Geometrical Model on the geometric Pedagogical abilities of NCE 2 mathematics students on junior secondary school students' performance/achievement in geometry as it affects school location. Therefore, quasi-experimental research design was adopted. The study involved both NCE 2 mathematics students doing the teaching of geometry and examining JSSIII students learning outcome in geometry as it relates to urban and rural students' school location.

2.10 School Type and Mathematics Achievement

In the early days, and especially in traditional Northern Nigeria Informal Education tended to separate girls from boys as the knowledge, skills and values given were extremely sex stereotyped. The trend was the case even when formal education was introduced, structured and became comprehensive. Education of boy child was given greater value than that of the girl. Although, there was a gradual extension of education to girl child. Girls were taught separately from boys, resulting in a predominance of single – sex schools. Consequently, schools found in our societies where the formal learning of mathematics started are categorized into two, namely, the single school boys only and girls only especially in the northern part of Nigeria. The

bringing of boys into girls was adopted over time due to civil pressure and advocacy for the recognition of equal rights of the girl child education, Benjamin (2006), Barmo, Mondoh and Bosire, (2008) . However, co-education became a normal system in education structures; it aroused intent interest among, not only educators but also thepublic at large. The rationale for this categorization according to Benjamin, (2006), (Barmo et al, 2008) cannot be unconnected with the issue of moral decadence, enrollment exploration and proximity to the learner's community. Most importantly, the rationale for these debate according to the literature cited above centered more on managing students discipline rather than on achievement issue. The question of whether schools differ significantly in impacting student academic achievement is essential in education. Hence, identifying school factors that make schools more effective is crucial.

Studies by Lubienski and Lubienski, (2006) on charter, private, public schools and academic achievement: New evidence from NAEP Mathematics data revealed that, issues of school sector were highlighted as an important consideration in student's academic achievement. In 2004, it was contested that charter school students scored lower than students in public schools. This contest resulted in the release of other studies which indicated that charter schools produce greater gains in student learning. Similarly, studies of students using vouchers to attend private schools ignited heated debates about whether or not those programme boosted students' achievement, especially for poor or minority students.

However, according to (Lubienski and Lubienski, 2006), common wisdom and past research holds that private schools achieve better academic results. Assumptions of the superiority of private style organizational models are reflected in voucher and charter programme, and in the choice provisions of the No child left Behind Act. According to this thinking, schools in the choice-based independent sector are the best model for improving achievement in public schools. Market-oriented school choice

reforms are premised on the idea that, by positioning parents as the driving force in the quest for quality, schools will be forced to improve when faced with competition from high performing rivals.

Similarly, from a study of a large comprehensive dataset on US students' achievement, substantial differences between different types of private schools were found base on the 2003 National Assessment of Education Progress (NAEP). On mathematics examination, analysis compares achievement in public, charter and different types of private schools. When compared with other subjects (like reading for instance), mathematics is more heavily influenced by school than home experiences. So studying mathematics achievement provides clearer insight into the relative performance of different types of schools. This result was obtained using complete raw data through advanced statistical techniques (i.e. hierarchical linear modeling) to study the relationship between school type and mathematics achievement while controlling for demographic differences in the populations served by the schools. Indeed, finding reveals that, private schools scored higher than non-charter public schools, without controlling for student background differences. Also in-depth analysis carried out to determine whether they are simple due to the fact that higher proportions of disadvantaged students were enrolled in public schools and extent to which the gaps persist after controlling for potential student – and school – level confounding variation, including meanings of socio-economic. The study demonstrates that demographic difference between students in public and private schools account for the relative high raw scores of private schools. Indeed, after controlling these differences, the presumably advantages, "private school effect" disappears, and even reverses in most cases.

Enukoha and Meremikwu (2010) conducted an investigation on instructional aids, school variables and pupil's Mathematics achievement in Primary schools in Cross-River State, Nigeria. The aim of the study was to determine the effects of the use

of instructional aids and school variables on pupils' mathematics achievement in both public and private schools. The study adopted quasi-experiment research design involving pretest – posttest with the use of instructional aid as the treatment for experimental group. School variables (school location and school type) were the main variables, while gender was the moderator variable. The administration of the treatment lasted for six weeks. A 20-item multiple-choice mathematics achievement test was used for data collection. Analysis of covariance was used to test the null hypothesis. The result revealed that pupils' mathematics achievement was significantly dependent on the treatment, school type and school location but not their gender. Also all the interactions of the treatment, gender, school type and school location were statistically significant in explaining pupils' mathematics achievement.

However, the purpose of the current study was to determine the effects of Van Hiele's Geometric Model on pedagogical abilities of Nigerian Certificate in Education Mathematics Students on junior secondary school students' geometry achievement by school type. The difference between the earlier study reviewed and this current study is in the cognitive development ability level of the subjects and statistical analysis. The similarities are in the school variables that is school type and school location. In Instrumentation, both studies used an achievement test (in mathematics and geometry respectively).

In a related study, Hassan (2010) investigated the effects of school type on visual perception of geometric shapes and performance of junior secondary school students in Minna Metropolis, Nigeria. The study was a survey type. A total of 370 (M = 186, F = 184) were randomly sampled from 13 junior secondary schools. Two instruments were used for the study, the geometric perception from the environment test (GPE) and test of geometric achievement (TGA) with reliability coefficient of 0.60 and 0.67 respectively. Data collected were analyzed using F– test statistics. Findings from

the study indicated that, significance difference exists in visual perception of geometric shapes and performance in geometry. Also, girls in pure girls' school performed better than boys in boys' school and mixed school. The similarities in the current and the earlier studies reviewed were in the school type, content area covered, instrumentations and cognitive level of subjects involved. The current study intends to find the effects of Geometric pedagogical abilities of NCEII Students on junior secondary school students' achievement in Geometry.

Similarly, Ibu, Ngban and Maliki (2009) carried out a study on the analysis of students' performance in junior secondary school mathematics examination in Bayelsa State, Nigeria. The research design adopted was inferential survey. The aim of the study was to find out the relationship between such variables as sex, school location, school type and performance. The subjects for the study were 660 randomly selected junior secondary school 3 students. Objective paper of 2006 was used as the instrument for data collection. The statistical tool used was mean, standard deviation and t-test for one sample mean and independent t-tests to analyze the data. On school type and performance, the result showed that students from private schools performed better than those from public schools. This could be attributed to the fact that, private schools are more integrated than public school and that private school produce better cognitive outcomes just as they control for student quality. The current study is similar to that of Ibu et al, 2009 in terms of the subjects involved in the study, the junior secondary 3 students and the statistical tools used in analyzing the data. However, the major difference were in the area of concept of school type (private and public) while the current study uses (boy's only, girl's only or mixed), the research design was quasi-experimental while the purpose was to determine the effects of van Hiele's geometric model on pedagogical abilities of NCEII Mathematics Students as it affects junior secondary school students achievement by school type.

2.11 Review of Empirical Studies in Geometry

To strengthen the current study other related works done both in Nigeria and outside Nigeria were reviewed. Thus, Jones (2002) and Mahwah (2007) cited the works of Clements and Sarama (2000) and reported that, the van Hiele model of the development of geometric thinking to consist of five levels of understanding, numbered 0 through 4. Hence, they suggested that another earlier level, pre-recognition exists; this level would indicate lack of attainment of the van Hiele's first level. Similar studies were reported by (Unal, 2005). However, their report does not include or emphasize pre-recognition level. The aim of this study was to investigate the effects of van Hiele's geometric model into NCEII Mathematics Students' pedagogical abilities, so as to create awareness on the van Hiele's phases of instruction. Also, to report if this has any influence on geometry teaching at secondary school levels. This perhaps, can enhance geometry understanding of the NCEII Mathematics Students.

In addition, Mahwah (2007) described some properties of the model (van Hiele model) and reported that three are of particular importance to the Mathematics teacher. They are:-

1. Students must proceed through the levels in order.
2. Students move through the level without skipping any level. Their progress from level to level is more dependent on the content and method of instruction than on age.
3. For learning to occur, instruction must occur at the level of the learner. If instruction is delivered at a higher level than the learner, the student will have difficulty following the thought process used. Therefore, they recommended that;

1. When it comes to children's knowledge of shapes, students need opportunities to learn. Having such opportunities is more important than waiting for students to reach a particular level.
2. In instruction and assessment tasks, the setting, including the collection of shapes, influences children's abilities to choose a shape in a collection.
3. Teachers should reconsider teaching basic shapes only through examples. Children need elaboration not just pictures. Teachers need to help children develop the language attributes and description of shapes.
4. Teachers need to be accurate in their statements. For example, the statement "two triangle put together always make a square", is not correct.
5. The use of a wide range of good examples and non-examples is important. Materials, both curricular and real-world, promote limited examples of shapes, that is, most triangles are equilateral or isosceles. Teachers should vary the size, material and color of examples as well as the orientation and dimensions. For triangles, it is important to vary the type that include scalene and obtuse.

6 Indeed, Mahwah (2007) acknowledged the importance of what teachers say in shaping children's ideas about shapes. Thus, she made several recommendations for teachers as they talk about geometric figures in the classroom with students which also are relevant to the current study. Thus, she classified them into Dos and Don'ts on triangle and rectangles as guide to Mathematics teachers.

1. The Dos:

a. Do say that triangles have three sides or line segments and three points or corners with all sides straight and all sides connected.

b. Do point out that triangle may vary in orientation, size, symmetry and 'pointedness'

2 The Don'ts are:

- Do not say that triangles have points at the bottom and one at the top.
- Do not say triangle have a point in the middle; have a flat bottom; are pointy; are like the open triangles used in music class or a cone-shaped clown hat; can be made from any three line segments.

Teachers should consider the following when talking about rectangles.

- Do say that rectangles have four sides with opposite sides congruent and have four right angles.
- Show students how to use a corner of a piece of paper as a 'right-angle checker'.
- Do not limit the definition to four sides only, as this statement will lead children to accept all quadrilaterals as being rectangles.
- All sides are connected and straight, and rectangles are symmetrical. Cutting rectangles in half and comparing the pieces or making rectangles by combining identical right triangles helps children understand symmetry. The corners of rectangles never vary, although rectangles can vary in size and orientation.
- Do not say that rectangles are long; have two long sides and two short sides; are like any three dimensional shape; such as a shoe box.

Another study by Ohakwe (2006), reasons for the poor preparation of Mathematics Pre-service teachers. He conducted his investigation using Primary Education / Mathematics, Mathematics / Computer Students in a college of education on MAT 111 and MAT 114 offered by these categories of students. In particular, MAT 114 (Basic Concepts in Mathematics) contains topics like Sets, Basic concept in geometry etc. The content of these courses contain the topics these students were expected to have done in Secondary Schools and also expected to teach the pupils/students at the Primary and Junior Secondary School levels after their graduation

in College of Education. However, the same trend of poor performance was observed by Ohakwe (2006) as the results have nothing to write home about. He concluded that, the reason for the poor performance of students in Mathematics is because the teachers themselves have misconception and gaps in their mathematical knowledge domains which are transferred to their students. At this juncture, Ohakwe (2006) recommends that, the mastery acquisition of the topics in Junior Secondary Mathematics curriculum contents and the methods of imparting them, which must have been mastered by the student-teachers, should also be looked into as this will create room for meaningful teaching and learning of Mathematics in our schools. He emphasized the need for the NCE II Mathematics Students to master various teaching techniques / strategies for teaching various topics in the curriculum. Therefore, it has become very necessary for this study to investigate the level of understanding of these pre-service Mathematics teachers on geometry and Van Hiele's geometric model and find-out if it has guided their understanding in geometry and pedagogical abilities. At the end, Ohakwe (2006) recommends the inclusion of mini-teaching which should either be introduced in Mathematics department or enshrined into MAT123 with credit inserted. This will give the lecturers the benefit of doubt of observing student's capability as regards to their effectiveness in handling these topics in their respective classes when they must have graduated from the college.

Karras, (2012) studied a Diagrammatic Reasoning Skills of Pre- Service Mathematics Teachers. The study attempts to explain a possible relationship between diagrammatic knowledge of pre- service mathematics teachers. Diagnostic skill involved a sequence of steps from visuality, to interpretation to formation, are all at the core of teachers content covered for teaching. Geometry is the only course in Mathematics curriculum that develops Diagnostic reasoning. A group of volunteers of teachers Representation were presented with "visual proofs" of certain theories and

asked to explain the theorem by diagnosing from diagram. The findings were analyzed with respect to the participants attained Van Hiele level. The study found that, participants who attained higher Van Hiele level were more skilled at recognizing visual theorem and ‘proving ’. The study found a correspondence between participants’ diagrammatic reasoning skills and certain behaviours attributed to Van Hiele levels. However, the vans Hiele levels attained by the participants was consistently higher than diagrammatic reasoning skills will indicate.

Similarly, a study of Bolaji (2000) investigated the effects of 2 medium of instructions on geometry. He investigated the use of Hausa and English medium in the teaching of geometric forms in Primary schools. The study revealed that, there was a significant difference in the performance on tasks of visual perceptions of geometric forms between English-medium and Hausa-medium in primary schools. Also, males performed better significantly than females in English medium and Hausa medium schools. These findings are significant to the current study in the sense that, the prospective Mathematics teachers in colleges of education are prepared to go and teach Mathematics in the primary school and Junior secondary schools after graduation. Furthermore, the education policy emphasized that; the medium of instruction at the junior classes of the primary school should be the language of the immediate environment. Therefore, these findings are applicable at that level and when adequately taken care of by the NCEII Mathematics student in geometry teaching and learning would lead to a better understanding and enhance higher achievement in geometry. It is in the light of this that, Bolaji (2000) opined that, in effect, improved geometry instruction in the public schools can only be guaranteed if the necessary facilities are provided by the government and adequate qualified teachers that will teach English as a functional subjects are sent to those schools.

Aburime (2003) conducted a study on geometrical manipulates as Mathematics resource for effective instruction in junior secondary schools. The basis of his study was the report by Ale (1989) in Aburime (2003) that, teaching problems constitute about 61% of the cause of failure in Mathematics and advance this as one of the reasons for conducting the investigation and by extension, with geometry as confirmed by van Hiele (1986). Hence, his findings revealed that, improvised geometrical manipulates when applied to geometry teaching and learning improved the Mathematics achievement of students. This affirmed van Hiele's geometric model which says the first two stages of cognitive development in geometry is enhanced through the use of concrete materials. Therefore, the study by Aburime (2003) is similar to the current study because NCE II Mathematics Students is expected to apply these findings during and after training as Mathematics teachers in primary and– Junior Secondary Schools. Therefore, geometry instruction to be more effective should involve an effective use of manipulates (geometrical) as a resource for improving geometry understanding.

Another literature report by Balakar (2006) reported an indigenous group called Mundurukui, who lived in isolated villages in several Brazilian states in the Amazon jungles. This group has no words in their language for square, rectangle, triangle or any other geometric shapes except circles. The members use no measuring instruments or compasses; they have no maps in their words for directions but are limited to sunrise, sunset, upstream and downstream. The Munduruki language has few words for number beyond five except "few and many" and even those words are not used consistently.

Yet, researchers have discovered that, they appear to understand many principles of geometry as well as American children do, and in some cases as well as American adults. An article describing the findings appears in January, 20 issue of science.

"Across cultures that live extremely different lives, we see common foundational sets of abilities". "And they are not just low-level kinds of abilities that human

shares with other animals but abilities that are at the centre of human thinking at its highest reaches". (Balakar, 2006).

To test their understanding of geometry, the researchers presented 44 members of a Munduruki group and 54 American with a series of slides illustrating various geometric concepts. Each slide had six images. Five of that were examples of the concept; one was not.

The Munduruki subjects assisted by a native speaker of Munduruki working with a linguist were used to identify the image that was 'weird' or ugly. For example, to test the concept of a right angle, slide shows five right triangles and one isosceles triangle. The isosceles triangle is the correct answer. In data that do not appear in the article but were presented by email from the authors, Munduruki's children scored the same as American children –64% while Munduruki adults scored 83% compared with 84% for the American adults.

The researchers also tested Munduruki with maps, demonstrating that people who had never seen a map before could use one correctly to orient themselves in space and to locate objects previously hidden in containers lay out on the ground.

The indigenous people were able to use maps to find objects, even when they were presented with maps at varying angles so that they had to turn them mentally to match the pattern on the ground in front of them. This was found particularly to be significant.

The idea that an understanding of geometry may be a universal quality of the human mind dates back, at least, as far back as Plato. In the menodialoque by Plato, written in about 480BC, he describes Socrates as he elicited correct answers to geometric puzzles from a young slave who had never studied the subject.

Do these findings among the Munduruki's confirm Socrates contention that concepts of geometry are innate? However, Bakalar (2006) reported that people learn

things after all just by living in the world. The Munduruki like all of us, do interact with 3D objects, navigate complex spatial environment and so on.

Instead, Balakar (2006) described an innate ability rather than an innate knowledge. "Our current thinking is that, the human brain has been predisposed by millions of years of evolution to internalize either very early on or through very fast learning, various mental representations of space, time and number' he explained. Therefore, he proposed that such representation provides a Universal foundation for the cultural construction of Mathematics. Balakar (2006) sees in these results evidence of the Universality of human thought process. "Geometry is centered no the development of science and the art" she said. "The profile of abilities that the Munduruki's show is qualitatively very similar to what we see in our own culture. This suggests that we are finding some of the common ground at the centre of human knowledge.

The significance of the findings to the current research could be seen from the following perspectives.

1. The theoretical framework:

The theoretical framework of the current study is focused on geometrical cognitive development based on van Hiele's geometric model. The current thinking in the field is the constructivist approach in which, every individual is capable of generating and processing information from the immediate environment and therefore is to some extent socially constructed as a result of individuals interaction with his/her environment. Therefore, every individual passes through the stages identified by van Hiele (1980) as reported by several researchers and Mathematics educationist irrespective of his cultural background.

2. Culture and geometrical thinking.

The revelations from Mundurukis is another evidence to buttress the fact that virtually all cultures have the potential to provide every individual with the ability to develop his/her geometrical thinking. Thus, many principles in geometry could be inferred from one's culture – a source to ignite human thinking in geometry. Probably reasons why researchers in the field do advocate use of available concrete relevant resources from the learners' immediate environment to enhance its understanding. Now using Mundunuki's case as a basis, the pertinent question to ask is how can differences in culture affect individual's geometric learning style as well as achievement in geometry?

Another study of Opadeyi (2005) reported that, geometrical probability is an important tool used in exploring different ways of equipping students to develop skills in problem solving. The techniques in geometrical probability follow similar pattern to those of scientific method as well as reflective thinking. It allows students to learn from their successes and failures, thereby resulting in real comprehension of facts since it permits the student's thinking in learning process. It is a technique that calls for the internal process of thinking/development of cognition. Thus, geometrical probability is replete with interesting problems that apply to all levels of general Mathematics, from elementary algebra, trigonometry and Calculus. Opadeyi (2005) posits that solving problems in geometrical probability require such concepts as finding the area of trapezoid, graphing inequalities or law of Sine. In addition, Opadeyi (2005) reported that a particular nice feature of geometrical probability is that its definition is very intuitive and can be presented in a short time, thus allowing students to begin working on significant problem immediately.

Opadeyi (2005) explained that, geometrical probability deals with probability on infinite sample spaces where each outcome of the experiment in question is equally likely to occur. It allow us to calculate the probability of an event occurring at random

in a single trial of an experiment by identifying the space with a geometrical region R and the event with a sub region *r* of R. In essence, to find the probability of success on a single trial experiment, we associate each outcome of the experiment with a point in a geometric region. A geometric region will be either a curve segment (one dimensional region) or a planar region (two dimensional regions). Once this is achieved, it is easy to see that an outcome of the real-world experiment occurring at random corresponds to a point being chosen as random in geometric region representing the sample space of the experiment. This mathematical experiment of choosing a random point in a geometric region is the mathematical model of the real-world experiment. Hence, each applied problem requires translating the situation into a mathematical model. Making such translation, they said lies at the very foundation of problem solving, and any additional exposure students can get to this kind of thinking will indeed be valuable.

However, the current study does not intend to investigate problem solving as a technique of teaching but, problem solving as a needed skill in every aspect of mathematical learning including geometry. Also, problem solving is a type of learning that calls for internal process of thinking, - cognitive development oriented. Therefore, Opadeyi's (2005) study is relevant since it has added to the ways to increase the NCE II Mathematics student's knowledge in geometry and instruction practices.

Another study by Agwagah (2005) said, one of the important aims of Mathematics instruction is to develop critical thinking skills in the learner, which enables him/her to live effectively in the society. However, many students graduate without developing this skill. The major factor responsible for this is the Mathematics teachers' lack of strategies for teaching critical thinking skills in Mathematics instruction, Agwagah (2005). She opined that a critical thinking skill implies very important information processing upon which future knowledge depends. She defined critical thinking as the intellectually disciplined process of actively and skillfully

conceptualizing, applying, analyzing, synthesizing and evaluating information gathered from or generated by observation, experience, reflection, reasoning or communication as a guide to belief and action. It entails the examination of these structures or elements of thought, Implicit reasoning leading to conclusions, implications and consequences, objections from alternative view points and frame of reference. Furthermore, critical thinking is not a single skill but a battery of skills. It is an ability to distinguish between facts and opinions, draw valid conclusions from data, identify assumptions underlying conclusions, identify limitations of given data; ability to speculate, imagine and see connections among ideas. All these are cognitive demands made in learning Mathematics.

Consequently, Agwagah (2005) said, there are some topics or concepts and techniques in Mathematics that effectively and easily aid development in critical thinking which include geometric proof in geometry learning. Therefore, geometry learning and its teaching equipped the learner with critical thinking skills. It is as a result of this that, Agwagah (2005) recommends that teachers should regularly engage students in critical thinking and reasoning in the classroom. The responsibility of Mathematics teachers ends when he has taught his students the fundamentals of critical thinking and when he has taught them to apply these skills in a wide variety of instances in mathematical field.

Another study of Iji and Harbor-Peters (2005) reported that, one may therefore; associate poor Mathematics performance by Nigerian students to some pedagogy adopted by the teacher. They reported that, instructional strategies adopted by the teacher affect the cognitive, affective and psychomotor outcomes of the learner.

In addition, Iji and Harbor-Peters (2005) stated that, instruction can be organized in such a way and manner that all students in a class can succeed at a high level. At present, only good students accomplish this. The impact of Bloom's statement

psychologically stimulated teachers to search for ways which are likely to promote the learning of Mathematics for both high and low ability students. Therefore, Iji and Harbor-Peters (2005) recommend a feasible and practical ways that would improve instructional strategies and achievement in those three domains. Furthermore, they emphasized the need for re-examination of instructional strategies in the nation's educational institutions. The current study intends to investigate or re-examine application of van Hiele's geometric model in geometry and instructional practices of NCE Mathematics Students in our Colleges of Education.

Similarly, Iji and Harbor-Peters (2005) conducted an investigation on the effect of logo and Basic programming on the achievement in geometry of Junior Secondary School students. From their study they recommend the following which are relevant to the current study.

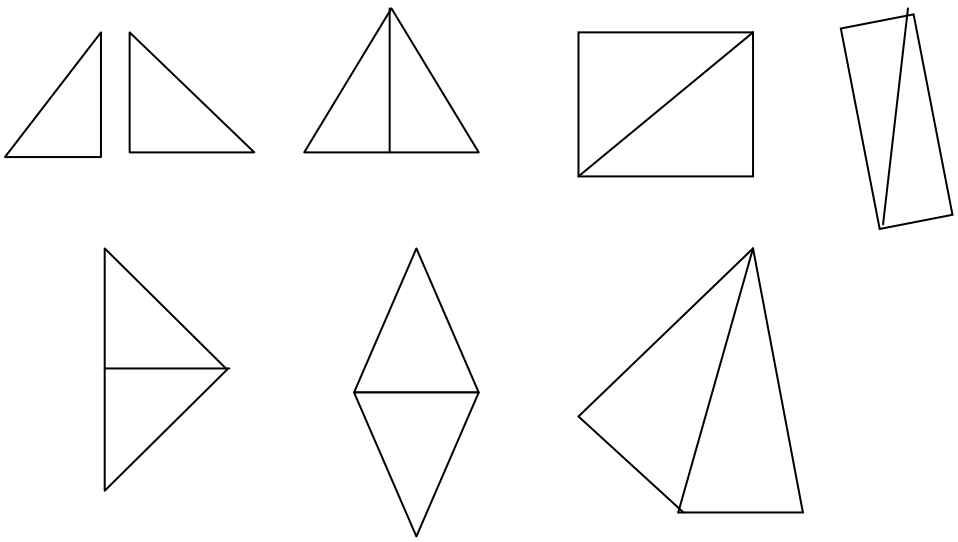
I. The effects of logo and Basic programmes on the achievements in geometry appears to be relatively new, they should be incorporated into Mathematics curriculum for the pre-service teachers programme. This may help them to learn and use LPM and BPM in their teaching.

II. Workshop should be organized for in-service Mathematics teachers to enable them incorporate these methods into their teaching.

In a related study, Fujita, Jones & Yamamoto (2004) in their paper on the role of intuition in geometry for students in lower secondary schools reported some innovative geometry teaching discovered in the early part of the 20^{th} century, a time when significant efforts were made to improve the teaching and learning of geometry. According to Fujita et al (2004), intuition occurred in geometry learning when an attempt is made by the Mathematics teachers to make students or learners to 'see' geometrical figure and solids by creating and manipulating them in the mind to solve problems in geometry. They adopted historical approach to report their findings from

the analysis of writings by P. Treutlein (Germany) and a text work by C. Godfrey (England), who acted to improve the teaching of geometry in the early 20th century. In UK, it was agreed that a practical and intuitive approach should be introduced in the early stages in geometry teaching in secondary schools, since students would attain the foundation of skills to tackle geometry based on deductive proofs in later stage. In geometry, Klein, F advocated that Mathematics in schools should be recognized from a 'functional thinking' point of view. This, practical and instructional approaches were considered important for learning geometrical concepts. Example is treutlein's Geometrical Intuitive Instruction.

According to the instruction, the teaching of geometry was organized for students aged 10-12 years and comprised the practical study of plane and solid geometry. Treutlein argued that it was very important to train student's imagination through studying geometry. Thus, this instruction aimed at developing spatial intuitive skills, which he considered as essential in geometry as well as in everyday life. Treutlein attained this aim through an example on the formation of new figures where



where students were required to make new figures by using triangle. Therefore, doing this by the learners allow them to manipulate figure in their heads. These tasks aim to achieve the developmental introduction of new figures and an utmost stimulation of

students' spatial imagination. As they turn figures, reflections of concepts are involved which enables them to of think about plane figures in space. Furthermore, studying of the air cubes by the students help them in the development of their' imaginative skills.

However, he recommended first studying of concrete models of a cube. Students were required to imagine 'air cube' by using their hands to undertake tasks, such as finding parallel sides, relative position of sides, etc. Treutlein considered that students' geometrical image would be further enriched through activities with 'air cube' after studying concrete models of cubes. An interesting feature in Treutlein's instruction is that, the teaching of geometry be started from concrete models of figures rather than observations of things in everyday life to develop spatial intuitive skill. He advanced the following reasons to support his arguments. Firstly, such things would disturb students' concentration and secondly, students would not find geometrical figure in the things unless they had image of such figures already in their minds. That is to say, the things in everyday life could not be "outer intuition", which would then directly form inner intuition in students' mind. Therefore, Treutlein hypothesized that unless students have the image of figures in their minds, they would not be able to find figure in things in everyday life. He concluded that, the teaching of geometry should start with models of figures, and that it was appropriate to give students the tasks by using the 'air cube' or making new figures, which would create inner tuition in their minds.

Another example is on how to develop students' intuition is the work of GODFREY'S GEOMETRICAL 'EYE' (1876-1924).

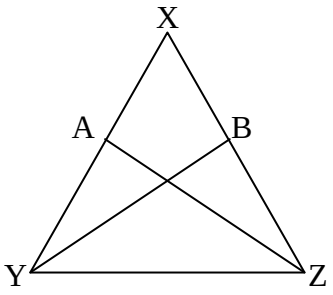
Godfrey's text in geometry became one of the most popular texts in secondary schools at the time in England. Elementary geometry consists of two parts: Experimental geometry and Theoretical geometry. To him, Experimental geometry aimed at consolidating concepts of geometrical figures as well as leading students to discover various facts in geometry. This mainly contains experimental tasks such as a

measurement or drawing dealing with both plane and solid figures. Godfrey's pedagogical backgrounds are based on the objectives that mathematics could provide us with an opportunity to develop deductive reasoning. He observed that, a sensible blend of experimental, intuitive and intuitive approaches should be achieved in the teaching of geometry. In relation to 'intuition', it is interesting that he distinguished experimental and intuitive approaches; as provided in the following example.

Experimental and intuitional methods are not identical…. Take the equality of vertically opposite angles. If I measure the angle, I am proceeding experimentally; if I open out two sticks crossed in the form of an X, and say that it is obvious to me that the amount of opening is equal on the two sides, and then I am using intuition. Fujita et al (2004).

What Godfrey attempted to describe is that, we could 'see' properties without depending either on actual measurements or deductive reasoning, but on intuition. Also, Godfrey's concept of geometrical eye is clarified as that; we need to exercise logical power as well as geometrical power; for solving Mathematical problems. Geometrical power is the power we exercise when we solve a rider (a difficult geometrical problem or proof). To develop this geometrical power, Godfrey argued, it would be essential to train each student's geometrical eye, which is defined as the power of seeing geometrical properties of figures.

Example: If A, B are the mid points of the equal side XY, XZ of isosceles triangle, prove that AZ = BY



Isosceles triangle XYZ

In tackling this problem, one would not be able to prove that AZ = BY unless, first of all, they could be seen clearly to be congruent. Godfrey stated that this kind of proof is creating proper images in the mind and would allow them to solve geometrical problems. In conclusion, both the earlier innovative geometry teaching of Treutlein and Godfrey suggested that, it would be essential to develop the skills first, to create and manipulate geometrical images in the mind, and then to apply them to analyze geometrical problems. They also suggested that such skills should be actively developed through appropriate tasks in geometry.

The approaches proposed by Godfrey and Treutlein are appropriate to the current study especially in geometry, which is an area of Mathematics in which intuition is frequently utilized. Research works of van Hiele (1986) did report models about the role and nature of geometrical intuition. However, views vary as to how intuition might help or hinder the learning of geometry. Piaget or van Hiele considered intuitive thought as important in their models of the early stages. Others tend to recognize the importance of geometrical intuition in the later stages.

Also, recently educators have suggested that intuition would have crucial roles in the teaching and learning of geometry. For instance, Fujita et al (2004) proposed the notion of 'figural concept' he said, sphere can be described as having intrinsic conceptual properties. It is not solely a concept, it is an image too, it possesses a property which usual concept do not possess, and namely, it includes a mental representation of a space property. Hence, notion of figural concept; geometrical reasoning is characterized by interaction between these aspects, the figural and conceptual. Also, Fujita et al (2004) Suggest that diagram can be thought of as a means. First and foremost for awakening mental imagery and, secondly, as ways of

augmenting, extending and strengthening mental imagery and hence mathematical thinking.

Similarly, Fujita et al (2004) reported that visualization in geometry suggests that the prerequisite to that is the ability to take a figure apart in the mind, see the individual elements, and make sufficiently good conjuncture about their relationships to guide the choice of further experimental and analytical tools. The interesting future of these earlier studies is that 100 years ago, these approaches were utilized and today they are still very relevant to the teaching and learning of geometry. Yet, the teaching and learning of geometry is not encouraging in our schools. However, they did not provide research evidence to show the extent to which Mathematics teachers have made effort to incorporate such innovative ideas into the teaching of geometry. Therefore, there is need to investigate how NCE II Mathematics students in cooperate such innovative ideas into their teaching of geometry during the period of training and after graduation for the improvement of teaching and learning of geometry.

A study by Jones, Fujita & Ding (2004) on the structuring of Mathematics lessons to develop geometrical reasoning, comparing lower secondary school practices in China, Japan and United Kingdom revealed that Achievement in Mathematics has been the subject of considerable international comparative research which mostly focused on pupil achievement as well as examine teaching methods, curricular, etc. According to Jones et al (2004), the central role of teachers and how they structure their lessons has emerged as a key factor in learning. They reported that, several projects have examined the structure of Mathematics lesson either to typified individual lessons in specified countries or as an attempt to describe the variety of lesson structure used by particular teachers in particular countries over a sequence of lessons. Also, they reported that, there has been little comparative work specifically on how teachers structure Mathematics lessons to develop geometrical reasoning despite the issue of how to

improve geometry teaching, considering its role in developing students' power of reasoning.

Deductive reasoning is central to Mathematics and intimately involved the development of geometry, providing a meaningful experience of deductive reasoning for students at school appears to be difficult, Jones *et al* (2004). Invariably, research shows that students fail to see the need for pupils to distinguish between the different forms of mathematics reasoning such as explanation, argument, verification and proof. Also, Jones et al (2004) opined that, lower secondary school curriculum provides a vital step in the learning process in geometry, when students begin to develop more sophisticated ideas of shape and learn to reason about angles and lines, probably in terms of short chains of deductions. Their study aimed at finding answers to the following questions:

1. What aspects (routine procedures, Mathematical thinking, learning precise Mathematical words etc) are important in geometry for teachers in different countries?
2. What problems for students do teachers pose (to develop reasoning) and why?
3. What approaches (individual or group) are used and why (to develop reasoning)?

In an attempt to answer these questions, they came to the conclusion that two major objectives of their research are:

1. Determine what influences how teachers structure their Mathematics lessons in the three selected countries of study.
2. Analyze selected suggestions that are available to teachers in the three countries to guide them in structuring geometry lessons for lower secondary school students.

Also, their study revealed that, it goes without saying that a range of things are likely to influenced the ways in which Mathematics lessons can be structured. Those that are

likely to influenced structuring geometry lesson include examinations, curriculum, textbook, etc.

In summary, mathematics teachers are likely to select a considerable quality of exercises as one of the class teaching strategies. Consequently, completing exercises is a main feature of Mathematics lessons. Also national textbooks are the most essential teaching and learning materials i.e. teachers usually plan lessons by referring to the textbooks. In addition, Mathematics lesson in china comprises the follow segments;

1. Introduction/Review/Experiment (about 5 minutes)
2. The teaching of new content (about 25 minutes)
3. Exercises on the content introduced (about 10 minutes)
4. Home work assignment (about 5 minutes)

China is a country with an extensive teaching tradition, teaching practices in China continue to be influenced by the ideas of Confucius (551-479 BC) and by text written in subsequent centuries. The distinctive character of Confuciunism in respect of learning is to ask question, constantly and to review previous knowledge frequently.

In Japan, the course of study only specifies the Mathematical content that should be taught, and preferably lesson structure. Rather than the design of textbooks, the occurrence of lesson studies, plus research into the learning and teaching Mathematics have all influenced how teachers structure Mathematics lessons in Japan. The design of Mathematics textbooks is that, Mathematics facts studied in lessons often do not come first, but they are shown after students fully understand them through various problems solving situation. Teachers work in small teams, carefully and collaboratively crafting lesson plans. However, lesson structures in Japan still vary and depend on teachers, students and material used among others. The characteristics of each area of Mathematics affect the ways teachers organize their lessons. It seems that Japanese teachers have a common view that the ‘Summing up’ stage, which summarizes facts

learnt in lesson, is very important. By the time that students reach this stage, they have spent considerable time investigating or thinking through the facts for themselves and that often is done through example, undertaking problems, discussions and so on, rather than routine procedures.

In summary, lesson study is one of the most common forms of professional development in Japan. This involves;

1. Formulating goals for student learning and long time development
2. Collaboratively plan a research lesson designed to bring to life these goals.
3. Conducting the lesson, with one team member teaching and others gathering evidence on students learning and development.
4. Discussing the evidence gathered during the lesson, to improve the lesson, the unit, and introduction more generally.
5. If desired, teaching the revised lesson in another classroom study and improving on it again.

Through these Japanese teachers develop view point about "good lessons of Mathematics" in summary this entail: Reviewing the previous lesson, presenting the problems for the day, students work individually or in group, discussing solution method, and highlighting and summarizing the main points.

In the United Kingdom, it was only relatively recently that there has been 'official' guidance for teachers of lower secondary school Mathematics about how they might structure their lesson. However, Jones et al (2004) suggested that certain teacher behaviours and certain ways of structuring lessons appear to correlate with high pupil achievement in Mathematics as well as in other subjects. An example that has influenced mathematics classrooms was the Missouri Mathematics effectiveness project conducted by Good and associate in the late1970s. In this project, a lesson format was

designed based on research findings, which elementary teachers were trained to implement. The lessons were structured for the teachers in four parts as follows:

1. Daily Reviewed.
2. Development
3. Individual work

4 Set homework assignment- Jones et al (2004) highlight this model as providing an example of particularly effective teaching. Indeed, it is their view that a technology of teaching and adequate teaching can be identified pragmatically through research evidence. In 2001 in England, a 'national strategy' was launched for key subjects for lower secondary schools, including Mathematics. In the guidance to Mathematics teaching strategy, a model provides a 'typical Mathematics lesson'. These consist of:

1. An oral and mental starter.
2. The main teaching activity.
3. A final plenary to round off the lesson.

In summary, research in the teaching and learning of Mathematics is another factor that influences how teachers structure their lessons in United Kingdom. The open ended approach is often used. These involve the situation in which the teacher gives the student a problem to solve in which the solutions are not necessarily determined in only one way. This approach helps to engage students in mathematical thinking such as finding properties, patterns and generalization or reasoning through the open ended problems. For example, there are parallel lines L and M; drawing other lines that intersect those lines produces many figures. Find how many properties of the figures are possible which holds whenever the lines intersect the parallel lines. Therefore to use such approach, considerable time must be devoted by the teacher. Hence the following are essential in designing open ended approach problem

1. An oral and mental starter.

2. The main teaching activity.

3. A final plenary to round off the lesson.

Jacobson and Lebrer (2001) cited in Pusey (2003) conducted professional development research with four elementary teachers on students understanding of arithmetic. Two of the teachers attended seminars addressing children's ideas of geometry and space. Clean discussion of students' conversations and the teachers questioning were videotaped from both set of classes. Student also took an eight-item test on transformational geometry at the end of the unit and again a month later to assess retention learning. They reported "the two classes in which teachers were more knowledgeable about students' thinking about space and geometry. The result showed that the students learn more than their counterparts, and difference in learning was maintained over time. This no doubt supports keeping teachers' abreast of learning theories like the van Hiele model, which has made a difference for class room teachers and their students.

In a study by Sharp (2001) as report by Pusey (2003) examined the effect of a professional development course offered to 11k-7 in service teachers through distance education. She was interested in giving teachers' the opportunity to experience a constructivist setting as learners. This is because many teachers have not gotten this kind of experiences in their own school. Therefore, her goal was similar to the current study because she aimed at helping them improve their content knowledge of geometry and model what she considered to be an effective teaching practice. An additional element of the course included exposure to the van Hiele model of learning, and helping teachers recognize various levels in their own thinking as well as the thinking of their students.

Throughout the course, teachers participated in a variety of activities during class as well as on their own. In particular, the teachers had the chance to investigate

geometry through the use of manipulatives. Teachers were responsible for reading assignments that were related to geometry content (various text books) and research on students learning. Class sessions consisted of discussions in which teachers recognized each other's level of van Hiele's reasoning and shared classroom experiences of analyzing their students reasoning. Finally, the teachers planned and carried out van Hiele lessons noting the level of reasoning demonstrated by their students. These lessons were followed up with appropriate additional questions for students based on the previous level ascertained.

The results were self-reported by participating teachers with the following themes. All participants felt they had grown in their understanding of geometry. Seven of the teachers admitted they had better attitudes about geometry in general as well as increase enthusiasm for teaching geometry. All but one perceived students learning of geometry differently based on knowledge of van Hiele model. Sharp(2001) in Pusey(2003) attributed these changes to the course emphasis on teachers analyzing van Hiele levels as well as the experiences which improve their content knowledge of geometry.

Halat (2008) in his study attempted to find and compare the pre-service elementary school and secondary Mathematics teachers reasoning stages in Geometry. A total of 281 subject participated in the study. This involved 125 elementary school teachers and 156 secondary Mathematics teachers. The researcher employed a multiple choice geometry test. t-test statistics was used to analyze the data at $\alpha = 0.05$. The study revealed that there was no statistically significant difference in reasoning stages between the pre-service elementary schools and secondary mathematics teachers, and that there was a difference in van Hiele levels between male and female pre-service secondary mathematics teachers favouring males, there was no sex related difference found between male and female pre- service elementary school teachers.

In a study by Adolphus (2011) reported that students shy away from the study of mathematics. Hence, the need calls for an investigate on the problems of teaching and learning of Geometry in secondary schools in River state, Nigeria. Therefore, the study aimed at identifying and proffering solutions. Two research questions were raised for the study. Data were collected by means of two different Likert scale questionnaires administered to 300 hundred student and 30 teachers drawn from 10 secondary. Simple mean was used to analyze the data. The study shows that, the foundation of mathematics in Geometry was poor. The students have poor background in mathematics. The teaching and learning environment is not conducive. Consequently, the study recommended among others that the State Government should as a matter of urgency send mathematics teachers for training and seminars for effective teaching and learning geometry.

Similarly, Sandt (2007) conducted two year investigation of pre-service teacher and student knowledge of grade 7 geometry using van Hiele theory and acquisition scale of Gutierraz Jaime and Fortuny (1991). The result revealed that both teachers and PTs fail to reach the expected level of geometry thinking and degree of acquisition. A relationship between student learning and the pre-service teachers education and years of experience seems to exist. Pre-service preparation programmes had no significant impact by either maintaining or positively impact on the already attained though level. Result may hold implication for pre and in-service training. Features of an improved program are suggested.

2.12 Implication of the Reviewed Literature

In the last three decades, the changes in geometry were represented by two points of view; the first is the epistemological which considers geometry as a deductive knowledge and socio-constructivist knowledge that depends on doing Mathematics by

discovering parallel modeling and visualizing. The second is a psychological view which describes the development of geometric thinking levels by the Van Hiele Model for reasoning. The rise of constructivism within the field of Mathematics Education has further enhanced the attention of psychologist and Mathematics Educators in terms of the process of Learning Mathematics. The emphasis was not only on general Mathematical thinking but also on thinking in specific content domains.

In Mathematics Education, the observation raised by van Hieles was that, school geometry that is presented in the traditional Euclidean fashion assumes that school children also think on a formal deductive level. But empirical evidence, however indicate that this is not the case, as many students experienced difficulty with geometry when it is presented in Euclidean way (Atebe, 2008 ;Wikipedia,2010). In response to many years of students experiencing problems with Euclidean formal axiomatic geometry, countries like United States, the Netherlands and Soviet began to advocate reform in the approach to school geometry in their Mathematics curriculum. Consequently, the changes that were put in place reflected the changes in didactics as a result of research work conducted in the 1950s by two Dutch Mathematics Educators, Pierre van Hiele and his wife Dina van Hiele-Geldof. Therefore, they conducted research on thought and concept development among their school children. Their work first came to lime light in 1957 in doctoral dissertation at the University of Utrecht. The van Hiele's geometric model identifies five sequential levels of thinking that learners pass through in geometry. Based on the model, the learner exposed to appropriate instructional experiences passes through these levels in a hierarchical order. Starting with recognition of shapes as a whole (level 1), progressing to discovery of proportion of shapes and informal reasoning about these shapes and their proportion (level 2 and 3) and culminating in a formal deductive and informs study of axiomatic geometry (level 4 and5). (Unal 2005; Atebe, 2008; Wikipedia, 2010). Also, five van Hiele phases

corresponding to cognitive levels were identified and recommended as instructional technique to be followed by the Mathematics teacher in any given geometry topic.

Since then western countries have conducted researches on van Hiele's geometric model to improve their Mathematics curricula. Atebe (2008) reported that only a few studies have utilized this model in an African context. In addition, in Nigeria Utilized the model involving randomly selected schools in Kwara state.

The available literatures reviewed could be categorized in to three groups.

1 The literatures/researches concerned with the testing of van Hiele theory itself. (Wikipedia, 2007; 2010);

2. The literatures/researches which focused on the verification and confirmation of the van Hiele's model (ie existence and hierarchy) are: (2005; Samara 2000; Unal, 2005; Sandt, 2007; Atebe, 2008; Halat &Sahin, 2008; Adolphus, 2011).

3. The literatures that focused on the Application of van Hiele's model that served as interventions and how to help teachers to improve content knowledge and their awareness of the theory are (Bolaji,2000; Hassan, 2010; Aburime, 2003; Jones and Yamatoto, 2004; Jones, Fujita and Ding, 2004; Inekwe, 2005; Opadeyi 2005; Agwagah, 2005; Iji and Habor-peters, 2005; Dindyall, 2007; Mahwah 2007 and Atebe, 2008). It should be noted that these categorization could have an overlap. Therefore, they should not be regarded as discrete compartments.

The third group is of major importance to this study when looked at from the perspectives of:

1. The advantages to be derived from applying a theory in a particular context through an intervention programme with the data/result obtained

from such applications could be a vehicle or means to improve the current situation. Many students are reported in research studies to perform poorly in geometry as a result of teachers' inadequate geometry content and pedagogical knowledge.

2. Application of the van Hiele's geometric Model in the context of teacher's preparation (intervention and awareness of the theory) at NCE level might give further insight to the phenomenon being studied. This could then inform either refinement of the existing theory or formulation of new theory. The current study is appropriately categorized in the third group because it seeks to determine if awareness of van Hiele's geometric model are effective in helping mathematics teacher preparation at College of Education level.

In many of such studies the idea was to identify a framework that could aid in assessing students' levels of thinking and their achievement in geometry domain, so as to facilitate instruction. The earliest framework in geometry was proposed by van Hiele. The van Hiele theory has been extensively used in studies to conceptualize students thinking in geometry at various levels as reported by the researchers mentioned earlier. Besides, in any form of Mathematics thinking, geometry thinking is quite difficult to conceptualize. It is definitely a form of Mathematical thinking within a specific content. Geometry according to Fujita et al (2004) is an attractive area in Mathematics and it can provide us with interesting and challenging course content which is run from primary to tertiary level. Therefore, Dindyall (2007) posits that geometric thinking is inherent in the type of skills we want to nurture in students. Dindyall (2007) proposed a set of five (5) basic categories of geometric skills relevant to school students:

1. Visual Skills: - involving recognition, observation of properties, interpreting diagrams, imagining, and recognition of different angles.

2. Verbal Skills: - Correct use of terminology and accurate communication in describing spatial concepts and relationships.
3. Drawing Skills: - Communicating through drawing, ability to represent geometric shapes in 2 & 3 dimensions, to make scale diagrams, sketch geometric figures.
4. Logical Skills: - Classification, recognition of essential properties as criteria, discerning patterns, formulating and testing hypothesis, making references, using counter examples.
5. Applied Skills: - Real life applications using geometric results learnt and real uses of geometry e.g. for designing packages.

Most of these studies reviewed only attempted to confirm the earlier theory of van Hiele models in geometric thinking among secondary school students in terms of readiness, stages of development and the acceleration of learning and achievement. Few studies report on the teachers' geometry understanding and the findings indicate that it is inadequate, while few attempted to investigate the teachers' geometric thinking. Many literatures mention earlier pointed to the fact that, continues poor performance of students in geometry could be linked to teachers inadequate understanding of the geometry content, and how to effectively develop students' skills in geometry themselves while on training. Consequently, their central role of developing geometrical skill and how to structure their lessons to develop geometrical reasoning of their students has emerged as a key factor in pupils/students learning. Hence, their findings indicate the following as likely factors that influence instructional practices, namely: examinations, curriculum, textbooks, research in the learning and teaching of Mathematics, characteristics of each area of Mathematics, certain teacher behaviour, Jones et al (2004). According to Jones et al (2004) there has been little comparative work specifically on how teachers structure Mathematics lessons to develop geometrical reasoning as identified by Dindyall (2007) despite the issue of how to improve

geometry teaching. Therefore, there is the need to investigate on how to help NCE II Mathematics students structure their geometry lessons to develop geometrical reasoning in the course of training, particularly in their Teaching Practice/Internship.

Also, several research findings have continued to indicate that, subject matter content knowledge is the first necessary but insufficient condition for effective instruction, Tahir (2006); Adedibu and Olayiwola (2007); Olaoye (2007); Olorukooba (2007); Udogu et al (2007). However, the literatures reported above have shown that there is no-fussion between the content knowledge and the Pedagogical knowledge, since each aspect is treated as an entity. This was identified to be the central problem of the prospective teacher training in our Colleges of Education. Thus, Adedibu and Olayiwola (2007) opined that the recurrent low preparation of Science Technology and Mathematics teachers spells doom for our developmental efforts if not nipped in the bud. The teacher has the knowledge of subject matter, and the knowledge of various methods of teaching it but the knowledge of how to apply the method (pedagogy) to ignite geometrical reasoning from the students is reported to be weak. Findings of (Landu 2002; Tahir 2006) and a host of others said, these are particularly observed in the organization and conduct of teaching practice or internship, supervision and grading awarded to such NCE II students. Specifically, their studies attributed these weaknesses to the period of internship (6 weeks), Lecturers from different subject areas rate students not base on their areas of specialization. Consequently, structural comments were lacking and students did not ask them any questions for further clarification on the lessons taught. In other words, NCE II Students may/may not present the learning beyond students understanding. The reason is that, teaching is not appropriately sequenced for the students' learner to assimilate the learning material into long term memory. Therefore, Landu (2000); Ali (2000); Sule and Chatta (2007) came to the conclusion that, students in teacher Education have some naïve or intuitive knowledge

about epistemology and classroom practice. Such views may be dissonant with the approved knowledge about epistemology, and classroom practices. If this is the case and the learning environment is not properly organized to expose the weakness of such views, learning will be adequately affected. By implications, the way they approach their teaching after the period of apprenticeship will be adversely affected. This view is based on what was found to be common in Nigeria teacher Education institutes, "handling over" of recipes and theories about common practices to students by teacher-Educators. Going by this observation, it seems appropriate to say that, the journey towards Science Technology and Mathematics Education requires urgent investigation in our Colleges of Education. It is based on these facts that, the current study intends to find-out NCE Mathematics teacher preparation in Colleges of Education using geometry and pedagogical abilities as the focus of the study. The study intends to investigate how they structure their geometry lessons to develop the geometric reasoning, as reported by van Hiele's geometric model, with a view to improve on the teachers structuring of Mathematics lessons to develop geometrical reasoning. Precisely, most of these studies cited do not actually address this area at College of Education level in Nigeria.

Also, in the literatures reviewed on the issue of gender as it relates to Mathematics teachers and Mathematics teaching. Most of the research findings continue to indicate that, there is low proportion of female's enrolment in Science, Mathematics and technology in our Colleges of Education, Ocholi (2000); Ekuri and Windapo (2000); Wasagu and Rabi, 2007). This confirmed the wide difference observed between male and female participation in Science Technology and Mathematics Education. Also, there were available literatures on secondary school students' gender achievement which is an inconclusive debate as some literatures indicate that male perform better than female in certain areas of Mathematics including geometry where both sexes perform poorly, TIMSS (2003); Adeleke (2007); Few studies however reported that

female pupils/students perform better than males students in geometry. This stresses the need to investigate the effects of van Hiele's geometric model on pedagogical abilities among NCE II Mathematics students at Colleges of Education.

However, only few studies of Olaoye (2007); attempted to report the extent to which students in Mathematics Education in Colleges of Education (level) claimed to be skilled in Mathematics and Pedagogy. Their findings indicate that females had a low score in teaching practice. This would have a multiplier effect on the students handled by these teachers after graduation.

Therefore, there is the need to investigate the NCE II Mathematics students' preparation in Colleges of Education in the area of geometry pedagogy and its effect on junior secondary school students' geometry performance by gender, school location and school type, using van Hiele's geometric model.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The main objective of this chapter was to describe the research design for this study, the population, the sample and sampling procedure. It also outlined the instruments used by the researcher, validity and reliability of the instruments and administrative procedure. The chapter also described the pilot study conducted and the method of data analyses, which paved way for the main study.

3.2 Research Design

A quasi-experimental research design was adopted for this study. “impact of van Hiele’s Geometric Model on Pedagogical Abilities of Nigeria Certificate in Education Mathematics Students in Colleges of Education in Niger State”. 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). This is because, the two groups received or were exposed to the same MAT114 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 dependant variable measures (Geometric Pedagogical Abilities) 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 a similar class Junior Secondary School III students taught by the control group.

Table 3.1: Format for the Research Design.

E → X_1 → O_2

C → X_o → O_2

Keys

E = Experimental group

C = Control group

O_2 = Post-test

X_1 = Treatment

X_o = No treatment

Thus training programme on van Hiele's geometric model was given to experimental group and the other group did receive training in general teaching method. The performance in geometry of students in the classes of the NCE II Mathematics Students with knowledge of van Hiele's geometric model was subsequently compared with performance in geometry of students in the classes of NCE II mathematics Students without knowledge of van Hiele's geometric Model.

3.3 Population of the Study

The population for the study comprised all NCE II Mathematics Students in Colleges of Education in Niger State who had registered for the course, MAT114 during the 2008/2009 session. They were 478 (M = 333, F = 145), (source; College Department of Mathematics, 2010). Therefore, the target populations were the NCE II Mathematics Students in the two colleges of Education situated in Niger State namely, Federal College of Education, Kontagora and Niger State College of Education, Minna respectively. In Nigeria, colleges of Education are recognized as the initial teachers training institutions and National Commission for Colleges of Education (NCCE) as the

supervisory agency that controls the quality of students' intake and implementation of minimum curriculum standard in Teacher Training. However, as in most research studies, it is not always possible to meet all members of the target population, which is all NCE II Mathematics Students in Colleges of Education in Niger State. Table 3.2 shows the target population by gender as at 2008/2009 session. Also a sampled-population of 1,617 junior secondary school students were involved in the study. These population of JSS students geometry performance was reported in this study. These students were captured from 54 Senior Secondary School within and outside Minna Metropolis. That is Urban and Rural Senior Secondary School.

Table 3.2: Target population by gender in 2008/2009.

S/no	College	M	F	Total
1.	Federal College of Education, Kontagora	12	8	20
2.	College of Education, Minna	321	137	458
	Total	**333**	**145**	**478**

3.4 Sample and Sampling Procedure

A two-stage sampling procedure was used for this study. First a purposive random sampling was used to obtain the twenty (20) subjects. The purposive sampling was used based on the knowledge and experience of this group by the researcher, (Ali, 2006). The reason was that only twenty (20) students were qualified to go for teaching practice as at 2008/2009 session and, most importantly, the study involved observing NCE II Mathematics Students in their respective places of teaching practice. At the second stage, a simple random sample procedure was adopted using drawing from the hat method to arrive at forty (40; M=18, F=22) NCE II Mathematics Students from College of Education, Minna. At the third stage, another simple random sampling was conducted on NCE II Mathematics Students from College of Education, Minna to

obtain sixty (60) subjects for the purpose of getting another two groups based on gender. Experimental group received experimental treatment while the other group did not receive the treatment. Each group consisted of 30 subjects. This sample size of 30 was maintained using the central Limit theorem as supported by McClave and Sincich (2000) that, for most sampled populations, sample sizes of $n \geq 30$ will suffice for the normal approximation to be reasonable.

However, one hundred and twenty (120) subjects were observed in geometry lessons in their respective schools of practical teaching by the researcher with one research assistant each from Minna and Kontagora with corresponding 1617 Junior Secondary School Students by the researcher and one research assistance from Minna and Kontagora towns in Niger State, Nigeria.

3.5 Instrumentation

Two instruments constructed by the researcher were used for collecting data for the study. One is an achievement test on geometry (GAT, 'A') which was developed by the researcher based on the JSS Mathematics curriculum. While the second instrument is a rating scale ('GTPA') also developed by the researcher.

3.5.1 Geometry Achievement Test: GAT 'A'

This was constructed by the researcher using a set of objectives derived from the instructional units based on the contents of junior secondary school basic geometry using a test blue print as shown in table 3.3 below.

Table 3.3: Table of specification for geometric achievement test (GAT A)

Content	Knowledge	Understanding	Application	Total
Drawing/construction and visualization of geometric figures	2	2	1	5
Identification of geometric figures and their associated properties	5	3	-	8
Analysis of properties of geometric figures	1	4	4	9
Application of properties of geometric figures	-	2	6	8
Total	**8**	**11**	**11**	**30**

Table 3.3: Showed the proportion of questions asked on different levels of objectives and content areas for geometric achievement test. The test contained 30 (thirty) multiple choice items with four options (A – D) for each item. Only one option is correct for each item. Geometry achievement test GAT 'A' has a reliability coefficient of 0.72.See appendix 'B'.

3.5.2 Geometry Teaching Practice Assessment.

This is a performance rating instrument. Each NCE II Mathematics student was observed during geometry classroom lessons. The instrument consists of two parts. Part one evaluated the geometry lesson structure statement of behavioural objectives based on 5 skills of teaching geometry (visual, verbal, drawing/construction, logical and applied skill,(Dindyall, 2007). While Part 2 evaluated the teacher's presentation of the geometry lesson in classroom. This is a check list of what constitutes evidence of the van Hiele's phases in an instructional setting. Hundred is the maximum score for this instrument. See Appendix 'C'.

3.5.3 Experimental Treatment

In this study, a training manual on the theory of van Hiele model of geometric thought and instruction was developed by the researcher. This training manual consists of instructional units, I, II, III, IV, V, VI and VII. This manual was used by the researcher on the experimental group – it served as the treatment to the research study. Therefore, it is a sensitization guide to the Nigeria Certificate in Education Mathematics Students. It teaches them how to prepare, design and implement instructions on geometry lessons at basic education level. Consequently, a major relevance of this treatment was that, it offers NCE II Mathematics Students a chance to identify clearly starting and ending points (Identify phases of instruction) in their efforts to raise the students understanding of geometry at any given level to the next higher level during instruction in geometry. See Appendix 'A'.

3.6 Validity of the Instruments

To ensure face and content validity of the instruments, the researcher made several visits to Federal College of Education, Kontagora and College of Education Minna to ensure that NCE II Mathematics Students were taught the same content of the NCE Mathematics curriculum. Indeed, the prepared materials were given to the lecturers of Mathematics department who have the teaching experience to enable them validate the material. The researcher solicited for their views for the improvement of the instrument.

In addition, to further strengthen the validation, three experts in Mathematics Education unit of science education department, Federal University of Technology, science education department were asked to go through the prepared material with the aim of making necessary corrections and modifications. Their comments were fully in cooperated in the final draft.

3.6.1 Reliability of Instrument

A test-retest method was applied to determine the reliability of the instruments 'GAT'A' and 'GTPA' at an interval of two weeks. Pearson Product Moment Correlation Coefficient was used to calculate reliability coefficient. A reliability coefficient of 0.72 obtained for 'GAT' .Similar procedure was used for GTPA to obtain its reliability coefficient of 0.78. Therefore, the two instruments used for this study GAT'A' with r = 0.72 and GTPA with r = 0.78 have a high reliability. Hence the instruments are consistent.

3.7 Test Administration and Procedure for Data Collection

The test was personally administered by the researcher with the help of some research assistants who are academic staff in the Mathematics department in the Colleges of Education involved in the study. The essence was to seek for their help in giving appropriate guidance to the NCE II Mathematics Students. The test developed for the JSS students is a power test and 40 minutes was used for the test.

In all the participating Colleges of Education and junior secondary schools, permission was sought by the researcher from the College administrators and Head of Mathematics department. The researcher arranged for the simple selection of the NCE II Mathematics Students using purposive and simple random sampling and the classrooms to be used for the sampled NCE II Mathematics Students for briefing by the researcher. The briefing contained the purpose of the research and its significance to the College and NCEII Mathematics Students in particular. A four hour lecture per week for 6 weeks was given to the prospective teachers on van Hiele's geometric Model. In addition, test materials were assembled; numbers of question papers were checked and ascertained to tally with the 30 students sampled from the junior secondary schools involved in the study. Similarly, adequate and appropriate Classrooms were used for the study.

3.7.1 Method of Scoring the Instrument

For the purpose of this study, one mark was awarded for each correct response in instrument A. The maximum score for instrument A was hundred percent. Each respondent's score was converted to percentage. Also, the lesson structure and lesson presentation by the sampled participants were scored and rated on base percentage (100%).

3.8 Procedure for Data Analysis

The following statistical techniques were used in the study to analyze the data collected for the study. Mean, Standard Deviation, t-test and Analysis of Variance (ANOVA) were used to test the hypotheses formulated in Chapter One. Specifically t-Test was used to test the Null hypotheses 1-4 and F- Test to test the Null hypothesis 5.

3.9 Pilot study

Pilot study enables the researcher to assessed the plan for the study. Hence, A field test using a total of Twenty (20) NCE II Mathematics Students were randomly selected for the pilot study. These comprises of Ten (10) males and Ten (10) females from College of Education, Zuba. These twenty (20) NCE II Mathematics Students were not used in the actual study. The twenty (20) NCE II Mathematics Students used in the pilot study were exposed to the same NCE Mathematics curriculum (MAT114) as those used in the actual study. Moreover, quality of student intake, teaching facilities and environmental conditions were similar to those of the actual NCE II Mathematics Students as they are controlled by same agency, the National Commission for Colleges of Education (NCCE).

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

The purpose of this chapter was to give detailed account of the data collected using the instrument of the study. Statistics such as the mean, standard deviation, t-test and F-test were used for the analysis and testing of research hypotheses of section 1.5 in chapter one. The results in this study were for 120 NCE II Mathematics students from two Colleges of Education situated in Niger State and One thousand six hundred and seventeen (1,617) Junior Secondary III Students were used only for the study. Specifically, the results and analysis were carried out in the following order.

(a) Statistical differences between NCE II Mathematics Students with geometric pedagogical abilities and those without.

(b) Students performance in geometry when taught by NCE II Mathematics Students with geometric pedagogical abilities and those without

(c) Statistical gender difference of NCE II Mathematics Students with geometry pedagogical abilities

(d) Students performance in geometry when taught by male and female NCE II Mathematics Students with geometric pedagogical abilities

(e) Students performance in geometry by school location (Urban and Rural) taught by NCE II Mathematics Students with geometric pedagogical abilities.

(f) Students' performance in geometry by school type when taught by NCE II Mathematics Students with geometric pedagogical abilities.

(g) Post-hoc-test by school type

4.2 Data Analysis and Results.

This section presents means and standard deviations of NCE II Mathematics Students with geometric pedagogical abilities and those without, as well as male and female NCE II Mathematics Students with geometric pedagogical abilities. Also, presented is Students' geometry performance when taught by these categories of NCE II Mathematics Students. by gender, school location and school type.

4.2.1 The Mean and Standard Deviation

This section presents the summary of the descriptive statistics used in this study, (Mean and Standard deviation) in tables (Table 4.01 to 4.06).

Table 4.01: Mean, Standard Deviation of Experimental and Control Groups

VARIABLE	N	MEAN(X)	S.D
Experimental Group	30	57.70	5.742
Control Group	30	48.43	2.144

Table 4.01 Presents the means and standard deviation of NCE II Mathematics Students with geometric pedagogical abilities (experimental) and those without (Control) groups.

Table 4.02: Mean, Standard Deviation by Gender of Experimental Group.

VARIABLE	N	MEAN(X)	S.D
Male	30	51.57	6.027
Female	30	54.57	6.404

Table 4.02 Presents the means and standard deviations of male and female NCE II Mathematics Students with geometric pedagogical abilities.

Table 4.03: Mean, Standard Deviation of Students taught by Experimental and Control Groups

VARIABLE	N	MEAN(X)	S.D
Students taught by experimental groups	150	27.73	8.99
Students taught by control group	150	26.23	7.85

Table 4.03 Presents the means and standard deviations of students' performance in geometry taught by NCE II Mathematics Students of Experimental and Control Groups.

Table 4.04: Mean, Standard Deviation of Students Taught by Male and Female in the Experimental Group

VARIABLE	N	MEAN(X)	S.D
Students Taught by Females in the Experimental Group	180	25.67	9.20
Students Taught by Male in the Experimental Group	180	26.63	7.34

Table 4.04 Shows the means and standard deviation of students' performance in geometry taught by the male and female NCE II Mathematics Students with geometric pedagogical abilities.

Table 4.05: Mean, Standard Deviation of Experimental Group in the Urban and Rural Schools

VARIABLE	N	MEAN(X)	S.D
Students Taught by the Experimental Group in the Urban Schools	180	32.40	14.89
Students Taught by the Experimental Group in the Rural Schools	180	25.87	7.67

Table 4.05 Revealed the means and standard deviations of Urban and Rural students' performance in geometry taught by the NCE II Mathematics Students with geometry pedagogical abilities.

Table 4.06: Mean, Standard Deviation by school type

SCHOOL TYPE	N	MEAN(X)	S.D
Boy's school	179	25.60	8.453
Girl's school	178	25.17	6.723
Mixed school	240	30.60	9.927

Table 4.06 Presents the means and standard deviation of students' performance in geometry taught by NCE II Mathematics Students with geometry pedagogical abilities by school type.

The table above revealed that mixed school had the highest mean score of 30.60 and standard deviation of 9.927 followed by Boy's school with the mean score of 25.60 and standard deviation of 8.453 and Girls' school only with lowest mean score of 25.17 and standard deviation of 6.723.

4.3 Hypotheses Testing

The data on pedagogical ability were collected by means of Geometric Teaching Performance rating instrument which was administered during the geometry lesson(s) conducted by the NCE II Mathematics Students. The data on students' performance in geometry were obtained from Geometric Achievement Test (GAT 'A') administered at the end of the geometry lesson(s).

Hypothesis 1

There is no significant mean difference between the NCE II Mathematics Students with geometric pedagogical abilities (knowledge of van Hiele's Geometric model and those without. t-tests was used to test the hypothesis.

Table 4.07: Summary of the t-test Analysis of Geometric Pedagogical Abilities of Experimental and Control Groups

VARIABLE	N	MEAN(X)	S.D	DF	t-value	P
Experimental group	30	57.70	5.742	58	**8.280***	**0.00**
Control group	30	48.43	2.144			

* Significant at P = 0.000

The result from table 4.07 shows that the t-value is significant at p=0.000 level. Thus, hypothesis 1 was rejected. This means that, there exists a difference between NCE II Mathematics Students with geometric pedagogical abilities and those without.

Hypothesis 2

There is no significant mean difference between students performance in geometry attributable to NCE II Mathematics Students with geometric pedagogical abilities. t-test was used to test the hypothesis .

Table 4.08: Summary of the t-test Analysis of Experiment and Control Groups Students' Performance in Geometry.

VARIABLE	N	MEAN(x)	S.D	Df	t-value	P
Students taught by the experimental group	150	27.73	8.99	298	1.783*	0.0016
Students taught by the control group	150	26.23	7.85			

* Significant at p < 0.05

Table4.08 presents a summary of the means, standard derivations and t-test showing students' performance in geometry when taught by NCE II Mathematics Students with geometric pedagogical abilities 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 experimental group and those taught by control group.

Hypothesis 3

There is no significant gender difference in the mean scores of NCE II Mathematics Students with geometric pedagogical abilities and those without. t-test was used to test the hypothesis 3.

Table 4.09: Summary of t-test Analysis of Geometric Pedagogical Abilities of Males and Females of Experimental Group.

VARIABLE/GENDER	N	MEAN(x)	DF	S.D	t-value	P
Male	30	51.57	6.027			
				58	1.868*	0.0067
Female	30	54.57	6.404			

Significant at $p < 0.05$

Table 4.09 shows the means, standard deviations and t-test for NCE II Mathematics Students with geometric pedagogical abilities by gender which was significant at $p < 0.05$ thus, hypothesis 3 was rejected. Therefore, there was significant gender difference between the mean scores of NCE II Mathematics Students with geometric pedagogical abilities.

Hypothesis 4

There is no significant mean difference in students' performance in geometry when taught by male and female NCE II Mathematics Students with geometric pedagogical abilities (van Hiele's Geometric Model, theory of instruction). t-test was used to test the hypothesis 4.

Table 4.10: t-test of Students performance in geometry taught by males and females in the experimental group.

VARIABLE	N	MEAN(X)	S.D	DF	P
Students taught by Males in the experimental group.	180	25.67	9.20	358	0.64
Students taught by Females in the experimental group.	180	26.63	7.34		

NS = Not significant at $p < 0.05$

The data in table 4.10 shows that there was no significant difference in students' geometry performance when taught by the male NCE II Mathematics Students and female NCE II Mathematics Students with geometric pedagogical abilities. Hence, hypothesis 4 was retained.

Hypothesis 5

There is no significant mean difference between Urban and Rural students' performance in geometry when taught by NCE II Mathematics Students with geometric pedagogical abilities (van Hiele's Geometric Model, theory of instruction). t-test was used to test hypothesis 5.

Table 4.11: Summary of t-test Analysis of Urban and Rural Students' Performance in Geometry when Taught by the Experimental Group.

VARIABLE	N	MEAN(X)	S.D	DF	t-value	P
Urban Schools	180	32.7	14.89	358	5.250*	0.0000
Rural Schools	180	25.9	7.67			

* Significant at $p < 0.05$

Table 4.11 presents a summary of the means, standard deviation and t-test for Urban and Rural students' performance in geometry. Hypothesis 5 was rejected. Thus, there was significant difference in geometry performance between the Urban and Rural

students when taught by NCE II Mathematics Students with Geometric pedagogical abilities.

Hypothesis 6

There is no significant difference in the mean scores of students from Boys schools, Girls school, and mixed school in the test on geometry when taught by NCE II Mathematics Students with geometric pedagogical abilities (van Hiele's Geometric model of instruction). F-test was used to test the hypothesis 6

Table 4.12: Summary of F-test Analysis on Students Performance in Geometry by School Type When Taught by Experimental Group.

Source of Variation	Sum of Squares	Df	Mean Square	F_{cal}	P
Between Groups	362.666	4	90.666		
Within Groups	2388.443	145	16.473	5.504*	0.000
Total	2751.109	149			

*Significant at $p < 0.05$

Table 4.12 shows the summary of ANOVA ($F_{cal} = 5.504 > F_{crit}$ 2.132 at $p < 0.05$. thus, hypothesis 6 was rejected. Hence, there is enough evidence to support the claim that there was a difference among the means.

Table 4.13: Summary of Scheff's Test on Students Performance in Geometry by School Type When Taught by Experimental Group.

Mixed	Single (Girls)	Single (Girls)	Single (Boys)	Single (Boys)
-----	1.333	0.533	-1.267	0.400
-1.333	------	-0.800	-2.600*	-0.933
-0.533	0.800	-------	-1.800*	-0.133
1.267	2.600*	1.800*	-------	1.667
-0.400	0.933	0.133	-1.667	------

*From the Table 4.13 above, the mean difference is significant at α=0.05 for Girls School vs Boys school and Boys schools vs Girls school, while mixed school Versus Boys or Girls are not significant.

4.4 Discussion.

The current study aimed at determining if the knowledge of van Hiele's Geometric Model (theory and instruction in geometry) by the NCE II Mathematics Students will help them identify and remedy students' misunderstanding about geometry through instructional design and delivery of geometry contents. It also aimed to find out if the geometric pedagogical knowledge of the NCE Mathematics Students would influence the junior secondary school students' performance in geometry. Moreover, the study aimed at determining the influence of NCEII Mathematics Students' geometric pedagogical ability on junior secondary school students' performance in geometry.

The finding of this study showed significant difference 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 schools students' performance in geometry. One can then deduce from the study that, students' improvement on geometric performance is largely determined by the NCE II Mathematics Students' geometric pedagogical abilities.

Therefore, providing Mathematics teacher with training on van Hiele's Geometric Model is a better intervention programme oriented toward teacher preparation and professional development. This finding is in consonance with (van Hiele, 1986; Ohakwe, 2006; Unal, 2006; Olorukooba, 2007; and Atebe, 2008) that Mathematics teacher preparation is a part of the teaching-learning process and those adequately prepared teachers can formulate appropriate learning experiences to help students to make orderly progress. Consequently, this will enable them to teach geometry better at junior secondary school levels after graduation. This in turn enhances students understanding of geometry.

The finding revealed significant difference in the mean scores of male and female NCE II Mathematics Students with geometry pedagogical abilities. This is in agreement with the explanation by Modupe (2000) that, there is apparent abandonment of teaching career by men for women probably due to their caring nature.

The implication of this could be that females' NCE II Mathematics Students teach geometry better than the males. However, the finding of this study appears not to support that claim. This finding is in agreement with Harbor-Peters (1994) on teacher-gender and student- gender interaction that it is still an inconclusive debate.

The finding also revealed significant difference in the mean scores/performance in geometry between the urban and rural junior secondary school students. The urban junior secondary school students performed better than the rural junior secondary school students in geometry when taught by NCE II Mathematics Students with geometry pedagogical abilities. This could be due to the nature of our schools in the rural areas in

which most of the classrooms are over-crowded; most parents do not show interest in their children's education due to poor socio-economic status, and government's neglect of rural schools. This finding is in agreement with the findings of Anne and Enukoha (2010) which indicated that students in urban schools performed better due to the reasons that, urban schools are better staffed, have better instructional facilities. Urban students are also exposed to good study habit, are highly motivated to study and have conducive learning environment, than their rural counterparts.

Also, the finding from this study indicated that there was significant difference in performance in geometry by school type when taught by NCE II Mathematics Students with the knowledge of geometric pedagogical abilities. This implies that when NCE II Mathematics Students with geometric pedagogical abilities taught geometry lessons in school types (mixed, single (boys), single (girls) there was an improvement in students' performance in geometry. Consequently, further analysis- Post-hoc test of Scheff's shows that significant difference exists in the mean scores when single (Girls) school was compared with single boys school and no mean scores difference was observed between Girls school or Boys and Mixed school.

4.5 Summary of Major Findings.

Based on the findings and discussion, the following are the major findings.

All the six hypotheses were tested and the results were as follows:

1. That there exists significant difference between NCE II Mathematics Students with pedagogical abilities and those without.
2. There exists significant difference in performance in geometry when taught by NCE II Mathematics Students with pedagogical abilities.
3. There was significant gender difference among the NCE II Mathematics Students with pedagogical abilities.

4. No significant difference was observed in students' performance in geometry when taught by gender (Male or Female) with geometric pedagogical abilities.
5. That significant difference exists between the mean scores of the urban school students and rural school students when taught by NCE II Mathematics Students.
6. That significant difference exists between the mean scores of students' performance in geometry by school type when taught by NCE II Mathematics Students.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The purpose of this chapter was to conclude the study and to bring together the findings in this study. To conclude the study, it is necessary to bring together the findings in this study. As a result, this chapter is made up of the summary of the research which embraces, among others, procedures, design and results. The conclusions drawn from findings of the study were also presented. The implications of the findings of this study for Mathematics Education in general and geometry in particular were also fully discussed. The chapter ends with some recommendations and few suggestions for further research.

5.2 Summary

The Training Manual on van Hiele's Geometric model for Nigeria Certificate in Education Mathematics Students were developed to serve as sensitizing guides for NCE II Mathematics Students to ensure effective teaching of geometry at the Junior Secondary School. These training manuals were written in units form namely unit 1, unit 2, unit 3, unit 4, unit 5, unit 6 and unit 7.

Unit 1 - Describes concept of geometry

Unit 2 - defines educational objectives and identifies objectives of teaching geometry in Nigeria

Unit 3 - is made up of the causes of difficulties in learning geometry

Units 4 - Describes Behaviorist and Constructivist theory of Learning and the difference between them.

Unit 5 - is made-up of Van Hiele's Geometric Model.

Unit 6 - Describes Van Hiele phases of ɔn

Unit 7 - is on the characteristics of Van Hiele theory

Geometry Teaching Practice Assessment rating was used on each NCE II Mathematics Student's to assess his/her pedagogical ability during geometry lesson. It consists of two major parts. Part one assessed NCE II Mathematics Student's ability to state behavioral objective logically and adequately for the geometry lesson from any of the five skills of teaching geometry as reported by Dindyall, (2007). These skills are visual, verbal, drawing/construction, logical skills and applied skills. Part two assessed the teacher's (NCE II Mathematics Students) pedagogical ability during geometry lesson presentation. GTPA has a reliability index of 0.78. The second instrument is a geometry achievement test. This instrument was developed to assess JSSIII students' understanding of geometry in the Junior Secondary Schools Mathematics Curriculum. The test consists of 30 items. Each item has four options including the option. The reliability coefficient of this instrument was obtained at 0.72 using test-retest method with two weeks interval and computed using Pearson Product Moment Correlation Coefficient which was found to possess high coefficient of reliability.

A purposive and random sampling procedure was used to sample the Nigeria Certificate in Education Mathematics Students (NCE II levels) from the two Colleges of Education in Niger State. This was because of the fact that, at NCE II level, only students whose sessional CGPA is greater than 1 can go for practical teaching. Thus, only 20 students were qualified in Federal College of Education, kontagora and 410 in College of Education, Minna. In fact, NCE programmes (Mathematics Education inclusive) in Nigeria is under one supervisory agency, the National Commission for Colleges of Education (NCCE). Thus, NCCE evaluates the extent to which Colleges of Education in Nigeria provides quality in students' intake and curricular issues such as the minimum content areas to be covered in a programme. A total number of 120 Nigeria Certificate in Education Mathematics Students were involved in the study. 30

subjects were maintained in each of the experimental and control groups based on central limit theorem. The experimental groups were trained and sensitized on van Hiele's Geometric Model (theory of instruction) in addition to the NCE II general methodology education courses while; the remaining 30 in the control groups were not exposed to the van Hiele's Geometric Model but possessed the general Education methodology courses only. Hence, these 120 sampled NCE II Mathematics Students were posted to 20 secondary schools based on their choices. This therefore, these determined the number of schools involved in the study. The details relating to the procedure for selecting the students sample was treated in chapter three.

5.3 Limitation to the Study.

Only 120 NCE II Mathematics Students were used for this study. Also, their posting to schools of practice teaching were purely based on their choices because of finance and proximity or accessible to be seen by their lecturers. According to (Fraenkel and Wallen, 2008), Static Group Comparison Post-test only control group research design requires two groups both of which were formed. One group received experimental treatment while the other group did not.

5.4 Conclusion.

In view of the findings reported in chapter four, the following conclusions were reached for the study.

1. The study revealed that van Hiele's Geometric Model or geometric pedagogical training at Colleges of Education level of NCE II Mathematics Students could be a better intervention programme oriented toward Mathematics teachers' preparation and professional development. Thus, pedagogical preparation in specific content area is a skill needed by every Mathematics teacher. This could be a strong factor to be considered in enhancing students' better understanding in geometry.

2. The findings suggest several directions for the future research for example using geopolitical zones with bigger study population to determine the applicability of the findings on a wider population and using other subject areas in mathematics apart of geometry.

5.5

Implication for Teaching and Mathematics Teacher Education

In this study it was found that the study of geometry at Junior Secondary School level by the students can be enhanced if Mathematics teacher education preparation programmes can be oriented toward specific content pedagogical training. Consequently, training manual on van Hiele's Geometric model used in this study can help in that direction.

Also, the debate on who teaches geometry better Male Mathematics teacher or female Mathematics teacher need to be revisited because it is still an inconclusive issue. In this study, it is very difficult to attribute significant difference observed in students' performance taught by these two groups due to pedagogical ability. Moreover, the Quasi-Experimental study design was used where variable was manipulated but not under absolute laboratory control.

Also, it was found that urban students performed better in geometry than their rural counter-parts. It is therefore necessary for parents, private agencies and government to come to the aid of the rural schools by providing qualified Mathematics teachers, improving the parents' attitudes (socio-economic status) towards their children's or wards learning geometry and building more classrooms to reduce the classroom syndrome. With this, the gap between urban and rural students' performance in geometry would be minimized if not totally removed as reported by (Ibu etal, 2009).

Finally, there is a lot of advantage to gain in the study of geometry by individual. This is possible for the NCE II Mathematics Students who is adequately prepared in the content and pedagogy specific area of geometry. Therefore, at Colleges of Education level, NCE II Mathematics curriculum should contain the pedagogy of teaching geometry such as van Hiele's Geometric Model. This will help them to teach geometry better after graduation.

5.6 Suggestions for Further Studies

From the findings and conclusions reached in this study, the following suggestions are made for effective teaching and learning of geometry in our Junior Secondary Schools. 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 their graduation.

It is therefore suggested that, similar kind of study be carried-out at preparatory stage with the university undergraduates and distance learning Mathematics teachers. Where senior secondary school students will be involved if such study is carry out. In addition, Nigeria Policy on Education (FRN, 2004) does not restrict the levels at which the university graduate Mathematics teachers can teach unlike the NCE graduates who are only expected or prepared to teach at primary or Junior Secondary Schools levels after their graduation.

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APPENDICES

APPENDIX "A"

Teaching Manual on Van Hiele Model and Instruction for the Prospective Nigerian Certificate in Education Mathematic Teachers

Introduction

This module deals with concept of Geometry, objectives of teaching Geometry in Nigeria, van Hiele level, the van Hiele phases, characteristic of van Hiele theory and constructivist approach to instruction.

Objectives

By the end of this model, the participants should be able to

i. Identify the need(s) for NCE Mathematics Teacher preparation in the pedagogy of geometry teaching and learning.

ii. Identify Van Hiele level Model? Van Hiele phases, characteristics of Van Hiele theory.

iii. Give reasons why Van Hiele phases is a constructivist approach to instruction and the need to apply it to their Geometry lessons.

iv. Plan, design and implement a geometry lesson based on this Van Hiele theory and instruction at any given level of primary/ secondary school geometry contents.

v. Identify objectives of teaching Geometry in Nigeria.

vi. Identify the Causes of difficulty in school geometry.

Unit 1. Definition of concept of Geometry

Introduction

In this unit, you will learn what is meant by Geometry, objectives of teaching geometry and causes of learning difficulties in geometry. The purpose is to strengthen your understanding of geometry and identify the objectives of teaching it and some causes of learning difficulties in geometry.

Objectives:

By the end of this unit, you should be able to

i. Define the concept 'Geometry'

ii. State the objectives of teaching geometry

iii. Identify the causes of learning difficulty in geometry.

Presentation

Considering the difficulties associated with any attempt to define a concept and also the fact that most concepts are better understood through listing of few definition from authors in the field, couple with wider application of the concept.

1. Fajemidagbe (1992) describes geometry as a study of spatial relationships (position, shape and size). Its study is carried out through observations, constructions and description of shapes; and location of point in one-two or three dimensional space. Furthermore, the knowledge of geometry is basic to understanding the environment in which we live. This can be verified by observing design of arts, Architecture, clothing, and aspect of socio-cultural surroundings. The ability to represent and interpret three dimensional geometry relations is a valuable skill for many secondary school subjects and technical occupation.

2. Clement and Battista (1992) defines school geometry as "the study of spatial objects, relationships and transformations that have been formalized (or mathematized) and the axiomatic mathematical systems that have been constructed to represent them.

In linking geometry with spatial reasoning, clement and Battista (1992) state that reasoning consists of the set of intellectual processes through which mental representations of spatial objects and the relationships between the properties of some objects are constructed and manipulated. This seems to indicate that geometry and spatial reasoning are two interwoven concepts with the later as a tool for exploring the former.

3. The chambers Dictionary (1998) defines geometry as that part of Mathematics which deals with the properties of point, lines, surface and solid either under the Euclidean assumptions, or (in the case of elliptic, hyperbolic e.t.c, geometry involving postulates not all of which are identical with Euclid.

Generally, geometry is the study of the properties of spatial object and the relations between these properties. Van Hiele (1986) describes geometry as a science, as form of study in which "we have no concern for space, nor for geometric figures in space, but (rather) only for the relations between properties of those figures. Based on this notion of geometry, Van Hiele (1986) proposes an intuitive introduction "to the study of geometry in which learners are given the opportunity for direct observation/manipulation of geometric figures, such as triangle, rectangle, quadrilateral so as to enable them to abstract the relationships between the properties of those shapes.

Activity:

1. What is geometry?
2. List at least 3 different ways in which geometry be studied

Summary:

This Unit is aimed at helping the NCE prospective Mathematics teacher to correctly define geometry and to identify various ways of studying it.

Conclusion

The definition of any concept provides the teacher with benefit of having a sharp focus and a common ground for understanding that concepts among various readers.

Unit 2 Objectives of teaching Geometry in Nigeria.

Introduction:

In this unit, the participants will be able to identify the objectives of teaching geometry in Nigeria.

Objectives:

By the end of the unit, participants should be able to:

1. Define educational objectives.
2. Identify at least 3 objectives of teaching geometry in Nigeria.

Presentation:

According to Bloom (1956), educational objectives are the expected behavior and cognitive changes in students as a result 0f their exposure to programmes or learning experiences. They are the intended behaviour of students exhibited, in the way they act, think and feel as a result of participating in some units of instructions.

The Nigerian secondary school Mathematics curriculum seems to emphasize mastery of 3 basic mathematical skills in the learning of geometry. These are:

1. Skill of geometrical constructions using straight edge compasses, protractors and set squares.
2. Skill of proving theorems
3. Skills of solving riders based on theories. Riders in Euclidean geometry should aim at promoting students' deductive reasoning.

From the above stated goals, it seems that the general objectives of secondary school geometry teaching in Nigeria are:

1. Development of students' spatial awareness and visualization through geometrical constructions.
2. Development of students' logical reasoning abilities through explicit teaching of deductive proofs in Euclidean geometry.

3. Development of students' problem-solving ability in geometry that has wide application in many other aspects of Mathematics and related fields,(Atebe ,2008) and (Odili ,2006).

Students Activity.

1. List at least 3 objectives of teaching geometry in Nigeria.

Summary

Educational objectives are intended behavior of students which occur as a result of participating in some units of instructions. Therefore, some of the objectives of geometry teaching are:

1. Understanding of the basic facts about geometric figures in the plane and solids in space.
2. Appreciation of the deductive method
3. An introduction to imaginative thinking
4. An integration of geometric ideas in to other parts of Mathematics.

Conclusion.

Understanding the objectives of concepts taught in Mathematics help the Mathematics teacher to be well- informed in selecting, planning and implementation of geometry instructional lessons.

Unit 3. Causes of difficulty in learning Geometry.

Introduction:

The persistence failure observed both in the teaching and learning of geometry as well as decrease in the level of students' performance, at national, regional and international Assessment standards (TIMSS, 2003), WAEC, NECO (2005;2000;1996;1995), TIMSS (2003) added to the number of Mathematics teachers who skip school geometry content have instigated the need for a critical look at Mathematics teacher preparation in geometry.

Objectives:

By the end of this unit, participant should be able to:

1. Identify the causes of students' difficulty in learning geometry.

Presentation:

A source of learning difficulties in secondary school geometry is a global phenomenon. This has been attributed to a number of factors. However, available literatures both national and international have categorized the sources in to three major groups.

(i) Curricular (ii). Textual (iii). Instructional/pedagogical (Atebe, 2008).

In Nigeria, a range of factors have been identified as the causes of students poor performance in Mathematics generally and geometry in particular. These include teacher's qualification, family background, school environment and the curriculum. The literature appears to underscore instructional- related issues as the most critical influence in student's performance, (Onabanjo and Akinsola, 2000). For the purpose of our discussion, we shall focus on instruction and pedagogy.

Instructional/Pedagogical factor

The classroom teacher remains one of the most powerful determinant who translates curriculum contents in to potential learning experience. Indeed, most school learning experience is framed by a teacher who selects, prepares and presents a wide range of instructional activities for the learner. Therefore, Tahir (2006) and Obanya (2006), believed that the most important people in any educational system are the teachers. By way of extension learning is strongly and necessary linked to teaching. Consequently, the amount of learning that takes place in the classroom depends mostly on teacher's knowledge of the subject matter to be learned. Also, research seems to indicate that teachers' classroom behaviour is often influenced by their knowledge of the subject matter and subject matter-specific pedagogy Fujemidagba (1998). Basically, a teacher with good content knowledge of geometry and a good teaching strategy in the subject would make learning easier for the students. Therefore, Shulman (1987) identified 3 different types of knowledge a Mathematics teacher should have in order to teach effectively. Also Landu (2000) added that, this knowledge should be given equal weighing during Mathematics teacher preparation. These 3 basic knowledge are:

1. Content knowledge: knowledge of the subject to be taught.
2. Pedagogical content knowledge: knowledge of specific strategies for the imparting the particular subject matter.
3. Curriculum knowledge: knowledge of material and program by which instruction and assessment are to be carried out.

Shulman(1987) concluded by saying that, knowledge of pedagogical content is perhaps the most important because it identifies the distinctive bodies of knowledge for teaching.

Finally, the literatures above indicate that much of the difficulties that students encountered with Mathematics generally and geometry specifically is due to teachers' lack of appropriate pedagogical content knowledge.

Atebe (2008); Unal (2005); Fajemidagba (1998). It was observed that children's knowledge and teachers understanding of that knowledge are central to instructional decision making. Therefore,

1. Many traditional teaching strategies do little to foster teachers' understanding of their learners mathematical thought.
2. There is the issue of teachers' reluctance to opt for new and more progressive methods of teaching despite recognizing the shortcoming of traditional behaviorist classroom, characterized by teacher- centered methods of teaching.
3. van Hiele (1986) asserts that the inability of many teachers to match instruction with their pupils' level of understanding in geometry, more than anything else, accounts for their failure to promote students conceptual understanding in the subject.
4. An improvement in students learning assumes an improvement in the pedagogy enabling that learning.

Activity:

1. Mention at least 3 causes of students' difficulty in school geometry.
2. State 3 different types of knowledge a Mathematics teacher must possess.

Summary

Teaching, not teacher is the critical factor in students' geometry learning. For teaching to be affective, Mathematics teacher must be well-groomed in subject matter knowledge, knowledge of pedagogy of the subject matter and knowledge of the curriculum.

Conclusion:

Researches continue to revealed that, teachers reluctance to embrace the generally acclaimed learner- centered social constructivist approach, inadequate balance in content knowledge, knowledge pedagogy and curriculum knowledge have contributed to students poor performance in Mathematics generally and geometry in particular. Therefore, teachers instruction should aimed at raising the level of students' mathematical thinking, and learner- centered approach is most appropriate.

Unit 4 Behaviourist and constructivist theory

Introduction,

This unit takes a look at behaviourst and constructivist theory of learning. It is aimed at helping the Mathematics teachers to distinguish between the two theories of learning and to see constructivist as the most appropriate theory of learning geometry (see Van Hiele theory as constructivist theory).

Objectives

By the end of this unit, participants should be able to:

i. Identify behaviourist and constructivist theory

ii. Identify constructivist theory as the appropriate theory of learning geometry

iii. Identify teaching strategies that go with each theory

iv. Distinguish between the two theories of learning.

v. locate the van Hiele theory as constructivist theory.

Presentation

Behaviourist theory of learning

Traditional Mathematics instruction has been base on transmission-absorption behaviourist model in terms of which pupils were expected to understand that mathematics was invented by others. Teachers were seen as holders of knowledge to learning, while pupils were often treated through drills and practices, as passive recipient of knowledge

Behaviorist theory of Learning

According to the school of behaviourism, learning focuses on the manipulation of external conditions for the learner modify his/her behaviours that eventually led to learning. In a behaviourist- oriented environment, completion of tasks is seen as ideal learning behaviour and mastering basic skills require students to move from basic tasks to more advanced tasks. In addition, learning is considered a function of rewarding and reinforcing student learning. Likewise, the emphasis is on correct answers rather than partially correct answers.

Teaching and learning in behaviourist term is a matter of optimizing and manipulating the instructional environment towards the fulfillment of rigidly and specifically designed educational objectives,

A behaviourist teaching style in Mathematics education tends to rely on practices that emphasize rote learning and memorization of formulas, one way to solve problems, and adherence to procedures and drills. Repetition is seen as one of the greatest means to skill acquisition. Teaching is therefore a matter of enunciating objectives and providing the means to reach those objectives and situated- learning is given little value in instruction.

Constructivist theory of Learning

Constructivism as opposed to behaviorist models of teaching and learning claims that knowledge should be transferred from one individual to another in educational environments. For constructivist educationist, knowledge must be actively constructed as the learner is an entity with previous experiences that must be considered as a "knowing being". Learning is therefore seen as an adaptive and experienced process rather than a knowledge transference activity. As learners encounter new situations, they look for similarity and differences against their own cognitive schemata.

In constructivist terms, learning depends on the way each individual learner looks at a particular situation and draws his/her conclusions. Therefore, people determine their own knowledge based on their own way of processing information and in accordance to his own beliefs and attitudes towards learning. Constructivism therefore gives recognition and value instructional strategies in which students are able to learn Mathematics by personally and socially constructing knowledge. Hence, constructivist learning strategies which are more reflective oriented activities include problem solving, group learning, discussions, and situated learning.

An earlier attempt in cognitive psychology is on how to identify a framework that could aid in assessing students level of thinking in geometry so as to facilitate learning. Hence was the work of van Hiele model, a model that explains development of geometric thought and instructional sequence.

Student Activity:

1. Distinguish between behaviourist theory of learning and constructivist theory of learning.
2. How does the behaviourist see teaching,?
3. How do the constructivists sees teaching?
4. Mention teaching strategies that go with each theory

Summary

Behaviourist theory of learning constitutes:

- Manipulation of external condition to learner.
- Modify behaviours that eventually led to learning (transference activity)
- Teaching relies on practices which emphasize rote and memorization
- Constructivist sees learning as the knowledge which must be actively constructed by the learner

- Teaching is a reflective- oriented activity, such as in problem solving, group learning etc.

Conclusion

Behaviourist and constructivist theory are two opposing theories of learning which have influenced how Mathematics is being learned and taught.

Unit 5 Van Hiele Theory

Introduction

In this unit, participants will learn van Hiele model and levels.

Objectives

By the end of this unit participants should be able to

i. Describe van Hiele theory

ii. Identify the five levels involved in van Hiele model.

Presentation

Van Hiele Model

van Hiele model is a theory that describes how students learn geometry. The theory originated in 1957 in the doctoral dissertations of Dina Van Hiele and Pierre Van Hiele (wife and Husband) at utrecht university in Netherlands. Soviet and Americans carry out a research on the theory in 1960s and 1980s respectively and integrated their findings in to their curricula. Indeed, Van Hiele model has greatly influenced geometry curricula through out the world.

Van Hiele Levels

The best known part of the theory is the five levels which the Van Hieles postulated to describe how children learn to reason in geometry. These levels are often understood to describe how students understand shape classification, but they actually describe the way students' reason about shapes. They identify students to 'plateau' at certain points in their understanding of geometry. In general, these levels are a product of experience and instruction rather then age. This is in contrast to piaget's theory of cognitive development, which is age dependent. A child must have enough experiences (classroom or otherwise) with these geometric ideas to move to a higher level of sophistication. van Hiele theory provides insight in to why many students encounter difficulties in their geometry courses

The van Hiele's model consisted of five levels, which means that geometric thought develops in sequence of these five levels. These levels range from lowest to the highest.They are:

Level 0 – Visualisation,

Level 1 – Analysis,

Level 2 – Information deductions,

Level 3 – Formal deduction and

Level 4 – Rigor.

Unal (2005) described the levels of thought as they develop as follows:-

LEVELS OF GEOMETRIC THINKING

Level 0 – Recognition and Visualisation

Geometric figures are viewed as a whole. Students can name and identify common geometric figures, and compare shapes such as triangles, squares and rectangles but figures are recognized by their shapes, not their parts or attributes. Figures are recognized by appearance i.e it looks like a square. Students can learn geometric vocabulary and if given a figure can reproduce it.

Level 1 - Analysis or Descriptive level

Students are able to perceive or identify attributes of a figure, but they are isolated and unrelated. Since each property is seen separately, no relationship between properties is noticed and relationships between different figures are not perceived. They judge a shape to be a type of figure based on the attributes it possesses. They have not yet mastered which properties are necessary and which are sufficient to describe a geometric shape. Class inclusion is not yet understood.

Level 2 Informal Deductions or ordering level.

At this level, deduction is meaningful. Logically students can order the property of figures previously identified and begin to perceive the relationships between these properties and between different figures. The student can construct proofs, understand the roles of axioms and definitions and know the meaning of necessary and sufficient conditions. Students are able to understand hierarchies of geometric figure. However, the role and importance of formal deductions is not yet understood.

Level 3 - Deduction:

The role of axioms, undefined terms, and theorems are understood. Students comprehend the significance of proofs. They also understand that a proof may be done in more than one way.

Level 4 - Rigor

Students can study non-Euclidean geometries. Also, students can understand and compare different axiomatic system.

Unit 6 Van Hiele Phases

Introduction:

The Van Hiele's recommended five phases for guiding students from one level to another on a given topic in geometry classroom instruction.

Objectives

By the end of this unit participants should be able to

i. Identify the five phases of Van Hiele theory of instruction

ii. Apply this phases appropriately in geometry lesson structure on any given topic.

Presentation:

Phase 1. Information: Through discussion the teacher leads the learners to become acquainted with the domain of investigation. Here the teacher is expected to show a picture / diagram and the class was asked to identify the diagram. Student should be allowed to use their own language (or imprecise terminology) with minimum interference from the teacher. Thus, this pave way to the identify background knowledge of the pupils in the topic or concept.

Phase 2: Guided orientation: The teacher guides the students to explore the object of instruction by assigning carefully structured but simple tasks that invite or permit only one solution. Example of such activities include folding, reflecting and measuring a shape such as in Rhombus where students can observe things like angle, side and diagonals. The teacher allows students to use their own language but occasionally injecting the right terminology.

Phase 3. Explicitation: Here the students describe what they have learned about the topic using their own language. Example, discuss what they found as properties of a rhombus. The teacher introduces technical terms associated

with the subject matter in order to promote accurate communication among the students.

Phase 4. Free orientation: Activities at this stage are designed to provide the students with problems that have multi – path solution in the network of relations. Exercises such as constructing a Rhombus given some vertices and sides. Tasks have open – ended answers.

Phase 5. Integration: The students are conversant with the field of study and have arrived at an overview of the topics. Thus, students have a clear sense of purpose with regard to the object of study, having developed a new network of relations pertaining to it and are able to summarise and integrate what they have learned. According to Van Hiele (1986), students have attained the next level which indicate that "problems set to which integration must be simple" for example, asking the students to "summarise and memorise the properties of the Rhombus.

The major significance of the Van Hiele learning phase is their link into the level of descriptions. The phase move hand – in – hand with the Van Hiele level of geometrics thought. This, offer teachers a chance to identify clearly the starting and ending point in their effort to raise students thought at any given level to the next higher level during instruction in geometry. Also, another advantage to the teachers is the opportunity to compare their current instructional practice with a model of teaching that places "introduction discussion straight forward exercise language development, multi – path solution exercise and topic overview in a sequence (Atebe, 2008). The development of van hiele model in geometry is a specific constructivist approach (theory) which shed more light on how individuals developed geometrical thinking.

Student Activity:

i. Prepare lesson structure on any choosen geometry topic from either primary Mathematics curriculum or junior secondary Mathematics curriculum

ii. Write out van Hiele phases which guide your lesson structure above.

Summary

van Hiele identifies five phases for guiding students from one level to another on a given topic. These levels are information, guided orientation, explicitation, free orientation and integration.

Conclusion

As a teacher of Mathematics, these phases must be your guide in teaching any geometry lessons in respective of the levels i.e. primary secondary or tertiary. Dina Van Hiele-Geldof reported that she conducted a teaching experiment with 12 year- olds in secondary school in Netherlands using this model and that she was able to raise student's level from 0 to 1 in 20 lessons and from 1 to 2 in 50 lessons (Wikipedia, 2010).

Unit 7 Characteristics of Van Hiele Theory.

Introduction

van Hiele theory is unique in the sense that it is both a theory of learning and a theory of instruction.

Objectives

By the end of this unit participants should be able to

i. Identify two types of educational theories.

ii. Give reasons why van Hiele is unique

iii. Mention three characteristic van Hiele theory

Presentation

i. Two type of educational theories are

   a. Theory of learning

   b. Theory of instruction

ii. Learning theories are descriptive in nature. They describe what has happened and what can reasonably be expected to happened. They describe those mental activities which children can do at certain ages or stages of their intellectual development. For example, piaget's theory of intellectual development. It did not prescribe procedure for teaching.

iii. Theory of instruction it is prescriptive in nature. It is prescriptive because it contains principles for the must effective procedure for teaching and learning facts, skills concept and principles, (Atebe, 2008). That is within the theory there are prescribed process and strategies for the attainment of objectives of instructions. Therefore, van Hiele theory is descriptive while Van Hiele theory of instruction is prescriptive.

iv. Also van Hiele's ability to describe and predict behaviour, and to prescribe procedures for the attainments of levels of thinking are important attributes for

any scientific theory. Therefore, van Hiele theory possesses three important characteristics.

1. Elegance: This refers to simple structure of the theory movement from one level to the next following the same principles. Example, the figures of level 1 is the foundation for properties at level 2. etc.
2. Comprehension. This Usiskin (1982) refers as the descriptive and prescriptive attributes of van Hiele theory. In other words, any theory which covers the whole of learning of geometry, and which seeks to explain not only why students have trouble in learning but also what could be done to remove their stumbling blocks.
3. Wide application: van Hiele theory has influenced major reforms in geometry curricula in Netherlands, Soviet, and United States. The model has greatly influenced geometry curricula through out the world, (Wikipedia, 2010). This according to Usiskin (1982), makes the Van Hiele theory widely and easily applicable.

Summary

In this unit, the participants have been introduced to the two types of educational theories. Reasons why van Hiele theory is unique and the three characteristics it possesses were also described.

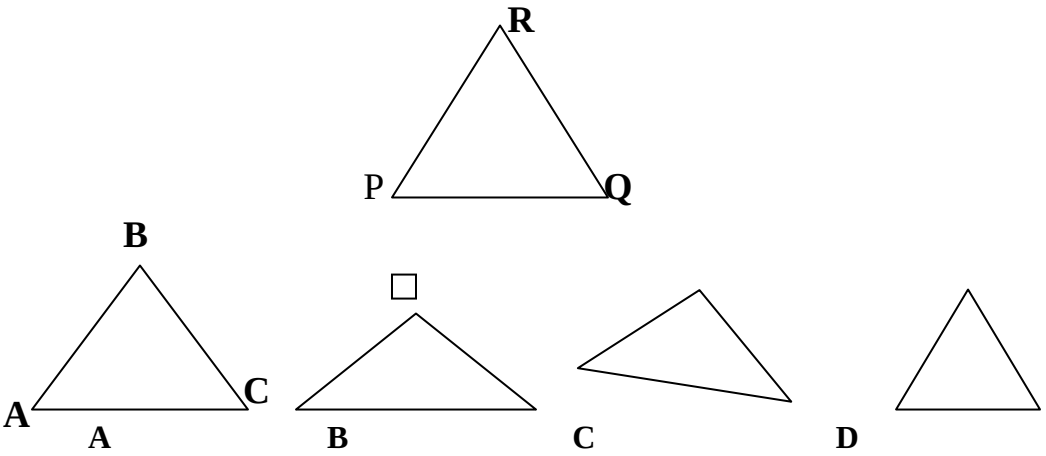
Conclusion

The unit discusses theories of learning and instruction. Also, it brings out the differences between the two theories. It also describes van Hiele theory as unique. Three characteristics van Hiele theory were, elegance, comprehension and applicability.

APPENDIX "B"
GEOMETRY ACHIEVEMENT TEST (GAT 'A')
INSTRUCTION: ANSWER ALL THE QUESTIONS
TIME 40 MINS

OPTION A

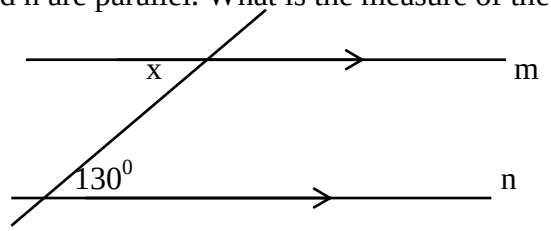
1. Which of the following triangles is similar to Δ PQR?



2. A polygon having four sides is best described as
   A. a rectangle
   B. a parallelogram
   C. a quadrilateral
   D. a trapezium

3. Two angles are said to be complementary if
   A. their pair is 180^0
   B. they are vertically opposite angles
   C. their sum is 90^0
   D. they are corresponding angles

4. Lines m and n are parallel. What is the measure of the angle marked x?



   A. 30^0
   B. 40^0
   C. 50^0
   D. 130^0

5. Which is correct? If two lines are parallel, then
   A. they have equal length
   B. they are also perpendicular
   C. they have a common starting point
   D. they have a constant distance between them

6. Consider the diagram below. How many sides and diagonals does the shape have?



A. 4 sides, 3 diagonals
B. 6 sides, 0 diagonals
C. 4 sides, 2 diagonals
D. 6 sides, 2 diagonals

7. A line that cuts a set of lines is called a transversal. Which is true of corresponding angles? If two or more parallel lines are cut by a transversal, then the corresponding angles
A. are equal
B. add up to 90^0
C. are the same as the adjacent angles
D. add up to 180^0

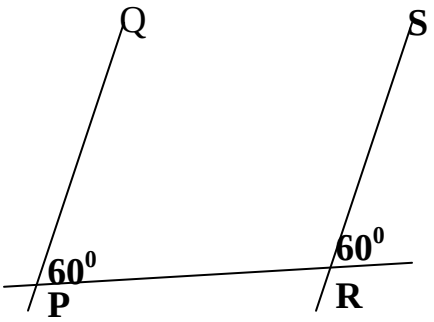
8. Which of these statements is true of a right angle triangle?
A. one of its angles could still be an obtuse angle
B. it has two angles which are complementary
C. it cannot be an isosceles triangle
D. it has two angles which are supplementary

9. A line that cuts a set of lines is called transversal. Which is true? If two or more parallel lines are cut by a transversal, then
A. co-interior angles are congruent
B. adjacent angles are complementary
C. co-interior angles are supplementary
D. adjacent angles are congruent

10. A line that cuts a set of lines is called a transversal. Which is true of alternate angles? If two or more parallel lines are cut by a transversal, then alternate angles are

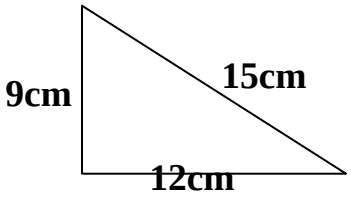
A. congruent B. complementary
C. supplementary D. reflex angle

11. Consider the diagram below. Which statement is true?



A. PQ and RS are parallel
B. PQ and RS are perpendicular
C. PQ and RS must have the same measure
D. PQ and RS will intersect each other at an angle of 60^0

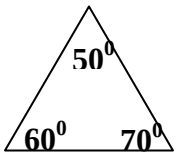
12. What is the Area of the triangle shown below?



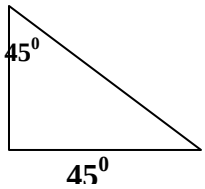
A. 36cm sq
B. 54cm sq
C. 108cm sq
D. 1620cm sq

13. Which is correct? The perpendicular line drawn from an angle of a triangle is the side facing the angle is called
A. a line of symmetry
B. the diagonal
C. an altitude
D. the angle bisector

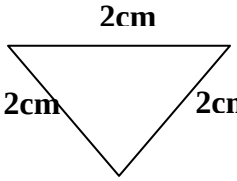
14. Which of the following is a scalene triangle?



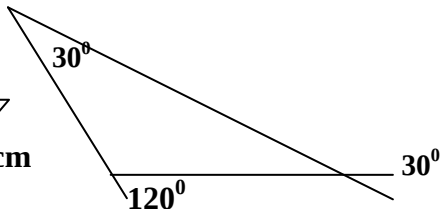
A



B



C

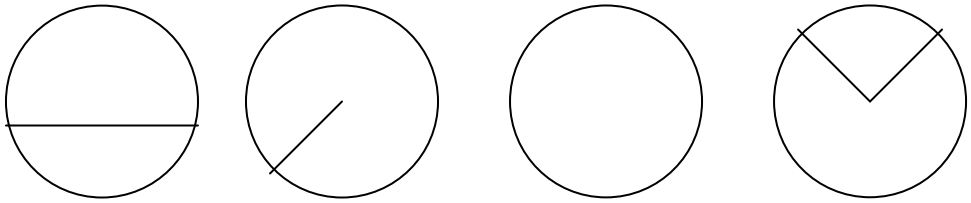


D

15. The measure of an obtuse angle is
A. greater than 180^0
B. 360^0
C. greater than 90^0, but less than 180^0
D. 180^0

16. In one of the following diagram, an arc has been represented by a thick line, which one is it?

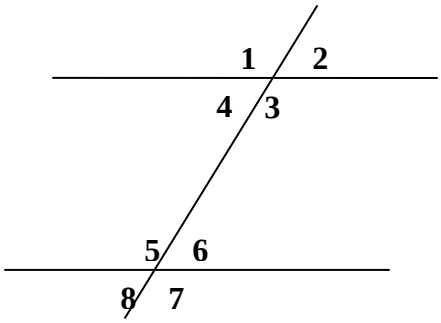
A B C D



17. Which of the following is true of two similar triangles?
    A. they are necessarily congruent
    B. their corresponding sides are necessarily congruent
    C. their corresponding angles are necessarily congruent
    D. they have the same area

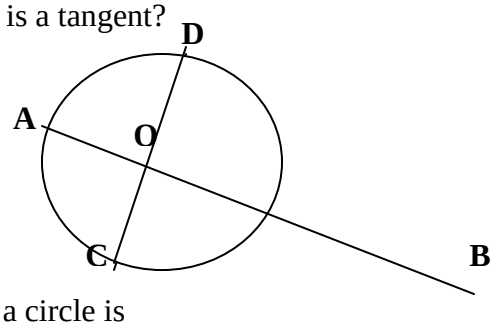
18. The region of a circle enclosed by two radii (which do not form a diameter) and an arc is called
    A. length
    B. a sector
    C. a segment
    D. perimeter of sector

19. Identify one pair of corresponding angle in the diagram below



    A. 1 and 3
    B. 3 and 5
    C. 2 and 4
    D. 1 and 5

20. In the diagram, O is the centre of the circle. Which of the following is a tangent?

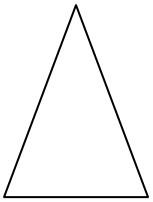


    A. AOB
    A. DB
    B. COD
    C. OB

21. An arc of a circle is
    A. the same as the circumference

B. the region between two radii
C. a part of the circumference
D. a semi circle

22. How many sides and diagonals are there in the figure below?



A. 3 sides, 3 diagonals
B. 0 sides, 3 diagonals
C. 3 sides, o diagonals
D. 0 sides, o diagonals
E.

23. A right angle is one that is
A. less than 90^0
B. 90^0
C. greater than 90^0 but less than 180^0
D. 180^0

24. Which is correct? If two lines are perpendicular to each other, then the two lines
A. are also parallel
B. intersect at right angles
C. intersect at their midpoint
D. have the same measure

25. If two or more circles are concentric, then they have
A. the same centre
B. the same radius
C. different centre
D. different radii

26. Each interior angle of a regular polygon is 162^0. How many sides has the polygon?
A. 8
B. 12
C. 16
D. 20

27. Which of the following ordered numbers represents the faces, vertices and edges for a cylinder.

A.	2	0	3
B.	1	0	2
C.	3	0	2
D.	2	1	3

28. P is a point on the same plane with a fixed point A. If P moves such that it is always equidistant from A, the locus of P is.

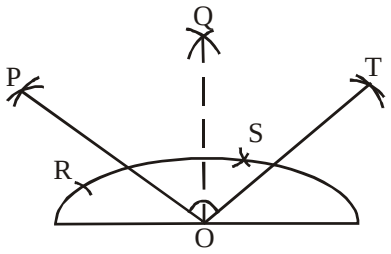
A. a straight line joining A and P
B. The perpendicular bisect of AP
C. a circle with centre A.
D. The triangle with centre P.

29. Which of the following condition is not sufficient to construct a unique triangle?

A. 3 Sides of a triangle
B. 2 angles of a triangle or any of its sides
C. 3 angles of a triangle
D. 2 sides of a triangle and the include angle.

30. In the figure below, what is <POT?

A. 120^0
B. 105^0
C. 90^0
D. 75^0



Appendix:C

Geometry Teaching Practice Assessment (GTPA)

Name of Student: ……

Subject: ……

Topic: ……...

Class: ……

Date: ……

Teaching Practice School: …….

		Max. Mark	Mark Awarded
1.	Lesson Plan		
a.	Statement of Objectives-base on 5 skills of teaching Geometry -Visual -Verbal -Drawing/Construction -Logical skills -Applied Skills	10	
b.	Contents – i. Logically and Sequence ii. Adequacy	10	
2.	PRESENTATION:. Introduction:		
a.	Teacher introduces the topic by recognizing and building on learners previous knowledge i. Use of questions or task ii. Use of rule or procedure iii. Use of activity iv. Draw diagram or chart v. Connect to concrete model vi. Give example/counter example	10	
b.	Teacher delays introduction of formal vocabulary, and condones learner's use of common informal terms in the ensuing discussion i. Use of questions or task ii. Use of rule or procedure iii. Use of trends or activity iv. Draw diagram or chart v. Connect to concrete model vi Give example/counter example	10	

c.	Teacher asks questions that seek to clarify students' imprecise terminology and gradually introduces formal Mathematical Language (Geometry) i. Use of questions or task ii. Use of rule or procedure iii. Use of trends or activity iv. Draw diagram or chart v. Connect to concrete model vi Give example/counter example	10	
d.	Teacher creates an interactive learning environment and encourages learners to challenge, contest and negotiates meanings and solutions to Mathematical Problems. i. Use of questions or task ii. Use of rule or procedure iii. Use of trends or activity iv. Draw diagram or chart v. Connect to concrete model vi Give example/counter example	**10**	
e.	Teacher asks questions that steers students' thought toward the central idea being developed. i. Use of questions or task ii. Use of rule or procedure iii. Use of trends or activity iv. Draw diagram or chart v. Connect to concrete model vi Give example/counter example	10	
f.	Teacher uses open- ended questions and encourages learners to seek their own solution strategies i. Use of questions or task ii. Use of rule or procedure iii. Use of trends or activity iv. Draw diagram or chart v. Connect to concrete model vi Give example/counter example	10	
g.	Teacher encourages learners to elaborate on their responses i. Use of questions or task ii. Use of rule or procedure iii. Use of trends or activity	10	

	iv. Draw diagram or chart v. Connect to concrete model vi. Give example/counter example		
f.	Teacher uses questions that encourage learners to reflect on, refine and summarize their ideas about the concept learned. i. Use of questions or task ii. Use of rule or procedure iii. Use of trends or activity iv. Draw diagram or chart v. Connect to concrete model vi. Give example/counter example	10	

Name/Signature/Date……..…….. Total Score:_____

APPENDIX D
GAT 'A'

1. A
2. C
3. C
4. C
5. D
6. C
7. A
8. B
9. C
10. A
11. A
12. B
13. D
14. A
15. C
16. D
17. A
18. B
19. D
20. B
21. C
22. C
23. B
24. B
25. A
26. D
27. C
28. C
29. C
30. C