IMPACTS OF SCAFFOLDING- ENRICHED COLLABORATIVE STRATEGY ON TEST –ANXIETY, PERFORMANCE AND RETENTION IN GEOMETRY AMONG SECONDARY SCHOOL STUDENTS IN NIGER STATE, NIGERIA

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA
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AUGUST, 2016

DECLARATION

I, Manko AHMAD with Registration Number (P13EDSC9002) declare that the work in this Thesis entitled: Impacts of Scaffolding- enriched Collaborative Strategy on Test-anxiety, Performance and Retention in Geometry among Secondary School Students in Niger State, Nigeria has been carried out by me in the Department of Science Education, Faculty of Education, Ahmadu Bello University, Zaria. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at this or any other institution.

Manko AHMAD	Signature	Date

CERTIFICATION

This thesis entitled**:** Impacts of Scaffolding- enriched Collaborative Strategy on Test-anxiety, Performance and Retention in Geometry among Secondary School Students in Niger State, Nigeria by Manko AHMAD with registration number (P13EDSC9002) meets the regulations governing the award of degree of Doctor of Philosophy in Mathematics Education of the Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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ABSTRACT

This study was designed to investigate the Impacts of Scaffolding- enriched Collaborative Strategies on Test- anxiety, Performance and Retention in Geometry among Senior Secondary Schools in Niger State. The study was borne out of the poor performance of students in Geometry area of mathematics in both internal and external examination as reported by WAEC Chief Examiners (2010). A quasi-experimental research design was used. From the total population of Sixty-two thousand, Two hundred and Forty-nine (62,249) Students in Two hundred and Eighteen (218) Senor Secondary Schools in Niger State, a total of Three hundred and Eighty(380) Senior Secondary Schools Two(SSSII) Students were randomly selected from three (3) Senior Secondary Schools in three (3) Educational Zones using simple randomly techniques. The experimental group one has sample size of One hundred and Thirty-Five(135) Students were exposed to Scaffolding enriched Collaborative Strategy(SCS), while the experimental group two with sample size of One hundred and Twenty(120) Students was exposed to Collaborative Learning Strategy(CLS) and control group with sample size of One hundred and Twenty-Five(125) Students exposed to Conventional Teaching Strategy(CTS). Four (4) instruments were developed and used for data collection. They are: Geometry Performance Test (GPT), Geometry Achievement Test (GAT), Geometry Retention Test (GRT) and Geometry Test Anxiety (GTA). They were validated and reliability coefficients estimated as r=0.79, r=0.69 and r=0.87 respectively. The hypotheses were tested using t-test statistics. The results revealed that (i) there was significant difference in the performance scores of students taught geometry using SCS and CLS than those taught with CTS. (ii) There was significant difference in the retention ability of students exposed to SCS and those exposed to CTS. (iii) There was significant difference in the retention ability of students exposed to CLS and those exposed to CTS. (iv) There was no significant difference in retention ability of students taught geometry using SCS and those taught with CLS. (v) There was no significant difference in reducing test- anxiety of students exposed to SCS and than those exposed to CLS. (vi) There was significant difference in reduction in test- anxiety level of students exposed to SCS and CLS than those exposed to CTS. Based on these results, the following recommendations were made: (i) SCS should be adopted in teaching geometry in secondary schools since the strategies have enhanced better performances among students. (ii) Since SCS promotes retention ability, then the teachers of mathematics should constantly use the method. (iii) SCS could serve as a viable alternative to the CTS in teaching geometrical concepts.

DEDICATION

This work is dedicated to my late father Alhaji Ahmadu Alkali, my mother Hajiya Zanaibu Uthman and my late wives (Maimunat and Khadijat) all in my living memory.

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LIST OF ABBREVIATIONS

BODMAS: Bracket of Division Multiplication Addition Subtraction

S.C.S: Scaffolding- enriched Collaborative Strategy

C.L.S: Collaborative Learning Strategy

C.T.S Conventional Teaching Strategy

C.O.E: College of Education

F.M.E: Federal Ministry of Education

F.G.N: Federal Government of Nigeria

G.A.T: Geometry Achievement Test

G.P.T: Geometry Performance Test

G.R.T Geometry Retention Test

G.T:A Geometry Test-Anxiety

L.T.M: Long Term Memory

M.O.E: Ministry of Education

N.S.S.S.E.B: Niger State Secondary Schools Education Broad

N.E.R.D.C: Nigeria Research and Development Council

N.C.T.M: National Council of Teachers of Mathematic**s**

N.T.I: National Teachers Institute

N.P.E: National Policy on Education

S.T.M: Short Term Memory

UNESCO: United Nation Educational Scientific and Cultural Organization

UNICEF: United Nations Children Fund

ZAD: Zone of Approximal Development

ZPD: Zone of Proximal Development

OPERATIONAL DEFINITION OF TERMS

Collaborative Learning Strategy: The terms collaborative learning and cooperative learning sometimes are used interchangeably. This is reasonable as both favour small-groups to study together and complete common a goal. It is an educational approach to teaching and learning that involves groups of students working together

Conventional Teaching Strategy: It is a traditional method of teaching in which the teacher does most of the talk.

Scaffolding- Enriched Collaborative Strategy: It is a teaching model designed from two strategies (collaborative & scaffolding)

Geometry Retention: is an ability of the students to reproduce the geometrical concepts learnt after an interval of time or when need arises.

Geometry Test-anxiety: This refers to the combination of psychological emotional and cognitive components that are caused by the stress and fear when confronted with geometry problems.

Geometry Performance Test: This refers to the initial test administered to the three groups in the study which served as the pretest.

Geometry Achievement Test: This is the test administered to the three groups in the study to evaluate their performances after the treatment.

Geometry Retention Test: is the test administered to the three groups to evaluate their retention abilities.

Geometry Test-Anxiety: This is the test administered to the three groups to known their level of anxiety.

Scaffolding Learning Strategy: This is an instructional technique that focuses on raising students' abilities one step at a time and removing the support as they progress.

Zone of Proximal Development: This is the level of potential development as determined through problem solving under adult guidance, or in collaborations with more capable peers.

Zone of Approximal Development: This is what a learner knows or is able to do on the basis of acquired knowledge and experience

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Mathematics as one of the science subjects taught in the primary, secondary and tertiary institutions in Nigeria, deals with the study of numbers, shapes and space which involve problem-solving activities and a very powerful way of communication. Benjamin (2007) describes mathematics as the science of pattern and relationship which can be expressed in symbols. It involves clarification of the problem, reduction of consequence and formulation of alternative as well as development of appropriate tools as part of the modern mathematicians' craft (Tisha, 2008). He further gives a full description of mathematics as context of reasoning analytically about particular types of quantitative and spatial phenomena. Mathematics consists of thinking in a logical manner, formulating and testing conjectures, making senses of things, forming and justifying judgments, inferences and conclusions. Mathematics is done when recognizing and describing patterns, constructing physical and/or conceptual models of phenomena. It is also creating a symbol system to assist in representing, manipulating, and reflecting on ideas and inventing procedures to solve problems. Mathematics concepts taught at the secondary school level in Nigeria are in seven major areas namely: Number and Numeration, Algebra, Mensuration, Geometry, Trigonometry, Statistics and Probability.

Geometry is an aspect of mathematics which deals with the study of different shapes. The shapes can either be plane or solid shapes. A plane shape is in geometrical form such that the straight line that joins any two points on it wholly lies

on the surface. A solid shape on the other hand is bounded by surfaces which may not wholly be represented on a plane surface. Examples of plane shapes are: triangle, rectangle, square, rhombus, circle and trapezium. Examples of solid shapes are cubes, cuboids, cone, pyramid, cylinder and sphere.

Geometry is a vital branch of mathematics which forms the building block of engineering and technical graphics. It has been observed that student have not been demonstrating strong conceptual knowledge of the course. Many students in the secondary schools were not adequately prepared for geometry courses (Senk, 2005). Duru (2010) found that there is too much emphasis placed on formal symbolism and naming in the curriculum while relational understanding was underestimated. Students in the senior secondary schools often lack experience in reasoning about geometry. They would have been capable of developing good reasoning about geometry situations, if they had substantial experience in geometry during their junior classes.

Learning mathematics with understanding is the main goals of teaching the subject at secondary schools level as opined by the (National Council of Teachers of Mathematics [N.C.T.M], 2000). Students must be mathematically competent for them to have meaningful and productive lives. It is not enough for an individual to have mathematics knowledge but mathematics power is what is needed to succeed in life (Hassan, 2010). Mathematics is the language of science and technology geared towards scientific/ technological development and all other activities of human development. For instance, automobiles, bicycles, furniture, cell phones, computers, which demand mathematics, input in their manufacturing processes (Gotring, 2005,

Musa, 2006 & Obioma, 2011). Mathematics is an academic subject in secondary school which one cannot afford to neglect because of its importance in all aspects of life. This led the Federal Government of Nigeria to make it one of the core subjects and spelt out the objectives of teaching mathematics, so as to develop interest in the subject and provide a solid foundation for everyday life. Efforts are also being made to develop computational skills and foster the desired level of accuracy to a degree relevant to the problem at hand and develop necessary background for further education. It is in recognition of this that our curriculum planners included mathematics as one of the major and compulsory subjects in our schools (Federal Government of Nigeria [F.G.N], 2013).

As a result, Nigerian tertiary institutions have pegged a credit pass in mathematics as a pre-requisite for admission into the science, social science, technical and engineering courses. The need is even so apparent today that to study any of the arts courses, at least a pass in O/level mathematics is required. The already mis-conceived idea about mathematics by most secondary school students in particular and the public in general that it is difficult, needs to be thrashed. No doubt, there are evidences of discontentment in the performance of students in mathematics at the senior school certificate examinations (Galadima & Okogbenin, 2012, Agwagagh, 2013 & Odetola & Salman, 2014).

National Teachers Institute (N.T.I, 2010) has outlined strategies of teaching mathematics in secondary schools. These strategies include: guided discovery, problem solving, reception, auto-instructional and mastery learning methods. Extensive studies have been conducted on the effect of each method and their relative

limitations on students' academic achievement, retention and level of anxiety (Birgan, 2010, Gimba, 2013). All strategies regardless of how they may be in terms of techniques, materials or procedures must meet certain requirements if they are to be effective in bringing about the desired learning outcomes.

These requirements are what Robert Gagne called "the conditions of learning" these refer to such things as Clear objective, meeting of pre-requisites, attention to the task, need for practice, knowledge of results (feedback) and reinforcement. Instructional strategies are simply methods of putting together these required six (6) conditions for learning.

For any strategy to be effective, it must account for all the conditions of learning for any given learning task. The strategy used successfully by one mathematics teacher may be unsuccessful with another Mathematics teacher or even the same mathematics teacher under different circumstances. It is very sad to note that strategy used in the teaching of Mathematics in our secondary schools is teacher-centered, verbal presentation of ideals and generalization of facts (Salisu, 2013).

Based on the report submitted by West Africa Examination Council [WAEC](2010) that the conventional learning strategy is deficient in meeting the needs of majority of learners. The conventional learning strategy is described as teacher centered and didactic with learners simply listening, copying notes, doing class work and doing assignment. It emphasizes 'Talk and Chalk' in the teaching of mathematics and is indeed an oral presentation. The strategy offers very easy coverage of the syllabus and faster dissemination of scientific information, fact and

mathematics formulae. The strategy allows easy handling of large classes without stress.

Kajuru and Ado (2010) have highlighted some limitations of the strategy which includes it does not promote meaningful learning of mathematics as it appeals to hearing only. The conventional teaching strategy, most often is found to favour the educationally advantaged children (gifted, high ability students) at the detriment of the educationally disadvantaged ones. This strategy has not been successful in promoting students' interest in learning mathematics, which would enhance their high achievements in geometry (Abakpa & Igwue, 2013).The teaching strategy used by teachers is one of the most important areas that researchers have put focused their attention on. Oluloye (2010) has submitted that teachers should improve their teaching methods in order to enhance better understanding and application of geometry among students so as to improve students' achievement as shown by the current West Africa Examination Council[WAEC](2010) result.

Collaborative and cooperative learning are learning instructions in which peers work together on a learning task, with the goal of all learners being to benefit from the social interaction. Abdullahi (2009) has stressed that cooperation and collaboration can be treated as synonyms. It is the most widespread and common strategy in teaching mathematics in Western Countries for the time being. It promotes teaching and learning process more than traditional instructional method as cited by (Abdullahi 2009 & Chianson et al.2011).

Collaborative learning teams are said to attain higher level thinking and preserve information for longer times than students working individually (Jenna el.at 2009).

The group tends to learn through discussion, clarification of ideas, and evaluation of others ideas and information discussed is retained in long term memory. Research by Chianson et al. (2011) suggests that students who worked collaboratively on computational problems earned significantly higher scores than those who worked alone. Students who demonstrated lower levels of achievement improved when working in diverse groups. In addition, students working in collaborative (cooperative) group tend to be more intrinsically motivated, intellectually curious, caring of others and psychologically healthy (Abdulrrahim et al. 2005).

The idea of collaborative learning has a lot do with Vygotsky's idea of social learning and zone of proximal development. There are some ways that gives best practices for collaborative learning in the classroom. There are: establish group goals, keep groups midsized, establish flexible group norms, build trust, promote and open communication for later tasks, create group roles, create a pretest and post-test, allow groups to reduce anxiety and establish group interactions. Students need to respect and appreciate each other's view points. For instance, class discussions can emphasize the need for different perspectives. Create classroom environments that encourage independent thinking. Collaboration is a learning process, if that it is managed correctly, it is powerful tool that can allow educators to impart new ideas and information to both small and large groups (Mamman & Isah, 2014). Thus, effective caregivers engage in regulating dialogue with children almost naturally. A key phenomenon of such interaction is that caregivers maintain the dialogue just above the level where children can perform activities independently. As children learn, adults change the nature of their dialogue so that they continue to support the child but they should also give the child increasing responsibility of the task. For example, the adult

might say “Now, see if you can find next the pieces of the puzzle yourself”. Jerome Burner and his colleagues called this Scaffolding. It takes place within a child’s zone of proximal development, a level or range in which a child can perform a task with help. Scholars like Clare (2012), Hmelo-Silver (2006) and Tisha(2008) are of opinion that the instructional strategy that is being explored to find its impact on teaching and learning is scaffolding learning strategy. The approach recognizes the important role of social interaction within learning environments which benefit many students and provide opportunities to participate fully in classroom activities. In this approach, teachers’ pay special attention to the nature of social interaction in the classroom.

In the mathematics discourse, students and teachers serve both social and cognition functions and this affects students opportunities to learn and retain what they have been taught (Hartman, 2002). Ugwuda (2008) has reported that students taught using the scaffolding strategy performed better than those taught using the conventional strategy. Chang and Chen (2002) have stressed that the scaffolding strategy is a useful strategy in teaching mathematics. That it could be used and popularized for teaching and learning mathematical concepts since it makes learners to be independent and problem- solvers. The scaffolding instructional strategy is therefore, a suitable teaching strategy that will definitely alleviate the problem students’ encounter in solving mathematical concepts.

The scaffolding strategy is a teaching strategy that originated from Vygotsky’s socio-cultural theory and the concept of the Zone of Proximal Development (ZPD) in 1978(Ugwuda, 2008). It is a teaching strategy that was cleverly named for the practical resemblance it bears with scaffolds used at

construction sites (Obioma, 2011).Scaffolding is a learning process designed to promote a deeper level of learning. It is the support given during the process which is tailored to the needs of the student with the intention of helping the student achieved his/her learning goals (Clare, 2012).

According to Sawyer (2006) instructional scaffolding is of three types: contingent scaffolding, reciprocal scaffolding and technical scaffolding. Scaffolding may involve modelling behaviours, coaching and prompting, thinking out a loud, dialogue with questions and answers, planned and spontaneous discussion as well as doing other interactive activities to bridge the cognitive gap. This can also include peer mentoring from more experienced students. These supports in the scaffolding strategies are referred to guidance, all of which depend on the instructor's approach.

Studies have shown that higher level of guidance has a greater effect on scaffold learning, but it is not a guarantee of more teaching (Jumaat et al, 2014). The impact of higher amount of guidance is dependent on the level of detail (Reingold, 2008). The scaffolding learning approach is most effective when it contributes to the learning environment. Scaffolding is gradually applied, modified and finally removed according to the needs of the student. This learning process should never be in place permanently whenever the goal of the student is achieved.

Test-anxiety is a term used for several conditions that cause nervousness, fear, apprehension and worry during a test. It is also seen as a cognitive behavior a rising from self-doubt and self-depreciation. Mathematics anxieties affect students' confidence in the subject (Josiah et al, 2014). Many students who suffer from mathematics anxiety have little confidence in their ability to master the subject and

this, in turn brings about poor performance. Mathematics anxiety involves a feeling of tension and apprehension about performing mathematics. It is associated with delayed acquisition of core mathematics and number concepts leading to poor mathematics competence. Garba (2013) has described mathematics anxiety as the panic helplessness, paralysis and mental disorganization that arises among some people when they are required to solve mathematics problem.

However, scaffolding when used with collaborative strategy can assist a great deal to reduce level of test-anxiety. Since group learning provide a source of support and create more relaxed learning atmosphere that allow for positive learning experiences. Groups use some stress-reducing strategies as long as they remain on task (Smagorinsky, 2007). Thus the present study was conducted to examine the impact of scaffolding enriched collaborative strategy on test-anxiety, performance and retention in geometry concepts among senior secondary school students.

Retention can be defined as the ability to retain materials or things that have been learnt or experienced. According to Desiree (2009) and Ahmad (2010), retention is the ability to retain and later recall information or knowledge gained after learning. Geometry retention is the ability to recall geometry concepts. Most students view mathematics as very abstract and difficult in understanding, assimilating and retaining the concepts. The Chief Examiner, West Africa Examinations Council [WAEC] report (2006) has revealed that one of the problems encountered by students in mathematics is their inability to recall mathematical processes. This is associated with methods by which it is being taught in the class. Hence mathematics concepts need to

be taught to the students in a way or method that touches their subconsiousness. This can trigger quick reproduction of the concept being taught or experienced.

Using a teaching strategy such as the scaffolding learning strategy both high and low ability learners would be able to collaborate in terms of learning and retaining the concept they have learnt in a mathematics class. West Africa Examinations Council Chief Examiner (WAEC, 2006) reported that the general performance of candidate over the three years 2004-2006 is indicative of poor quality of education at the senior secondary school level. WAEC maintained that the low level of performance calls for assessment and review of the methodologies for the teaching and learning of mathematics.

The depressed state of mathematics education at all levels of educational institutions in Nigeria has been a source of concern to mathematics educators, mathematicians, parents, government and all stakeholders. Despite the role of mathematics in national development, its study has not been effective in meeting the demands of national development in Nigeria. Students achievement in mathematics examination especially geometry, both internal and external from year to year, has never been encouraging as contained in the report of chief examiner (WAEC, 2005). This situation, therefore, calls for concerted efforts in identifying solutions to the problems of mathematics education in our institutions of learning.

1.2 Statement of the Problem

The teaching of Mathematics has been a subject of consideration in secondary school education in Nigeria but students continue to record poor performance in Geometry as reported by the Chief Examiner, West Africa Examination Council[

WAEC] (2005, 2006, 2008 & 2010). Josiah et al, 2014 has stressed that some of major among problems that contribute to consistent poor performance of students in Senior School Certificate Examination (SSCE) mathematics examinations are:

- Acute shortage of qualified professional mathematics teachers:
- Poor knowledge of mathematics content by many mathematics teachers;
- Adherence to odd teaching methods in spite of exposure to more viable alternative;
- Students negative attitude towards mathematics, and
- Undue emphasis on syllabus coverage at the expense of meaningful learning of mathematics concepts.

The identified problems do not create conducive environment for mathematics education to thrive in this country. Most students cannot comprehend geometrical expressions coupled with their high level of test anxiety and low retention rate towards mathematics in general. These cause tremendous consequences on their understanding and performance. Thus, it has become necessary to search for a teaching method which is capable of improving the students' performance, retention and reducing test-anxiety.

Furthermore, few researchers have tested the impact of scaffolding- enriched collaborative strategy on test-anxiety and performance in geometry. Based on this, the study investigated the impact of scaffolding-enriched collaborative strategy on test-anxiety, performance and retention in geometry among secondary school students in Niger State.

1.3 Objectives of the Study

The study was designed to find out the Impact of Scaffolding- enriched Collaborative Strategy on Test-anxiety, Performance and Retention in Geometry among Secondary School Students. It has the following objectives:

1. Assess whether students who were taught Geometry using scaffolding-enriched collaborative strategy will do perform better in the subject than those who were taught using conventional teaching strategy.
2. Examine whether students who were taught Geometry using scaffolding-enriched collaborative strategy will improve retention ability than those who were taught using conventional teaching strategy.
3. Determine whether students who were taught Geometry using scaffolding-enriched collaborative strategy will reduce level of test-anxiety than those who were taught using conventional teaching strategy.
4. Examine whether students who were taught Geometry using collaborative learning strategy will do perform better in the subject than those who were taught using conventional teaching strategy.
5. Assess whether students who were taught Geometry using collaborative learning strategy will improve retention ability than those who were taught using conventional teaching strategy.
6. Examine whether students who were taught Geometry using collaborative learning strategy will reduce level of test-anxiety than those who were taught using conventional teaching strategy.

7. Assess whether students who were taught Geometry using scaffolding-enriched collaborative strategy will do perform better in the subject than those taught using collaborative learning strategy.
8. Examine whether students who were taught Geometry using scaffolding-enriched collaborative strategy will improve retention ability than those who were taught using collaborative learning strategy.
9. Determine whether students who were taught Geometry using scaffolding-enriched collaborative strategy will reduce level of test-anxiety than those who were taught using collaborative learning strategy.

1.4 Research Questions

The study will attempt to answer following research questions:

1. What is the impact of scaffolding-enriched collaborative strategy and conventional teaching strategy on the performance of students taught Geometric concepts among senior secondary schools?

2. What is the impact of scaffolding-enriched collaborative strategy and conventional teaching strategy on the retention ability of learning Geometric concepts among senior secondary schools?

3. Will students taught Geometric concepts using scaffolding-enriched collaborative strategy that have reduction in test-anxiety than those taught using conventional teaching strategy?

4. What is the impact of collaborative learning strategy and conventional teaching strategy on the performance of students taught Geometric concepts among senior secondary schools?

5. What is the impact of collaborative learning strategy and conventional teaching strategy on the retention ability of learning Geometric concepts among senior secondary schools?

6. Will students taught Geometric concepts using collaborative learning strategy that have reduction in test-anxiety than those taught using conventional teaching strategy?

7. What is the impact of scaffolding-enriched collaborative strategy and collaborative learning strategy on the performance of students taught Geometric concepts?

8. What is the impact of scaffolding-enriched collaborative strategy and collaborative learning strategy on the retention ability of learning Geometric concepts among senior secondary schools?

9. Will students taught Geometric concepts using scaffolding-enriched collaborative strategy that have reduction in test-anxiety than those taught using collaborative learning strategy?

1.5 Hypotheses

The following null hypotheses were formulated and tested at $P \leq 0.05$ level of significance:

Ho_1: There is no significant difference between the mean performance scores of students taught geometry concept using scaffolding-enriched collaborative strategy and those taught using conventional teaching strategy.

Ho_2: There is no significant difference in the retention ability of students taught geometry using scaffolding-enriched collaborative strategy and those taught using conventional teaching strategy.

Ho_3: There is no significant difference in the level of test-anxiety of students taught geometry using scaffolding-enriched collaborative strategy and those taught using conventional teaching strategy.

Ho_4: There is no significant difference between the mean performance scores of students taught geometry concept using collaborative learning strategy and those taught using conventional teaching strategy.

Ho_5: There is no significant difference in the retention ability of students taught geometry using collaborative learning strategy and those taught using conventional teaching strategy.

Ho_6: There is no significant difference in the level of test-anxiety of students taught geometry using collaborative learning strategy and those taught using conventional teaching strategy.

Ho_7: There is no significant difference between the mean performance scores of students taught geometry concept using scaffolding-enriched collaborative strategy and those taught using collaborative learning strategy.

Ho_8: There is no significant difference in the retention ability of students taught geometry using scaffolding-enriched collaborative strategy and those taught using collaborative learning strategy.

Ho_9: There is no significant difference in the level of test-anxiety of students taught geometry using scaffolding-enriched collaborative strategy and those taught using collaborative learning strategy.

1.6 Significance of the Study

The findings of this study will hopefully uplift the standard of mathematics education in the following ways:

Mathematics Students: will have the opportunity to participate fully in the classroom discussions since collaborative and scaffolding strategies promote working together, sharing ideas and also arriving at joint decision. These may reduce mathematics anxiety and promote mathematics retention. It will also provide useful method of teaching mathematics based on understandings rather than on the conventional learning strategy.

Mathematics Teachers will find the result of this research a useful resource for training teachers as well as handling students of different abilities based on their previous knowledge. The social interactions that teachers and students have in collaborative and scaffolding strategies will assist them learn to work in groups and

increase their capacity of working cooperatively together, respecting the view of one another. In collaborative and scaffolding learning process, teachers are engaged in professional tasks such as curriculum evaluation, curriculum revision and curriculum development.

Policy Makers and School Administrators may wish to incorporate the use of scaffolding enriched collaborative strategies as a means of mathematics instruction in secondary schools. If done, it would create room for better achievement, reducing test- anxiety level and there will improvement in the retention ability of learners.

Furthermore, Mathematics Educators and Curriculum Planners will find the study beneficial if the strategy proves effective in helping students to access more advanced knowledge, skills and interest in mathematics. It would be included among the active instructional strategies in the teaching and learning of mathematics in our secondary schools in Nigeria.

Professional Bodies like the Mathematical Association of Nigeria (MAN) and Science Teachers Association of Nigeria (STAN) will be encouraged to organize workshops seminars and conferences for mathematics teachers on the use of the strategy.

Researchers in the Mathematics education can benefit from the study. This study will serve as base for further studies in algebra, trigonometry and statistics. It will also serve as a source of current information on mathematics education. High anxiety level acquired at the secondary school level could continue to hurt the students at post secondary education, if the trend is allowed to continue. It has consequence on scientific and technological development of our country. Since the knowledge of

mathematics used in modern our world of science and technology, the findings are expected to throw more light on how geometry lessons should be taught using the lesson model developed. This would help in reducing test-anxiety level; promote high retention memory and good academic performance. The findings of the study will also add new knowledge to the existing literatures.

1.7 Basic Assumptions

This study is based on the following assumptions:

1. It is assumed that the Senior Secondary School two (SSS11) students used for the study have acquired knowledge of geometry in mathematics and were also taught by well-qualified mathematics teachers.
2. It is assumed that the students were not taught using collaborative strategy enriched with scaffolding.
3. It is also assumed that the students were not taught using the collaborative learning strategy.

1.8 Scope of the Study

This study was conducted to examine the Impact of Scaffolding –enriched Collaborative Strategy on Test-anxiety, Performance and Retention in Geometry among Secondary School Students in Niger state. The study was delimited to (380) Senior Secondary School (SSS II) students in (3) senior secondary schools within (3) local governments of Niger State. The public schools were selected for the study because they were averagely the same. The variables covered were scaffolding – enriched collaborative strategy, test-anxiety, retention performance and retention. The

tests used were Geometry Performance Test, Geometry Achievement Test, Geometry Retention Test and each contained 40 objective questions. Geometry Test-anxiety contained 10 statements. The geometric concepts taught in the study were delimited to length of arc, chord, segment, cube, cuboids, cylinder, cone, sphere and hemisphere. The lesson models of scaffolding –enriched collaborative strategy and collaborative learning strategy were used.

CHAPTER TWO

REVIEW OF LITERATURES

2.01 Introduction

In this chapter, attempt will be made to examine the literatures that are relevant to this study, which are discussed under the following sub-headings: Theoretical Framework, The Concept of Collaborative Learning Strategy, The Scaffolding Learning Strategy**,** The Conventional Teaching Strategy, Test-Anxiety and Mathematics Performances, Retention Ability in Mathematics, Geometrical Performance of Students, An Overview of Related Studies and Implications of Literature reviewed on the Present Study.

2.02 Theoretical Frame Work

Socio-cultural theory served as the theoretical base of this study and with major components scaffolding and collaborative strategies. According to Vygotsky, learners construct their own knowledge and that maturation, experience, and social interaction play a role in learner's cognitive growth. He stressed the importance of social interaction and viewed learner's culture as the critical factor that determines cognitive growth. Teachers thus play an important role in learner's learning and cognitive development (Vygotsky, 1987).

The theory actually originated much earlier from the work done by Lev Vygotsky and his concept of the Zone of Proximal Development (ZPD) early in 20th century (Stuyf, 2002). According to Vygotsky, learning is basically the movement from Zone of Approximal Development (ZAD) to Zone of Proximal Development

(ZPD). He further, explained that ZAD is the zone of a learner; i.e. learner knows or is able to do certain things on the basis of previously acquired knowledge and experience. ZAD is the lower level of learners' independent performance without any support and ZPD is the higher level of the learners' performance with assistance. According to Vygostkain thinking, conceptual reasoning developed in mathematics classrooms is a result of interaction between everyday spontaneous concepts and scientific concepts. Scientific concepts involve higher order thinking which are used, as student engage in more proficient form of doing and talking mathematics. He maintained that the process of acquiring scientific concept reaches far beyond the immediate experience of the child (Sawyer, 2006).

Vygotsky's theory placed importance on cognitive development as a socially-mediated process involving scaffolding (Djwantoro, 2010). Even though Vygostsky recognized the importance of development factors, he emphasized the importance of environmental and social factors in teaching and learning. He stated that there are two learner's development levels, that is, the actual development level and the potential development level. Vygotsky's explanation indicates that good teaching is done by presenting material a little ahead of development. This suggests that learning precedes development (Vygotsky, 1986). The notion that learning precedes development is the hallmark of Vygotskian theory. Most other constructivists follow the Piagetian idea that the pace of cognitive development limits the concepts that young children can learn and therefore should limit the level of teacher instruction (Baroody, 2000).

In short, the ultimate achievement/goal in theory is to train students to become independent learners. One kind of constructivism that is applicable in classroom environment where there is interaction is social constructivism. In social constructivism, students learn concepts or construct meaning about ideas by interaction to their real world through serious active and interactive activities. Social constructivism plays an importance role in cognitive development (Remalyn, 2013). He stressed that social constructivist teaching practices are necessary for students' understanding of mathematics concepts learned. The practice includes dialogue, prior knowledge, mathematical modeling, multiple solutions, students' preconceptions, problem-solving, problem-posing and the importance of concept for building understanding. Teachers who follow the Vygotskian approaches scaffold children's instruction by identifying the Zone of Aproximal Development (ZAD) of each child.

Tisha (2008) explained that ZPD is one of Vygotsky's concepts and it is a range of tasks that the child cannot yet accomplish alone but can be completed with the assistance of an adult or more skilled peer group. As Vygotsky's was vague about exactly how the child reaches the upper level of the ZPD (Djwantoro, 2010). The present study focuses on a scaffolding learning strategy with the ZPD as a concept under the social constructivism

The idea of test-anxiety has a lot to do with Bandura in Salkin (2008) that test-anxiety develops in a social context. He observed that reciprocal determinism is the constant interaction of factors that are personal characteristics behaviours that happen is reaction to the behaviors of others and behaviors that happen in reaction situation. Anderson in Tan et al. (2003) has submitted that abstract concepts are best

understood after a foundation of concrete and relevant information has been established. The prior knowledge linkages influence the amount and proficiency of learning. The theories are all relevant and would be adopted in the present study.

2.03 The Concept of Collaborative Learning

The terms collaborative learning and cooperative learning are used interchangeably and are treated as synonymous. The use of collaborative (cooperative) learning strategy in the western countries has been in place since the early twentieth century. It is a part of John Dewey's social studies project, which has contributed greatly to the improvement of learning in general. It has become an appropriate substitute for the traditional strategy because of its substantial role in improving performance in the academic and social aspects of learning.

Collaborative learning is one of the most important strategies in teaching. It seeks to promote cooperation and interaction between students and removes the negative trend of competition among them. This leads to a kind of the individuality, disincentives and lack of participation with others (Miriam, 2011). Collaborative learning as the common work has been in the forming small groups. Through this, students work with each other to ensure that each student participate sufficiently in the action or collective duty (Abdullahi, 2009). Effective communication and collaboration are essential to becoming a successful learner. It is primarily through dialogue and examining different perspectives that students become knowledgeable strategic, self-determined and empathetic.

Moreover, involving students in real-world tasks and linking new information to prior knowledge, requires effective communication and collaboration among teachers,

students and others. Indeed, it is through dialogues and interaction that curriculum objectives come alive. Collaborative learning affords students enormous advantages not available in conventional instruction. A group-whether it is the whole class or a learning group within the class-can accomplishes meaningful learning and solves problems better than any individual can do alone.

According to Oloyede et al. (2012), there are three types of collaborative (cooperative) interaction strategies. The scripted cooperation in which partners work together to learn text material, broken down into sections such that both partners read the first section and one partner summarizes the material for his or her partner, who, in turn, provides a critique of the summary. They then alternate roles for the second section of the text, continuing in this way until they have completed the reading.

In reciprocal peer tutoring, students work together to teach one another, and they alternate between the roles of student and teacher. This technique combines elements of both motivational and cognitive approaches to collaboration. In contract to scripted cooperation and reciprocal peer tutoring, guided peer questioning technique is explicitly intended to promote knowledge construction through higher order thinking. It involves a process of question asking and answering. It is guided by the provision of question starters; students pick a few of the question starters, generate questions that fit the form of the starter, and they ask questions from their peers and answer their peer's question.

Miriam (2011) has raised the issue of whether the collaborative work will be done in class "or out of class". He claimed that the "out of class" assignment works best in the upper level and graduate courses by giving some hard task (which might be

called projects in other fields) and giving the students a week or more to work on them. Collaborative (Cooperative) interaction strategy, as used in this study, is where students work towards mutual goals and complete class assignments and exercises together. Each student's performance is based on the group performance. Previous studies have highlighted the merits of cooperative learning over the conventional approach. For instance, Felder et al. (2010) have stressed that students taught cooperatively tend to have better and longer information retention, higher grades, more highly-developed critical thinking and problems solving skills, more positive attitudes towards the subject and greater motivation.

Many teachers and the whole school system have adopted cooperation as the primary structure for classroom learning (Abdullahi, 2009).Thus, the present study would adopt cooperation learning structure as part of the collaborative in the classroom instruction.

2.03.1 Characteristics of a Collaborative Classroom

Collaborative classrooms seem to have four general characteristics. The first two capture changing relationships between teachers and students. The third characterizes teachers' new approaches to instruction. The fourth addresses the composition of a collaborative classroom.

- Shared knowledge among teachers and students in conventional classrooms. The dominant metaphor for teaching is the teacher as information giver. Knowledge flow only one way: from teacher to student. But, the metaphor for

collaborative classroom is shared knowledge. The teacher has vital knowledge about content, skills and provides that information to students.

- Shared authority among teachers and students. In collaborative classrooms, teachers share authority with students in very specific ways. In most traditional classrooms, the teacher is largely, if not exclusively, responsible for setting goals, designing tasks and assessing. Teachers differ in that they invite students to set specific goals within the framework of what is being taught, provide options for activities and assignment that capture different students' interest and goals, and encourage students to assess what they learn.
- Teachers as mediators. As knowledge and authority are shared among teachers and students, the role of the teacher increasingly emphasizes mediated learning. Successful mediation assists students to connect new task to their experiences. Teacher as mediator adjusts the level of information and support so as to maximize the ability to take responsibility for learning.
- Heterogeneous groupings of students. The perspectives, experiences, and backgrounds of all students are important for enriching learning in the classroom. As learning beyond the classroom increasingly requires understanding diverse perspectives, it is essential to provide students opportunities to do this in multiple contexts in schools. Students are not segregated according to supposed ability, performance interests or any other characteristics. Segregation seriously weakens collaboration and impoverishes the classroom by depriving all students' opportunities to learn from and with each other.

2.03.2 Teacher and Students Role in a Collaborative Classroom.

Across this nation, teachers are defining their roles in terms of mediating learning though dialogue and collaboration. Mediation has been defined as facilitating, modeling and coaching. Most teachers engage in these practices from time to time. What is important here is that these behaviours: (1) drive instruction in a collaborative classroom; and (2) have specific purposes in collaborative contexts.

Teachers

- Facilitator facilitating: This involves creating a rich environment and activities for linking new information to prior knowledge, providing opportunities for collaborative work and problem-solving as well as offering students a multiplicity of authentic learning tasks.
- Model-modeling has been emphasized by many local and state guidelines as sharing one's thinking and demonstrating or explaining something. However, in a collaborative classroom, modeling serves to share with students not only what one is thinking about the content to be learnt, but also the process of communication and collaborative learning. Modeling may involve thinking aloud (sharing thoughts about to do something in a step-by step fashion).

Students

Students also assume new roles in the collaborative classroom. Their major roles are collaborative and are active participators. It is useful to think how these new roles influence the processes and activities that students conduct before, during, and after learning. For example in learning, students set goals and plan learning tasks. During learning, they work together to accomplish tasks and monitor their progress.

- Goal setting-students prepare for learning in many ways. Goal Setting is especially important. It is a critical process that assists and guides many others before, during, and after learning activities.
- Designing learning tasks and monitoring-the teachers plan general learning tasks. For example, provide a product to illustrate a concept, historical sequence, personal experience. Students assume much more responsibility for planning their own learning activities.
- Assessment- Teachers have assumed the primary responsibility for assessing students' performance in the past but collaborative classrooms view assessment much more broadly. That is, a major goal is to guide students from the earliest school years to evaluate their own learning. When teachers and the school move from conventional to collaborative instruction, and several important challenges that are likely to arise include: classroom control, preparation time for collaborative learning, individual differences among students and individual responsibility for learning.

2.03.3 Condition for Collaborative Learning Application

The educational specialists have pointed out some important aspects to be considered when collaborative (cooperative) learning is used (Abdullahi, 2009). They are:

- Groups of students should be heterogeneous as much as possible.
- Teachers and students should prepare individual and collective objective clearly and concisely.
- Determine of what is required to be done by everyone in each group.
- Motivating superior individuals and groups.

- Distributing students in small group of (6-2) students.
- The dialogue and debate within the group should be face to face.
- The teachers' role should be guidance and counseling. The present study would adopt these conditions during the treatment of Experimental One and Experimental Two groups.

2.04 The Scaffolding Learning Strategy

Scaffolding is an instructional technique whereby the teacher models the desired learning task, then gradually shifts responsibility to the students. This teaching approach is described as the strategy that focuses on raising students' abilities one step at a time and removing support as they progress. This encourages and enables the students to be active learners in the teaching- learning process (Ugwuda, 2008). Scaffolding begins with materials that are just a step beyond what the learners are able to accomplish unassisted. The teacher builds on the students' previous knowledge and then removes himself as the support, allowing the learners to master the content. The Key to success in this teaching strategy is assessing accurately the learner's current abilities. It is also important to decrease support from the teacher at the appropriate time, neither too quickly, nor too slowly.

The method can be employed in any subject matter for any class level. Quintena et al (2004) conceived of scaffolding as a key element of cognitive apprenticeship, whereby students become increasingly accomplished as problem-solver through coaching, task structuring and hints without explicitly giving them the final answer. In the strategy, students have opportunities to engage in complex tasks that would otherwise be beyond their current abilities. Scaffolding makes the learning more

tractable for students by changing task and difficulties in ways that make these tasks accessible and manageable within students' zone of proximal development (Quitena et. al, 2004 & Hmelo-Silver, 2006).

The strategy not only guides learners through the complexities of the task, it may also problematize important aspects of students' work in order to force them to engage with key disciplinary framework and strategies (Reiser, 2004). Such scaffolds act by "rocking the boat" and stopping mindless progress through the task. Redirecting students' attention to important learning goals such as examining counter, claims, articulating explanation and reflecting on progress.

Teachers play an important role in scaffolding by ensuring mindful and productive engagement with the task, tools and peers. Students are well guided in the learning process, pushing them to think deeply, and model the kinds of questions that they need to be asking them; forming a cognitive apprenticeship. Scaffolding is not limited to the cognitive domain only but it also relates to affective and emotive factors. During the task, the teacher might need to manage and control for frustration, fear and loss of interest that could be experienced by the learners.

Encouragement is also very vital in scaffolding strategies. Clay (2005) has indicated that conversational exchanges between scaffold and student actually offer many opportunities for fostering cognitive, affective and psychomotor development. Conversation facilitate generative, constructive, experimental, and development speech and writing in the development of new ideas (Smagorinsky, 2007).In Vygotsky's words "what the child is able to do in collaboration today, he will be able to do independently tomorrow" (Vygotsky, 1987).

2.04.1 Types of Scaffolding

In the educational setting, scaffolding is of three types. The first type of scaffolding has two levels (Saye and Brush 2002): Soft and Hard. An example of soft scaffolding in the classroom would be when a teacher move around in the room and converses with students (Simons &Klein, 2007). The teacher may question their approach to a difficult problem and provides constructive responses. This type of scaffolding can also be referred to as contingent scaffolding. The amount of support required is dependent on the needs of the students during the time of instruction. But applying scaffolding correctly and consistently can be difficult when the classroom is large and students have various needs (Sawyer, 2006). Scaffolding can be applied to a majority of the students, but the teacher is left with the responsibility to identify additional scaffolding.

In contrast to contingent or soft scaffolding, embedded or hard scaffolding is planned in advance to assist learners with a learning task that is known in advance to be difficult (Saye & Brush, 2002). For example, the teacher who is considered as an expert would lead the students to discover the formula for the Pythagorean Theorem. The teacher gives hints or cues to help the student reach an even higher level of thinking. Reciprocal scaffolding was first coined by Holton and Clarke (2006). It is a method that involves a group of two or more collaboratively working together. In this situation, the group can learn from each other's experiences and knowledge. According to Vygotsky (1987), students develop higher-level thinking skills when scaffolding occurs with an adult expert or with a peer of higher capabilities.

Technical scaffolding is a new approach in which computers replace the

teachers as the instructors, and student can be guided with web links, online tutorials, or help pages (Yelland and Masters, 2007). Educational software can assist students to plan properly (Lai & Law, 2008). Learner support in scaffolding is known as guidance. The guidance takes on various forms and styles. The basis of guidance is any type of interaction from the instructor that is intended to aid and/ or improve student learning. The role and amount of guidance is better defined by the instructors approach. Instructionists and constructionists approach giving guidance within their own instructional frame works.

Scaffolding comprised proper guidance to learners to move them to achieve their learning goals. The Cognitive load of a learner must be structured and moderated for a proper administrative support. Instructionists tend to give a higher level of guidance in the light of the inquiry- driven style of learning experience. With each piece of a complex task being broken down, instructors give guidance for each of the separated part of the learning. In this way, higher guidance is a function of reducing cognitive load when students are working in a more individual manner. While constructivist approaches guidance differ as a result of their focus on transfer.

The concept of transfer focuses on a learners ability to apply learned task in context other than the modality in which it was learned. Research has shown that higher level of guidance has greater effect on scaffold learning, but it is not a guarantee of more teaching (Simons & Klein, 2007). Constructivists pay close attention to the context of guidance because they believe that instruction plays a major role in knowledge retention and transfer.

2.04.2 Features of Scaffolding

Remalyn (2013) has submitted that the term scaffolding assumes that a simple, more knowledgeable person, such as a parent or a teacher, assists individual learners, providing them with exactly the support they need to move to the next level. One of the most critical aspects of scaffolding is the role of the teacher or the expert. The expert not only assists to motivate learners by providing just enough support to enable them to accomplish the objective, but also provides support in the form of modeling, highlighting the critical features of the content, and providing guidelines and expected questions that might help learners to reflect. The expert or teacher is knowledgeable about the content of instruction as well as the facilitator with the skills, methodologies and processes required for teaching (Stuyf, 2002; Abraao, 2006).

Mehmet (2004) and Remalyn (2013) have pointed out several key elements of scaffold instruction which are:

(i) **Common goals**: That is, inter-subjectivity is combined with ownership of the task between the teacher and the student, and setting a common goal.

(ii) **Ongoing diagnosis and adaptive support**: The most important element of instructional scaffolding is the fact that the teacher or expert is constantly evaluating learners' progress and providing appropriate support for "this tutee, in this task at this point as task master" (Mehmet, 2004). This results in interactions that are different in content and form from individual to individual and for the same individual at different times. As Reiser (2004) and Clare (2012) have noted, scaffolding interactions comprise of a theory of the task and a theory of the tutee. The teacher or expert needs to have a thorough

knowledge of the task and its components. The sub-goals should carry out as well as knowledge of the students' capabilities as they change throughout the instruction, (i.e. knowledge of ZAD and ZPD).

(iii) **Dialogue and interactions**: A critical factor in the ongoing diagnosis and calibrated support is the dialogue nature of scaffolding interaction. The learner is an active participant and a partner in deciding the direction of the interaction, not a passive recipient. The dialogic nature of scaffolding is best illustrated in the reciprocal teaching studies of Hunter (2007) in which students were all united in their belief. Students can talk and interact in mathematically appropriate ways. They can also lead the group discussions, engaging in comprehension monitoring strategies.

(iv) **Fading and transfer of responsibility**: The final feature of scaffolding is reducing the support provided to learners so that they are in control and take responsibility for their learning. The best scaffolding will eventually lead learners to internalize the processes they are being helped to accomplish (Remalyn, 2013).

In the original description by Tisha (2008), the important aspect of the transfer of responsibility is that the child has not only learned how to complete a specific task but has also abstracted the process of completing the given task.

2.05 The Conventional Teaching Strategy (CTS)

It is sometimes referred to as traditional method of teaching. It is the traditional talk-chalk method of teaching in which the teacher does most of the talk, while the

students listen and take down notes. CTS are less tedious, save times and provide fascinating and aesthetically stimulating experience especially for the new students on the topic of interest (Salisu, 2012).

Teaching is more than imparting of knowledge. It includes attempts to assist someone acquire or change some skills, attitudes, knowledge, idea or appreciation. Its functions include informing, explaining, stimulating, directing, guiding and administering. The teacher identifies what to learn and learning problems evaluates reports and records the performances of the students. Other functions include classroom management, class unity, giving security, development of school community relationship, participating in school professional activities.

However, Kajuru and Popoola (2010) are of the opinion that the conventional teaching strategy is a teacher-centered with little or no participation of the learner who remains a passive listener. The persistent use of the traditional mode of instruction is one of the major shortcomings affecting performance and higher achievement in Mathematics. In this strategy, the learners are usually presented with the content to be learnt in a systematic manner. For example, a teacher might begin by considering the formula, for finding the area of a triangular. He will them present the formula as ½ x base x height (1/2 b h) where 'b' is the base of the triangle and 'h' is the height. He c goes further to give examples and later give some problems for the students to work in classroom and at home.

The teachers' main task here is to organize his/her instruction so that the content will be received by the learners in a way that can be incorporated meaningfully and easily with the previous learning. This method is found very useful

for slow learners. The teaching strategy seems to be a valuable strategy for summarizing ideas, showing relationships between theory and practice and re-emphasizing the main points. Many teachers use this teaching method almost exclusively, as it is considered the simplest, but it is not the most effective teaching method to teach all students, especially younger ones, who often need a more engaging hands-on in order to learn effectively. According to Jamilu (2013) the traditional method can be an effective method for communicating theories, ideas, and facts to students. The primary aim of every lecturer is to make sure that they communicate effectively with their student. In order to do so, a lecturer should try to achieve clarity of delivery, clarity of expression and clarity of structure.

However, there are some steps expected in the teaching of concept. These are:

1. The teacher should state the objectives of the lesson clearly and should present the students with many examples.
2. The teacher should be aware of the required knowledge that will facilitate the understanding of the students. The student must be able to distinguish one object from another. This ability to discriminate among objects, ideas, etc. is a pre-requisite for knowledge acquisition.
3. The teacher should present definitions' and examples. The teacher should first select the definition, including the attributes, before selecting the appropriate examples and non-examples.
4. The teacher should provide for response from students and give feedback. He should test the students' knowledge of concepts by having them point out new

and unfamiliar examples of each concept. When necessary the teacher should demonstrate the use of the concepts (N.T.I, 2008).

The West African Examination Council (WAEC) Examiner report (2008-2010) reveals that students' performance in science subjects and Mathematics is becoming low. Such problems have been traced to the traditional method of teaching used as well as laboratory facilities, equipment and apparatus. Mathematics educators are strongly advocating for change in methodology of science and mathematics teaching. It has been identified as one of the factors that contribute to poor achievement (Kajuru & Ado 2010, Jamilu, 2013, Abakpa, Benjamin &Iji 2013).There is need for mathematics teachers to initiate strategies that will level up with materials learnt.

2.06 **Test Anxiety and Mathematics Performance**

Psychologists have viewed the concept of anxiety as any situation that threatens the well being of an organism is assumed to produce a state of anxiety. By anxiety, we mean a normal reaction to stress. Sometimes, it can be positive; if it assists you deal with a tensed situation in the office, study harder for an exam, handle a new situation, or stay focused on an important task. In general, it assists people to cope. But when anxiety becomes excessive, doesn't fit the situation, or lasts for a longtime, it can get in the way of your everyday activities and may interface with how you get along with others. There are several recognized types of anxiety conditions. These include: Panic anxiety**,** Social anxiety, and Specific phobias and generalized anxiety. The latter involves excessive, unrealistic and tension even if there is little or

nothing to provoke the anxiety, such as test anxiety. In this unit it will be divided into the following subunits for easy understanding. These are:

- The Concept of test-anxiety
- Symptoms of test-anxiety
- Causes of test-anxiety
- Treatment of test-anxiety
- The Theory of test-anxiety
- The Educational implication of test-anxiety
- Geometry test-anxiety and performance

2.06.1 Concept of Test-Anxiety Anxiety

Test anxiety is a combination of over arousal, tension and somatic symptoms along with worry dread or fear of failure and catastrophizing, which occur before or during test situations. A little bit of nervousness can actually be helpful, making you feel mentally alert and ready to tackle the challenges presented in an examination. Excessive fear, on the other hand, can make it difficult to concentrate and you might struggle to recall things that you have studied (Kendra, 2015).

Test anxiety is a type of performance anxiety. In situations where the pressure is on, and a good performance counts, people can become so anxious that they are actually unable to do their best. While people have the skills and knowledge to do very well in these situations, their excessive anxiety impairs their performance. The severity of test anxiety can vary considerably from one person to another (Putwain, Wood & Symes, 2010). Some people might find it difficult to concentrate on the

examination. Others might experience a racing heart beat and a sense of shakiness. In the most severe cases, people can feel nauseous and short of breath or might even experience a full-blown panic attack.

2.06.2 Symptoms of Test Anxiety

Kendra (2015) has reported that the symptoms of test anxiety can vary considerably and range from mild to severe. Some students experience only mild symptoms of test anxiety and are still able to do fairly well in examinations. Other students are nearly in capacitated by their anxiety, performing dismally on tests or even experiencing panic attacks before or during exams.

Physical symptoms include: sweating, shaking, rapid heartbeat, dry mouth, fainting and nausea. Milder cases of test anxiety can cause a sense of butterflies in the stomach while more severe cases can actually cause students to become physically ill.

Cognitive and behavioral symptoms include: fidgeting or outright avoidance of testing situations. In some cases, test anxiety can become so severe that students will drop out from school in order to avoid the source of their fear. Students with test anxiety report blanking out answers to the test even though they thoroughly studied the information and were sure that they know the answer to the questions. Negative self-talk, trouble concentrating on the test and racing thoughts are also common cognitive symptoms of test-anxiety.

Emotional symptoms of test- anxiety can include depression, low self-esteem, anger and a feeling of hopelessness. Students often feel helpless to change their situation or belittle and berate themselves about their poor test performance. Fortunately, there are

steps that students can take to alleviate these unpleasant and, often times, harmful symptoms. By learning more about the possible causes of their test anxiety, students can begin to look for helpful solutions.

2.06.3 Causes of Test-Anxiety

Test anxiety can be very stressful for students who suffer from it, nervousness and are perfectly normal reactions to stress. Now what are the causes of test anxiety? For many students, it can be a combination of things. Bad study habits, poor past test performance and an underlying anxiety problem can all contribute to test-anxiety. Kendra (2015) is of view that there are two major causes of test anxiety: Biological and Mental factors. He explained that anxiety condition have changes in certain brain structure that control memories linked with strong emotions. In addition, studies have shown that test anxiety runs in families. This means that they can at least be partly inherited from one or both parents like risk hearts disease or cancer. Moreover, certain environmental factors, such as trauma or significant event may trigger an anxiety problem in people who have inherited susceptibility to developing the condition (Akman, 2012).

Olaleye and Odebode (2013) have submitted that the causes of mathematics anxiety can be classified into three categories: Personality factors: these include reluctance to ask question due to shyness, low self-esteem and for females, viewing mathematics as male domain.

Environmental factors include negative experience in the classroom, parental demand, insensitive teachers and use of traditional teaching method where mathematics is taught and thought of as the memorization of formulas, the long,

monotonous computation and manipulation of numbers (Adaramola & Obamanu, 2013).

Intellectual factors include, being taught with mismatched learning styles, students' attitude and lack of persistence as well as lack of confidence in mathematics ability.

2.06.4 Treatment of Test- Anxiety

Treatment for generalized anxiety can involve cognitive-behavior therapy: learn new coping skills, relaxation techniques and medication based on submission made by Kendra (2015):

- Cognitive –behaviour therapy is often an effective treatment. This therapy focuses on changing disrupting thinking and assists the individual to change their reductions to stress.
- Learn new coping skills and relaxation techniques is often beneficial to test anxiety client using systematic desensitization. The desensitization process has three major components. Which are:
    i. Repeated safe exposure to anxiety-evoking situations
    ii. Stop visualizing and continue relaxing, and
    iii. Visualizing anxiety and evoking scene when relaxed. The aim is for relaxation to replace the anxiety previously associated with the scene:
- Medications including anti-pleasant and anti-anxiety drugs are often used in combination with the therapy. Any co-occurring

problems must be treated using the appropriate therapies, treatments or medications.

2.06.5 Theories of Test-Anxiety

Test anxiety refers to a combination of physiological, emotional and cognitive components that are caused by the stress of taking exams and may interfer with one's concentration, planning and academic performance (Salkin, 2008). George and Seymour in Salend (2012) developed the theory that anxiety present in testing situations is an important determinant of test performance. Individuals that become highly anxious during tests typically perform more poorly on tests than low test anxious persons, especially when such tests are given under a stressful evaluation condition. The feeling of forgetfulness or drawing a blank are developed because of anxiety produced interference between relevant responses and irreverent responses generated from the person's anxious state. The difference in performance of a high anxious test taker compared to a low anxious test taker is largely due to the difference in their ability to focus on the tasks required.

Putwain, Woods and Symes (2010) have stressed that a low academic self-concept was associated with higher worry and tension about their abilities to do well on a test. Student meta-cognitive beliefs play an important role in the maintenance of negative self-beliefs. Salkin (2008) is of the opinion that anxiety reactions can be generalized from previous experience to testing situations feeling of inadequacy, helplessness, and anticipations of punishment or loss of status and esteem manifest anxiety responses. As well, the presence of an audience can debilitate performance

of a high anxious test taker and increase the performance of low anxious test takers. Interestingly, persons who score high on anxiety scales tend to describe themselves in negative, self-devaluing terms. Highly anxious test-takers also blame themselves for their failure significantly more than low anxious test takers.

Yerkes-Dodson's law has stated that there is a correlation between anxiety and performance. That is if the child doesn't have a feeling of fear or failure or some sort of encouragement to perform well on the test, then the child is unlikely to put the necessary effort into preparing or being motivated when taking the test and so he or she will not perform to their fullest potential. Another interesting theory is that of attention theories, which have two main groups that attempt to explain compromised performance in pressure situations.

One group of theories is the explicit-monitoring theories. They stated that when a person is expected to perform a specific skill, the pressure may cause an increased self-consciousness and inward focus, which can disrupt their ability to successfully perform that task (Andrews & Wilson, 2004). The second group of theories is distraction theories. These theories have stated that a high pressure environment create a dual task situation. In which case the person's attention is divided between the task at hand and unhelpful thoughts about the situation and possible negative consequences of poor performance (Andrews & Wilson, 2004).

Attention is an important part of working memory, which is the system that actively holds several pieces of relevant information in the mind while inhibiting irrelevant ones. Working memory has limited capacity, and the addition of stress and anxiety reduces the resources available to focus on the relevant information. When comparing these two theories in the context of academic performance, a majority of

work supports distraction theories. One reason for this is that many of the skills performed in the classroom have heavy demands on working memory.

However, there are different kinds of pressure situation. There is monitoring pressure in which an individual's performance is impacted upon due to the pressure of evidence. The outcome pressure is another one in which an individual's performance is influenced by the consequences of the testing result. Findings have indicated that performance is compromised in different ways depending on the type of task and the types of pressure. Both theories can be correct (Vaez & Laflamme, 2008).

2.06.6 The Educational Implications of Test Anxiety

Psychologists such as Liebert and Morris in Salend (2012) have analyzed the structure of test anxiety given on two distinct factors: cognitive test anxiety and emotionality. Cognitive test anxiety is also known as worry. It is mostly composed of the individual's cognitive reactions to situations where they are being evaluated in the times prior to, during, and after those tasks. Some of the thoughts that individuals with high cognitive test anxiety are constantly dealing with are: comparing self performance to peers, considering the consequences of failure, low levels of confidence in performance, excessive worry about grades, feeling that they are unprepared for tests, and loss of self-worth.

Emotionality means that the individual shows high levels of several different symptoms related to test anxiety that can be seen through physiological responses, experienced during situations where they are being evaluated. Emotionality is a distinct part of test anxiety. However, it can be seen that when an individual displays high

emotionality it means that it is mostly associated with declining performance, but only when the individual is also experiencing high levels of worry.

Moreover, adolescents have to cope with the strong emotions they don't understand and hardly control. Girls and boys become attracted to each other and move in groups. They need sympathetic and knowledgeable adults to guide them through the confusing explanations and advice from different sources. As a teacher of Mathematics, you have a role to play in this situation. Some of educational implications of emotion in mathematics classes are:

- As a mathematics teacher, you should understand the bodily changes taking place in adolescents and how they affect their emotional reactions. You should make allowance for accessional outbursts and guide them to understand and overcome the effect of these changes.
- Know that an emotional behavior can be generalized from one situation to another. As a result, the mathematics class and school should be a pleasant place to work and play in.
- If the ensuing emotional experience is pleasant, it will lead the student to love learning. If failure is greeted with scolding, corporal punishment, little attention to motivation, charity, and relevance, students will dislike schooling. When learning becomes so unpleasant experience, it creates the emotion of fear and boredom.
- In such situations, even the bright students will fail to profit from learning.

- Emotional reactions such as fear, anxiety, guilt, jealousy and anger can inhibit bodily function, growth and even learning. Therefore teachers of mathematics must learn to satisfy the emotional needs of their students.
- Mathematics teachers must promote the emotions of love, tenderness, rest, joy, pleasure, humour and laughter to facilitate mental health among learners of mathematics (N.C.T.M, 2000).

2.06.7 Geometry Anxiety and Performance

Geometry anxiety is a phenomenon which leads students to experience irrational fear of geometry to the extent that they are unable to think about, learn, or be uncomfortable with the subject. Garba (2013) has observed that the feeling of tension and anxiety interfere with manipulation and solving of geometrical problems in a wide variety of ordinary life and academic situations. Geometry anxiety affects students' confidence in geometry and mathematics in general. Many students who suffer from geometry anxiety have little confidence and ability to do geometry. They tend to take the minimum number of required mathematics course, greatly, limiting their career choice options (Olaleye, 2007).The pertinent question is: what is the level of anxiety which is acceptable and beyond which performance is negatively significant? The correlation between mathematics anxiety and academic performance is negatively significant (Garba, 2013). It was also found that students with a high level of mathematics (geometry) anxiety have lower level of mathematics performance (Josiah, Owolabi, &Efuk-iren, 2014).

Salawu (2000) has lamented on poor performance of students in Mathematics and he is of believed that if the mathematics teachers use suitable instructional methods,

the students' performance will improve. Kajuru and Popoola (2010) have advocated active involvement of students in the teaching and learning processes as an index to high achievement. This study is using collaborative and scaffolding learning strategies that can neutralize the prevalent mathematics anxiety related to high achievement in mathematics. The truth or falsity of this claim is also a concern in the study.

2.07 Retention Ability in Mathematics

Learning can be defined as a relatively permanent change in an organism's behaviors due to experience. Learning changes behaviour, but the change should be relatively permanent and should be as a result of experience. Learning is an internal process. The psychologist agreed on the importance of learning as an object of study but disagreed on the mechanics of how the learning process occurred (Ajani & Popoola, 2013). There are about three major schools of thought on (Adaramola and Obomanu, 2013). These are:

- **Behaviorist- Associationist**: This views learning as resulting from the forming of connection between stimuli and observable response. This school describes learning as logical and requires a memory system to retain products so learnt.
- **Cognitive-Gestaltist**: They believe that learning results from the re-organization of perceptions and forming of new relationships. Learning is seen as the understanding of a total meaningful relationship and that the only acceptable approach to the study of learning is the cognitive one.
- **The Information-processing Approach**: Contemporary theories of human learning and memory have proposed that the stimulation encountered by the

learner is transformed, or processed into a number of ways by internal structures during the period in which the changes were identified as learning take place.

Although there are different types of learning, it is difficult to make a clear-cut classification as the individual categories tend to overlap with one another. Bloom divided learning into three (3) major types:

(1) Cognitive learning which emphasizes intellectual endowments such as learning facts and problem-solving.
(2) Affective learning deals with development of attitudes and emotion.
(3) Psychomotor learning is concerned with skills development such as walking, writing, swimming, knitting, etc. These require the use of motor skills.

2.07.1 Theories of Retention

Anderson (1977) in Tan et al (2003) developed schemes of theory which is related to levels of processing and retention. The term scheme was first used by Piaget. So it was not an entirely new concept. He views knowledge as an elaborate network of abstract mental structures which represent what one understands of the world.

The contemporary learning theory also embraces schemes theory which says that information is best encoded in the long-term memory. The theory emphasizes the nature and purpose of scheme as the fundamental elements of cognitive processing (Tan et al 2013). Research by scheme theorists indicates that abstract concepts are best understood after a foundation of concrete and relevant information has been established. The general knowledge provides a framework into which the newly

formed structure can be fitted. Prior knowledge linkages influence the amount and proficiency of learning. It also elaborates upon attentional control theory, anxiety disrupts the balance between these two systems (directed and stimulus driven).

Therefore, this theory supports the fact that, there is strong evidence that anxiety largely impairs processing efficiency rather than retention and performance efficiency (Salend, 2012). People with higher working memory capacity do better on retention and academic performances, but this change when people are under acute pressure (Vaez & Laflamme, 2008).

Another relevant theory on retention is that of John and Sherawn in Augustina (2014). They proposed four psychological theories: attitude behavior theory which provides the overall structure of the theoretical model, coping behavioural (approach-avoidance) theory, self-efficiency theory, and attribution theory; locus of control that lead to academic and social integration. The four psychological theories are of view that learning must relate new knowledge to what the learner already knows. For learning to be meaningful, it requires knowledge to be constructed by the students not transmitted from the teacher to the student (Mamman & Isah, 2014). That meaningful learning must contain eight (8) primary attributes. These are: manipulative, constructive, reflective, intentional, complex, contextual, collaborative and conversational as in the scaffolding enriched collaborative strategies.

The network theory of memory organization propounded by McClelland in Augustina (2014) is on how you file and store billions of things over your lifetimes at a place called nodes. This links information through thousands of nodes, which make up a gigantic interconnected network of files for storing and retrieving information. Nodes are mental files that contain related information organized around a specific

topic. Thousands of mental files are arranged in a certain kind of order called network hierarchy (Augustina, 2014). In the theory, nodes or mental files are like thousand of cities on a map and are connected or associated by roads. According to network theory, when you are asked a question, you look for the answer using different node files or mental files. This idea of the network theory is confirmed by recent findings showing that the branding seems to have its own built in filing system (Augustina, 2014).

2.07.2 Forms of Learning

Human learning can take many forms, but we shall discuss it in the forms that are necessary for functioning as teacher. These are:

a. Simple versus complex learning.
b. Whole versus part learning.
c. Rote versus discovery learning.

2.07.2.1Simple verses Complex Learning

Learning can be simple. This approach builds on the assumption that human learning must take into account the stage of development of the learner. An experienced teacher must always teach the younger child, the simpler skills and ideas that would be mastered. Simplicity in learning means that we should build the necessary foundation for more demanding learning tasks. It is a fact that a young child of 2years cannot be taught how to read before he learns the alphabets of a given language. He would be too young for this learning activity. Also, adults can engage in simple learning. In this case, we are primarily concerned with the nature of the

learning task. If the outcome of learning is defined as the ability of the learner to recognize, remember or recall a given fact, then this is simple learning.

On other hand, learning can take a complex form. In such a case, the learner is required to build on previously acquired knowledge in performing subsequent tasks. With practice, it is possible for someone to move from simple sentences to the construction of compound and complex ones. Complex learning also involves the utilization of a learned method in the solution to problems of similar nature. The learning of mathematics is based on the assumption that when the child understand the tasks involved in addition, subtraction, multiplication, and division, he naturally has a good chance of coping with more complex mathematical task. For example, consider the use of "BODMAS" (bracket of division, multiplication, addition, subtraction) in solving some more complex problems in Arithmetic (Kajuru & Ado, 2010).

2.07.2.2Whole versus part learning

Among teachers, there are those who believe that learning proceeds better if the learner adopts a step-by-step approach. That was the argument by some scholars (Adaramola &Obamanu, 2013). Learning task contains certain elements which need to be broken down before it makes meaning. In calculating the length of the chord of a circle, their position is that, the major arc and the minor arc should be learnt before the major and minor segments. In this instance, even common sense would dictate this approach. It is in the interest of the learner, since during recall, the learner has a great chance than when his mind is crammed with information. The advantage of this kind

of learning is that it gives ample opportunity to a learner to clear areas of difficulty before proceeding to other areas.

2.07.2.3Rote versus Discovery Learning

In rote learning, the learner commits a learning material into memory without understanding it. Discovery learning encourages the learners to look beyond available facts. Rote learning is not very efficient because it does not prepare the learner to utilize present knowledge in the performance of subsequent and more demanding task. But discovery learning encourages the students to search for knowledge by themselves. It brings added interest to the learning activity.

Observation and analysis of several finding have indicated to us that each human being possesses a number of qualities that make him different from others. There are some specific individual qualities that affect learning such as: age, self-concept, family circumstances, peer group and level of ability. Teachers can do their work with greater effectiveness if they take into account and show awareness of these variables that go with learning

2.07.3 Stages of Learning

Learning is an internal process and it often occurs in stages. Psychologists have identified three stages in learning. The three stages are not exclusive of each other. Rather, they are interrelated and in succession:

- Acquisition
- Retention
- Recall

2.07.3.1 Acquisition: This is when the learner receives the information as stimulus. This stage of processing the information is referred to as acquisition by the learner.

2.07.3.2 Retention: The information received by the learner may be stored in the memory. This is the stage where mental processing begins in terms of meaningfulness, interpretation and decoding.

Memory is our ability to store retrieved information. It is very important for the survival of the human species for without it no one would retrieve any previously learnt information. People think and reason using remembered facts and can only deal with the concept of time-past, present and future with the aid of memory.

Retention could be in Short Term Memory (STM) or Long Term Memory (LTM)

Short Term Memory (STM): the function of this storage system is to process information that had been stored and which is needed immediately.

Long Term Memory (LTM): Here, the information which is not immediately needed is processed and pushed out of the short term memory into the long term memory. This implies that only information that is needed over a long period is stored in long term memory.

It was reported that most human beings can retain an average of seven items of information at a time in short term memory. Given the short term memory's capacity for retaining information, people tend to be selective about the stimuli they receive. They focus only on what is perceived to be relevant and important for their processing. Long term memory on other hand is not only unlimited in capacity but

also capable of retaining all the experience a person had during his life time. Information in long term memory may not be forgotten easily (N.T.I. 2008).

A number of factors have been identified, to enhance our ability to store and retrieve information already learnt. Teachers working for the promotion of teaching and learning need to be mindful of these factors for that would assist them fulfill their duties. The factors are: recognition, rehearsal, org*a*nization, meaningfulness, mnemonic devices, attention and relearning.

2.07.3.3 Recall: This is the process whereby information that had initially been acquired and retained is subsequently retrieved. If for any reason, acquired information cannot be recalled, something may be wrong with retention, which has not made learning possible. It is important to note that learning completes its circle when information acquired is retained and are subsequently retrieved or recalled.

2.07.4 The Concept of Geometry Retention

The concept of geometry retention has been defined variously by different writers according to their understanding and perspective. Geometry retention is defined by Bello (2013) as the ability of the students to reproduce the geometrical concepts learnt after an interval of time or when the need arises. Geometry retention takes place when learning material is coded into memory. Thus, appropriate coding of incoming information provides the index that may be consulted. Retention takes place without an elaborate search in the memory lane (Omar, 2013). The nature of the materials to be coded contribute to the level of retention in terms of their meaningfulness, familiarity, concrete and image evolve characteristics.

According to Chianson, Kurumeh and Obinda (2011), mathematics retention is the preservation factor of the mind. The mind acquires the materials of knowledge through sensation and perception. Those acquired in the mind need to be preserved in the form of images for knowledge to develop. Whenever a stimulating situation occurs, retained images are revived or reproduced to make memorization possible. Hence, mathematical concepts needed to be presented to the students in a way or method that touches their consciousness which can trigger quick recalling of the concept being taught or learnt. Using such teaching methods as collaborative and scaffolding, both high ability and low ability learners would be able to collaborate in terms of understanding, explaining and retaining the concept they have experienced in a mathematics class.

Collaborative and scaffolding strategies emphasize active participation. They reduce ambiguity and assist the learner to connect the new information to what they already know. While reducing learning ambiguity and assisting the learner place the new information in their own internal representation of the knowledge. Scaffolding aids in the construction of meaningful and structured relationships between what the learner knows and new knowledge as well as transforming the new information into personal knowledge (Abraao, 2006). The teacher's role is to guide the process of learning and make it pleasurable. This means that he should make special effort to understand the nature of learning and those conditions that result in very effective teaching. Teaching can be done in various ways. The teacher is encouraged to vary his style of doing things so that he can ensure learners retain their interest in what goes on in mathematics class.

2.07.5 Factors Affecting the Retention of Geometry.

Psychologists have made attempts to study or understand why certain body of information or skill is forgotten after a while. A number of explanations are often given on the factors affecting Mathematics performance and retention. The Major factors are: lack of attention, learning too much mathematics materials at a time, poor rehearsal, and poor organization of serial position effect, previous unpleasant experience, and interference from present or previous learning.

- Lack of attention: mathematics learning material will not be processed into the short-term or long term memory if it is not attended to. It will disappear since it has not been processed at all.
- Too much mathematics materials at a time: the sensory memory and short-term memory have limited capacity for storing and processing mathematics material. Our ability to understand and recall what we experienced largely depends on how much material we are forced to deal with at one time.
- Poor rehearsal: when material being learnt is not well practiced, it cannot move from the short term memory to the long term memory. Similarly, material in the long term memory will be difficult to reproduce if it is not used for a long time. Indeed, there is a limit to the amount of time that information lasts even in long term memory. In other words, after a very long time, forgetfulness sets in. This is outlined in the Chinese proverb: 'I see I remember, I hear I forget, I do I understand. Another emphasis is on motivation and interest. This implies that the teachers' role is to facilitate learning by providing a variety of experiences already familiar and important to the students.

- Poor organization: a good mathematics teacher must not teach disjointed facts, or unrelated materials. This will confuse the learner as they will find it difficult to organize it into the scheme they already have in their long term memory. At the time of retrieval, they are likely to find it difficult to get cues. But when the material learnt is meaningful and well organized it is recalling is enhanced. The search for them at the time of recall becomes easy.
- Serial position effect: when we attempt to reproduce a list of words, we begin by recalling words at the end of the list, which is those more recently presented. Then we proceed to the recently presented and then proceed to the beginning of the list. The words in the middle are most likely to be easily forgotten. These is because the early experienced items were better encoded or rehearsed and are therefore more likely to be stored in long-term memory. Furthermore, the items that fall at the end of the list are well reproduced because they occurred so recently that they may still reside in the short term memory. This can be easily demonstrated in the learning of the alphabets or numerals by children in the primary school.
- Previous unpleasant experience: previous knowledge recorded in the long term memory influences the recall of information. Particularly painful or sad memories or events are though still in the long-term memory they are prevented from coming into our consciousness. This is because their recall would cause us strong feelings of guilt and anxiety. This is sometimes referred to as motivated forgetfulness or repression.
- Interference from present or previous learning; we forget because the learning of one group of materials may interfere or inhibit the recall of some other

learnt material. When previously learnt items prevent the recall of new learning, we say there is proactive inhibition. Conversely, when newly learned materials hinder the recall of previously learnt ones, we say there is retroactive inhibition.

Thus, mathematics retention is one of the most important variables in learning mathematics. According to Olunloye (2010), teachers should improve their teaching methods in order to enhance better understanding and application of geometry among the students, so that their interest could be aroused. There is need to explore approaches that will improve students' achievement and retention. Current result (WAEC, 2010) indicates that the conventional teaching approach is deficient. Teachers of mathematics have the potential of exerting strong influence on students learning. It was reported that there is a positive correlation between good teaching strategy, retention and achievement (Hassan, 2010). Also Iji (2005) has stated that good teaching approach improves both low and high ability students in geometry at the upper basic education class. Good teaching approach produces high retention and achievement among learners of mathematics. This is what necessitated the researcher to examine the efficiency of scaffolding-enriched collaborative strategy on academic achievement, retention and anxiety in geometric concepts among senior secondary school students.

2.08 Geometrical Performance of Students

The rise of Geometry was simultaneous with the rise of civilization. When people were aggregated into permanent population centers, it became necessary to precisely measured areas so that proper taxes can be collected and measure in the

third dimension so that magnificent buildings can be constructed. These developments could not be achieved without the knowledge of Geometry. In the beginning, Geometry was a collection of rules for computing lengths, areas and volumes. Many were crude approximation derived by trial and error. This body of knowledge developed and was used in construction, navigation and surveying by the Babylonians and Egyptians, which was later passed on to the Greeks.

The Greek historian Herodotus in the 5^{th} Century BC gave credits to the Egyptians for originating the subject geometry. But there was much evidence that the Babylonians, the Hindu civilization and the Chinese knew much of what was passed on to the Egyptians. When the ancient knowledge of Geometry was passed on to the Greeks, they insisted that Geometric statements be established by deductive reasoning rather than trial and error. When people are familiar with compotators, right or wrong, they now developed logical Geometry. This orderly development of theorems by proofs was the destructive characteristics of Greek mathematics.

At about 300BC, Euclid organized all the geometry and much of the arithmetic's and number theory that was known (some 300years of work by earlier Greek mathematics) into a single cohesive work, the Elements. Euclid was a disciple of the platonic school. He produced the definite treatment of Greek Geometry and number theory in his thirteen (13) volume elements. In compiling these master pieces, Euclid built on the experience and achievement of his predecessors in the preceding centuries. Though Euclid's heirs have not been able to collect royalties on his work, but he is regarded as the most widely read author in the history of mankind. His approach to Geometry has dominated the teaching of the subject for over two

thousand years. This branch of mathematics has been subjected to challenges from age to age. Among those who contributed to this area of mathematics are: Fermat, Gauss, Jean Victor, Chatus Julian, Brancham, Julius Pluckier, to mention but a few. Geometry is an integral branch of mathematics which deals with the study of points, line, angle surfaces, and space.

The study of Geometry creates spatial relationship of different shapes, positions and sizes. It assists to observe, think and find out the value of image produced and how to combine two or three-dimensional shapes to create one in the environment. The study of Geometry assists to develop the mind in determining differences especially at early stages of our life as in games. Children are made to place different shapes in the right positions (Hassan, 2010).

Despite the importance of Geometry and its application to human life in construction, technology and spatial relationships. It is least understood by students, thereby contributing to their low achievement (Abakpa et al, 2013). Geometry as a vital branch in mathematics curriculum of senior school continued to be disliked by majority of students. Some of the students are known to record poor performance in both internal and external examinations in mathematics with greater differences in geometry (Awotunde & Bot, 2013).

Senior secondary school students in Nigeria are capable of developing good reasoning about geometry concepts if they have had the basic knowledge foundation at the junior secondary school level. Majority of students develop misconceptions and others fail to go beyond simple visual perception of geometric shapes (Hassan, 2010). Geometry in particular can be said to make the least impression on students. This is

because some students do not only avoid learning it, but perform poorly as they make effort. Students exhibit weakness in areas of angles, properties of plane shapes, loci, bisection, mensuration, construction and in the solution of three dimensional problems (Awotunde & Bot, 2013). They also indicated that specific weakness in solving geometry questions were manifested in the construction of trigonometric graphs, division of a given line segment into a given number of parts or ratio, bearing and inability to drew correct diagram for a given problem situation.

The Chief Examiners WAEC (2007) report on students' areas of deficiency in school certificate examinations indicated that students' least understood geometry concepts as shown by their achievement. Most students avoid geometry question or haphazardly attempted them. The learning of mathematics has become an imperative in every society if the citizens are up to cope with the fast changing developments in science and technology. Research evidences indicated that many reasons account for students' poor achievement in Geometry. Among these are poor teaching strategies (WAEC, 2007&Oluloye, 2010).

Teachers have the ability of exerting strong influence on students' learning (Uloko & Usman, 2007). They reported that there is a positive correlation between good teaching strategy and students' achievement in mathematics. Also, Iji (2005) has stated that good strategy improves both low and high ability students in geometry at the upper basic education class. Good teaching strategy produces high achievement among students of any level while poor teaching strategy will lead to poor learning and low achievement.

2.09 An Overview of Related Studies

Studies that have been carried out in the past that are related studies to this study were reviewed to serve as a guide. Especially on impact of scaffolding and collaborative strategies on academic performance, test-anxiety and retention in different institutions of learning in Nigeria and world at large.

The study conducted by Chianson et. al (2010) on the effects of cooperative learning strategy on students' achievement in geometry in secondary schools in Benue state. The purpose of the study was to examine the effects of cooperative learning strategy of senior secondary two (SS2) on achievement of content knowledge of circle geometry. Cooperative learning was compared to the conventional teaching method using a quasi-experimental design. An achievement test consisting of twenty (20) questions on circle geometry designed by the researchers was administered to 358 students. The pre-GAT (Geometry Achievement Test) scores were used as covariates to adjust for possible pre-existing difference between the groups. The data collected in the study were subjected to Analysis of Covariance (ANCOVA) at 0.05 level of significance. The result showed significant difference between the cooperative learning group and the conventional learning group in achievement. There was no significant gender difference in the achievement score of the students taught using the cooperative learning method. Based on the findings of the research, cooperative learning should be introduced as viable learning strategy in secondary schools in Benue State. The following variables used by the researcher, such as, geometry, senior secondary (SS2), strategy instruments are all relevant variables in this present study, so it has gives the present researcher an insight. The researchers have left an

important aspect which is affective domain, which this present study would address.

Another interesting study was the study conducted by Oloyede et al (2012) on the effects of competitive, cooperative and individualistic classroom interaction models on learning outcomes in Mathematics in Nigeria senior secondary schools. The study sought to find out the relative effectiveness of three classrooms interaction strategies which are known to affect student learning outcomes in mathematics. 484 senior secondary school three (SSIII) students were randomly selected through judgmental and stratified random sampling from government-owned secondary schools in Ikere and Ado-Ekiti local government area of Ekiti State. The instrument was a self-constructed one, validated and used for collecting data. The experimental treatment lasted for four weeks, and the data collected were analyzed using one-way ANOVA, two-way ANCOVA, and the TurkeyHSD post hoc pair wise comparisons analysis. The findings showed that the students learning outcomes in mathematics were better promoted by the cooperative and competitive strategies but rather, minimally by both individualistic and conventional strategies. The researchers presented a beautiful lesson model on cooperative learning strategy which is relevant to this present study. And that gives insight into how to modify it for the present study. The level of education in the study is the same with that adopted for the present study, thereby made the instrument constructed vital for this study.

A study conducted was by Mamman and Isah(2014) on the influence of cooperative learning strategy on retention in geometry among junior secondary school students in Sokoto metropolis. A quasi experimental design was employed with ten (10) co-educational junior secondary schools with 3,137 students forming the

population of the study. Two (2) schools out of the ten (10) were selected purposively as the sample of the study of (133) making (266) students. A hypothesis was formulated and tested, using t-test. The result of the study indicated that there was significant difference in the mean scores of the experimental group over the control group at alpha= 0.05 level of significance.

Though, the level of education used by the researchers is not the same with the present study but other variables used are relevant. The researchers also left out academic performance and anxiety but the present study would look into them.

Another interesting research was conducted by Kajuru and Isah (2014) on the impact of cooperative learning strategy on performance in geometry among junior secondary school students in Sokoto Metropolis. A Quasi experimental design employing pre-test and post test was adopted. The population size was 3137 students from (10) juniors secondary schools with sample of 133 making 266 students. A hypothesis was formulated, to investigate the problem. The result of the study revealed that there was significant difference in the mean scores of the experimental group and the control group at alpha=0.05 level of significance. Also, it was found that cooperative learning strategy has significant impact on teaching and learning of mathematics than lecture method. The finding of the study served as reference point for the present study because it has dealt with some important variables- teaching strategies used, geometry and performance. The study would guide the researcher on how to construct the lesson model on cooperative learning strategy and t-test used for hypothesis testing. The present study would expand the scope by including retention and anxiety.

A research conducted by Abdullah (2009) investigating the effect of cooperative learning on the academic achievement and retention of mathematics concepts at the primary school in Holly Makah. The study sample was (59) students divided into two groups, the control group (29) students been taught traditional strategy and experimental group of (30) students being taught mathematics concepts using the strategy of cooperative learning. An achievement test was used as an instrument to collect information and study data frequencies, percentage, means, standard deviation as well as (t.-test) were used for the analysis of the data and information.

The results of the study showed that there is a statistically significance difference at the level of (0.05) between the means of performance of experimental and control group on the achievement and retention test for the benefit of the experimental group. The study is carried out from different level of education and place, but the literatures supports use of multiple intelligences, incorporating group work, and using positive reinforcement to increase student academic performance in Mathematics. The study is relevant to this present study because of the literatures cited in it.

The research conducted by Remalyn (2013) on the effects of scaffolding strategy on students' attitude and performance. He used eighty (80) students who were randomly selected. The study made use of the true experimental design, the pretest-posttest, descriptive and correlation research design. The experiment group was exposed to scaffolding strategy, and they were handled one hour from Monday to Friday (11.00-12.00pm). Combinations of several techniques such as modeling, offering explanations, clarifying students' responses, use of scaffolding questions, use

of visual organizer, cooperative learning (think pair-share technique), guided practice, and computer technology integration were employed to the experimental group. The control group was exposed to conventional strategy which utilized board work, workshops, lecture method, and the likes with an hour lecture from Monday-Friday (12.00-1.00pm). Both groups completed the selected topics in mathematics which were classified as quadrilaterals, properties of parallelograms providing quadrilaterals as parallelograms. There were two instruments used for the study. The study revealed the following findings.

1. Based on the pretest, the two groups were comparable

2. There was no significant difference in the level of attitude of the two groups before and after the conduct of the study in terms of confidence in learning mathematics, attitude toward success in mathematics, mathematics anxiety and perception of teachers' attitudes.

3. A positive high relationship existed between performance and attitudes of the experimental group.

4. The scaffolding strategy was found to be effective in improving the performance. It also had an impact on the attitudes of the participants toward mathematics. The findings points to fact that scaffolding teaching strategy can improve mathematics performance of secondary school students just as it enhances personal connection with teacher and peers in the classroom. A positive attitude toward mathematics can result to higher performance in the subject.

Remalyn (2013) has given the following recommendations as drawn from the findings and conclusions made from his research work. Mathematics teacher should use scaffolding strategy in combination with the traditional methods in teaching mathematics. Teachers of mathematics should continue to work to bring about changes, especially in the development of intervention materials strategies and the integration of instructional technology in the mathematics classroom. This would help the students to explore and discover mathematical concepts on their own for better retention and develop higher appreciation and positive attitudes toward subject. This study will guide the present research in selecting combinations of several techniques since the researcher of the work made some recommends for further studies to be undertaken on scaffolding strategy, which involve intensive and extensive use of the strategy. This serves as an encouragement to the present study. The lesson timetable, instruments, methodology and statistical tools used would serve as a guide to this research.

The study conducted by Hunter (2007) at a New Zealand urban primary school involved four teachers and one hundred and twenty (120) students. The students were from low socio-economic backgrounds. At the start of the larger study, students were predominantly at their lowest levels of achievement. The teachers were all experts with at least five years of teaching experience. They had completed the professional developments programme. A "Participation and Communication Framework" was designed as an organizing tool to assist the teachers to scaffold students, use of proficient mathematical practices within reasoned inquiry and argumentation. The framework of 'questions and Prompts' was a tool co-constructed during the study to deepen student questioning and inquiry. Student development of mathematical

practices is not the focus of the study but how they were inducted into the discourse of inquiry and argumentation. Data were collected from multiple sources, such as field notes, classroom artifacts, teachers' interviews, video and digital photo records of mathematics lessons.

The researcher provided extensive scaffolding for the students by the teacher through the use of a Communication and Participation Framework as well as Framework of Questions and Prompts. The teacher guided the students into the use of average proficient mathematical practices. These included using reasoned mathematical explanations, justification representations and generalization within mathematical argumentation. At the conclusion of the study, they were all united in their belief that all students can talk and interact mathematically in appropriate ways. This improved their attitudes toward mathematics and retention. The implication of the study is the need for mathematics educators to consider not only the importance of the development of mathematical knowledge, but also how it is constructed through collaborative and discursive talk. In this form, scaffolding needs to be metaphorically viewed as a "tool-and-result" and teachers need not only address how they teach but how their students learn. The Mathematical Association of Nigeria has an important place as a professional development tool but teachers need to develop their own script rather than use these rigidly. This research will assist the present study on how to address social constructivism, scaffolding and traditional teaching. The study is relevant to the present one because it will serve as an eye opener to the researcher the even when the level of education is different.

Abraao (2006) worked on two different methods for improving mathematics

learning in the classroom. The first method is a scaffolding strategy emphasizing active participation. The second method is solving equations by algebraic manipulation. Vygotsky asserts that the teacher or facilitator can provide the information by helping the learner build a structure into which he puts the new experience. The act of building this structure is called scaffolding. Put more simply, zone of proximal scaffolding is an interactive process by which the learner is assisted by others (teachers or peers) to acquire a skill which cannot be acquired without assistance.

Algebraic manipulation is a means whereby a student uses the rules of arithmetic to manipulate the variables and numbers in an equation to make it easier to solve and understand. The questions made for the study were organized into two different curriculums. The curriculums were organized so that all the questions in their share the same topics. The purpose of each curriculum was to determine the effectiveness of two different learning strategies. The students who received the experimental section with the scaffolding strategy were presented with a series of questions that broke down the problem into smaller steps, each one dealing with a more specific concept. Similarly, students who were assigned the hint strategy section were given a number of the answers but without the steps necessary to arrive at the answers and without asking them any questions. Data were collected and analyzed using statistical tool called star-view.

The study revealed that scaffolding is a more effective teaching strategy than providing only hints to the students. The second experiment compared algebraic manipulation, against variable substitution. According to “common belief”, it is more

effective to teach students how to solve problems; that is teaching them how to do algebraic manipulations than to tell them to plug in numbers at random .The latter strategy might be effective when given a small number of choices; it becomes problematic if that is not the case. This study shows that scaffolding is an effective teaching strategy than just using hints. Solving questions using algebraic manipulation is better than just guessing the answer. This study is an insight in to how to draw questions for pre-test and post-test. It also guides the present study on how to design the scaffolding strategy lesson model for an experimental group.

Gambari et al. (2014) investigated the effectiveness of computer animation and geometrical instructional model on mathematics achievement and retention among junior secondary school students. It also examined the influence of gender on students' achievement and retention. The research had pre-tests, post-test, experimental and control group design. Forty junior secondary school students were drawn from two secondary schools within Minna metropolis. Stratified random sampling technique was used to select 40 students (20 males and 20 females). The Geometry Achievement Test (GAT) was used for data collection. The reliability coefficient of 0.87 was obtained using Kuder-Richardson as the instrument. T-test statistic was used for data analysis.

The results obtained showed that students taught Geometry using computer animation performed significantly better in post-test and retention test than the control group that was subjected to instructional model and the conventional method respectively. However, there was no significant difference reported in the post-test performance scores of male and female students taught Geometry using computer

animation and instructional model respectively. These findings indicated that Geometrical concepts in mathematics could be taught and learnt meaningfully through the use of computer animation. Variables that are involved in this study are essential to the present study. It will serve as a guide and the instrument used will be adopted for this study.

Tisha (2008) also compared teachers' use of children's literature, mathematics manipulative and scaffolding to improve preschool mathematics. The primary aim of that was to determine if the implementation of an intervention involving teachers' use of children's literature, related storybook manipulative and a scaffolding approach to learning would improve preschool children's mathematics test scores. Sixty (60) preschool – aged children and sixty (60) teachers from two child care centre were sampled for the study. Two (2) research questions and two (2) hypotheses were formulated. The study was built on a quasi-experiment and two instruments were developed by the researcher for data collection. The ANOVA was used for data analysis.

The finding revealed that the scaffolding strategy is more effective than other instruction with young children. He suggested that there should be study on preschool children's ability, achievement and interest in mathematics. Teachers of mathematics should try to read and understand the scaffolding approach in learning of mathematics so that a good foundation would have been laid down.

Another study was conducted by Djwantoro (2010) on the use of scaffolding approaches to enhance students' engagement in learning structural analysis. According to him, several approaches have been attempted and the scaffolding

approach has been chosen for study because it makes the subject more interesting and the learning process more engaging. Quite a number of reports are available on the use of scaffolding practices in many different areas of learning; including mathematics learning (Abraao, 2006). The study which used primary school pupils nevertheless is relevant to the present study in that the researcher tried to explore different instructional models in relationship to performance. The finding would serves as guide to this study

Lipscomb et al. (2004) stressed that it is imperative to determine the right ZPD to make the use of scaffolding approach a success. He suggested two steps to be followed in the application of the scaffolding approach in teaching structural analysis and any area of studies:

"Development of instructional plan to lead the students from what they know to a deep understanding of new material".

This step involves the introductory part that raises students' interest on the topic, and to help them to connect with the prior knowledge. It is then followed by the delivery of the history and the theoretical background of the method. This is normally performed in traditional lecture format within a set time frame which is normally kept minimal. After providing one or two examples on the use of the method to analyses structures, it then followed by distributing worksheet equipped with procedures or steps, formulae, hints and tables. The scaffolds are carefully selected and prepared to make sure the activities are within the students ZPD.

Now the second step:

"Execution of the plans, wherein the instructor provides support to the students at every step of the learning process".

As students are busy with their worksheets, the teacher takes time to move around to see how they are progressing. Let them make mistakes from which they will learn. Lipscomb and his colleagues commented that despite some weaknesses, they found that the approach is worth to apply as one of the approaches to teach structural analysis to civil engineering students. Students are helped to learn by themselves or in a group through properly designed guided tasks, which are removed gradually with students' growing competence.

Another very important study is that of Chianson et al (2011). They investigated the effects of the cooperative learning method compared with the conventional learning method. The study was carried out on senior secondary II students in the education zones in Benue state. Three hundred and fifty-eight (358) students were sampled for the study and an independent t-test analysis was used to determine whether a statistically significant difference existed between the control and the experimental group.

The findings of the study confirmed that students who were exposed to the cooperative learning strategy were able to retain the concepts of circle Geometry more than those students who were taught using the conventional learning strategy. Hence, they suggested the adoption of cooperative learning strategy in teaching Mathematics in our secondary school in Nigeria. In fact, cooperative learning is an integral part of scaffolding learning strategy. Retention, circle geometry and conventional learning strategy are variables involved in this research. The reviewed study is of great

relevance to the present study because it is going to serve as reference point since retention and geometry are variables in this study.

Ugwuda (2008) conducted a quasi-experiment study on the effect of scaffolding on students' achievement and interest in learning simultaneous linear equation. Multi-stage random sampling and simple random sampling techniques were used to select 320 JSSII students, drawn from 4schoools, male and female in Ogbaru local government area of Onitsha Education Zone in Anambra State. Two instruments were used for data collection and two lesson plans were drafted, one for the scaffolding strategy and the other one for the conventional strategy.

Results of the study indicated that students exposed to the scaffolding technique achieve more and showed greater interest in learning the simultaneous linear content than those who were taught using the conventional method. It indicated that the scaffolding technique is an important strategy that will assist to bring a total change in method of teaching and learning in all subjects, especially mathematics. This study is relevant to the present research for it uses similar scaffolding teaching strategy and has shown how scaffolding skills can be taught. It serves as guide and reference point to the present researcher.

Obioma (2011) examined rebranding teaching strategies in mathematics using scaffolding instructional strategies as a way out. He looked at the concept of rebranding, meaning of scaffolding as a rebranded strategy, steps in the use of scaffolding instructional technique and effect of scaffolding strategy in enhancing achievement and interest. The researcher recommended that mathematics teachers should incorporate this technique as one of the techniques that will be used to bring a

total change (re-brand) in teaching mathematical contents in order to increase students' achievement and interest in mathematics.

This study is relevant to the present study in that its use of two lesson plans, one for scaffolding and other one for conventional strategy, steps to be used for the strategy, all of which are similar to this study. The conventional learning strategy of teaching is incapable of producing the effects required for coping with the problems of globalization in the world of science and technological development. The implication of this is that teachers of mathematics must search for good methods of teaching that would solve our problem.

2.10 Implication of Literatures Reviewed for the Present Study

Mathematics is a very important subject and an essential tool in the formation of a educated man. Its application in other field of studies, mostly in the sciences, is appreciative. Without it, knowledge of the sciences often remains superficial (Gambari et al., 2014).In Nigeria, mathematics is taught as a core subject to all students at the primary and post primary school levels. This is to give a sound basic foundation for scientific and reflective thinking and prepare them for tertiary education (F.G.N, 2013).

According to Abakpa et al. (2013), geometry is an integral part of mathematics which involves solid and plane shapes. Its operations, through Geometry, Algebra and Trigonometry help to develop reasoning and logical thinking among learners. It is imperative to point out that students' achievement in secondary school mathematics, especially Geometry, has been relatively low over the years (Hassan, 2010 & Gimba, 2013). Several factors that have been advanced to affect students' performance,

anxiety and retention include: the student factor, teacher factor, learning material factor, gender factor, socio-economic factor of parents and the teaching method adopted by the mathematics teachers.

Bichi (2004) in the context of his study teaching of science at secondary schools revealed that, our conventional teaching methods does not promote critical thinking as it develops only rote-learning. It also hardly catered for Bloom's Taxonomy of educational objectives. The affective and psychomotor domains were simply ignored in the teaching- learning process. Thus, the cognitive domain lowers intellectual skills, i.e. knowledge comprehension, and somewhat application were incorporated while analysis, synthesis, and evaluation remained ignored mostly (Adaramola & Obomanu, 2013).

Consequently, teaching method resulted to gender disparity, teacher centered, high level of anxiety, and low ability of retention, poor learning and achievement (Kajuru & Popoola, 2010; Hassan, 2010 & Gimba, 2013). Researchers have indicated that the scaffolding learning strategy is mostly better in terms of the reduction level of anxiety, retention and achievement. Abraao (2006) has stressed that scaffolding strategy reduces ambiguity and assists the learner connect the new information to what he already knows. It aids in the construction of meaningful, structured relationships between what the learner knows and the new knowledge.

Bhutto et al. (2013) submitted that scaffolding strategy can be provided in several different ways. The strategy may provide explanations of certain core concepts of the question when the learner does not understand the question. It may contribute ideas and suggestions on what approach the learner should take. This is in the form of hints.

The strategy provides room for interaction between the learners and the supporter (teacher or peer). It enables the learners to think through the problem and show what ideas and concepts are important for a particular question, it also assigns those who may know some concepts. In this role, the strategy provides evidence that the learner is following the right path, or statement refuting the answer provided if it is incorrect. In this process, students are fully involved in the lesson which makes the strategy to be student-centered. This improves the students' retention ability and reducing the level of anxiety.

From these numerous studies, it is safe to conclude that teachers using good strategy in teaching mathematics are highly essential as it could be of facilitative effect on their performance in mathematics. On the other hand, poor instructional strategy could block students' chance of good performance, cause anxiety and poor retention in mathematics (Gimba, 2013). On the basis of these findings, the research questions and hypotheses of this study were directed towards investigating: "the effects of scaffolding learning strategy on students' academic performance, anxiety and retention among senior secondary school students".

However, the present researcher observed that in all these research reports, students performed better. The present study would find out this study whether Scaffolding enriched collaborative strategies are more advantageous than the conventional ones, since the strategies are construction of knowledge among social group. The review studies are limited to cognitive domain. There the is need to consider other of Bloom's taxonomy for effective achievement, especially geometry in which served as a course that forms the building blocks of engineering and technical graphics.

Many students in the secondary school level were not prepared for the course (Senk, 2005). Duru (2010) has submitted that there is too much emphasis being placed on formal symbolism and naming in the curriculum while relational understanding was underestimated. The literatures so far reviewed have given some direction and guidance for designing and conducting the present study. Based on the insight derived from literatures reviewed, the treatment part of the study employed lesson model known as Scaffolding Collaborative Lesson Model (SCLM) involving thinking, peering and sharing. The present study has addressed test-anxiety which was left out in the literatures cited. On this basis, the impact of Scaffolding- enriched collaborative strategy on student performance, retention and test- anxiety in geometry among senior secondary schools was investigated.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This study attempted to find the Impact of Scaffolding- enriched Collaborative Strategy on Performance, Retention and Test- anxiety in Geometry among Senior Secondary School Students. This chapter described the design and the procedure used in the study. The chapter has following sub headings: Research Design, Population of the Study, Sample and Sampling Procedure, Instrumentation, Validity of the Instrument, Pilot Testing, and Reliability of the Instrument, Administration of Treatment, Data Collection Procedure and Procedure for Data Analysis

3.2 Research Design

The research design adopted for this study was quasi experimental design described by (Sambo, 2008). The study has three (3) groups (one control group and two experimental groups) that were pretested to ascertain their homogeneity. The experimental group one was exposed to scaffolding- enriched collaborative strategy and experimental group two was exposed to collaborative learning strategy to see if there was significant difference in their performance, retention and test-anxiety. Let EG represents the Experimental Group; CG for the Control Group, X represents treatment variable and O for the dependent variable. Therefore; the design of the study was illustrated in Figure 3.1:

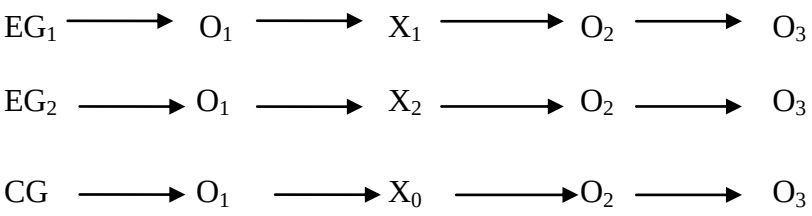


Figure 3.1 Research Design

Key: EG_1 – Experimental Group One.

EG_2- Experimental Group Two.

CG – Control Group.

SCS- Scaffolding- enriched Collaborative Strategy (SCS)

CLS- Collaborative Learning Strategy (CLS)

CTS- Conventional Teaching Strategy (CTS)

X – Treatment variable (X_1-S CS, X_2 – CLS, X_0 – CTS)

O – Dependant variable (O_1-:pre-test, O_2: post-test, O3:post-post test)

Pre-test(O_1) is GPT (the initial measurement), the X_1 and X_2 in the figure 3.1 indicated the treatment variable using scaffolding enriched collaborative strategy and collaborative strategy applied to the two experimental groups respectively. The X_0 in the design indicated teaching of conventional approach to control group. Post test (O_2) are GAT and GTA, administered to three groups (experimental group one, experimental group two and control group) to record their performance scores and anxiety levels after treatment. At the end of the two weeks period both groups were subjected to Post-post test (O_3/ GRT) to examine their retention ability.

3.3 Population of the Study

There are three (3) educational zones in Niger state with two hundred and eighteen(218) senior secondary schools distributed over twenty five(25) local

governments in the state. These schools are under Niger state Ministry of Education. The target populations of this study was made up of sixty two thousand, two hundred and forty nine (62,249) Senior Secondary School Two (SSS11) students. The state public schools were considered, mainly due to their common socio-economic background, admission and promotion policy, staffing and availability of instructional materials. The ages of the students ranged between 18-25 years. The details of the population are presented in (Appendix I).

3.4 Sample and Sampling Procedure

Multi-stage random sampling and simple random sampling techniques were applied. In the first stage three local governments was randomly selected from three (3) three educational zones of the state. From the three local governments, one secondary school was randomly selected from each of the three local governments. Two of the selected schools were identified as the experimental groups; while the one other served as control group. A simple random procedure was applied for the selection.

In the second stage of the randomization process in each of the schools, one class was selected out of the total number of SS11 classes in the school. The intact classes were selected to avoid disrupting schools programmed. The sample for the study was made up of total of three hundred and eighty (380) SSII students. 135 students were identified for experimental group one, taught Scaffolding- enriched Collaborative Strategy, 120 students was for experimental group two taught Collaborative Learning Strategy and 125 students known as control group taught Conventional Teaching Strategy. Details are shown in Table 3.1:

Table 3.1 **Sample for the Study**

S/N	Group	School	No. of Student
1	Experimental	A	135
2	Experimental	B	120
3	Control	C	125
Total			**380**

3.5 Instrumentation

The difficulty of getting standard measuring instrument for the study made it necessary for the researcher to develop or modifies his research instrument; this is supported by (Sambo, 2008). He pointed out that in this kind of situation a researcher must develop his/her instrument taking cognizance of the required conditions (clarity, validity and reliability of the items). The instruments used for the study was four and as follows:

(i) Pre-test (Geometry Performance Test)

(ii) Post-test (Geometry Achievement Test)

(iii) Post-post test (Geometry Retention Test)

(iv) Geometry Test-Anxiety

3.5. i Geometry Performance Test I (GPT)

The GPT was drawn from the mathematics textbooks used in SSI classes in the selected schools. The items are prerequisite of SSII geometry topics and consist of forty multiple questions with four options. The test items covered Perimeter and Area

of plane shapes: Quadrilateral, Parallelogram, Trapezium, Triangle, Square, Rectangle and Circle. It consists of two sections. Section A: Introduction, Instructions and Bio-data while Section B is made up of objective questions with four (4) options (A-D). (See Appendix A)

3.5. ii Geometry Achievement Test (GAT)

GAT was developed by Gambari, et al. (2014) and adopted by the researcher. It was generated through careful study of past examination of West Africa Examination Council (WAEC, May/June 1988-2011) and National Examination Council (NECO, June/ July 2000- 2011). The test consists of forty (40) items with four options. The aim of the test is to evaluate their academic performance after the content has been taught to them. It covered the surface areas and volumes of Cylinder, Cone, Cube, Cuboids, Sphere, Hemisphere and Circle geometry: Arc, Chord and Segments. The test consist of two sections: Section A: Introduction, Instructions and Bio-data while Section B: consist of objective questions. (See Appendix B)

3.5. iii Geometry Retention Test (GRT)

The GRT was randomizing of GAT to test the students' retention ability. The GRT was to examine the students' retention ability after the topics had been taught to them. Two weeks gap was allotted between the tests with assumption that students may have forgotten the questions of post-test (GAT).The GRT was made up of 40 multiple choice items with four options. These also consist of two sections: Section A: Introduction, Instructions and Bio-data while Section B is the objective questions.(See Appendix C)

3.5.iv Geometry Test-Anxiety

GTA was developed by Richard (2004) adopted and modified by the researcher on five points scale. The model consists of ten statements about geometry in mathematics. After each statement, the numbers (1, 2, 3, 4, and 5) are used to rate how true each of the following is of you, extremely or always true, to not at all or never true. Note that there not right or wrong answers to the statements in the inventory. (See Appendix D)

3.5b Contents of the Treatments

The treatment covered solid menstruations under geometric concepts, using scaffolding- enriched collaborative, collaborative and conventional strategies for the three groups: experimental groups and control group. The contents were selected because they were being taught at SSS II. Another reason was because students recorded poor performance in the areas according to WAEC Chief Examiner's reports (2010) and (2014). The Table 3.3 shows table of specification for 40-items test that ensure adequate representation of the topic covered within six (6) weeks. Based on the submission made by curriculum expert, Benjamin Bloom Taxonomy on cognitive domain cited in (Maruf & Aliyu, 2013). The item specifications are presented in Table 3.2:

Table3.2: Table of Item of Specification

S/N	Topic	Knowledge	Comprehension	Application	Total	Percentage
1	Cylinder & Cone	3	3	4	10	25
2	Cube & Cuboids	3	2	4	9	22.5
3	Sphere & Hemisphere	2	3	4	9	22.5
4	Arcs & Sectors of Circles	2	2	2	6	15
5	Chords &Segments of Circles	2	2	2	6	15
	Total	**12**	**12**	**16**	**40**	**100%**
	Percentage	**30%**	**30%**	**40%**	**100%**	

3.5.1 Validity of the Geometry Performance Test (GPT)

The face and content validity of the instruments (GPT, GAT , GRT &GTA), items were achieved by distributing them to two experts on the rank of senior lecturers from department of science education, A.B.U. Zaria and three senior staff on rank of Asst. Director of Education from Niger State Secondary Education Board, Minna to vet thoroughly to determine suitability and adequacy. After a careful study, they recommended the modification of the instruments and clearly identified exclusion of some items not relevant in the study. Corrections were made and forty (40) items were selected as items for the instruments (GPT, GAT & GRT) and ten (10) items for GTA. The content validity of the test items were found to be within ability level of students, free from any ambiguities and has covered the study area. It also means that instruments were able to measure up the intended area of the study.

3.5.2 Pilot testing

Two schools besides those selected for the main study were used for pilot study. These schools are Government Secondary School, Minna and Government Day Secondary School Kutigi, the number of students that participated in the study was forty (40) from SSII. The main objective for the pilot study was to determine the

psychometric properties of the instruments. A GPT of Geometry Performance Test and Geometry Test Anxiety (GTA) were administrated to both experimental and control group. After treatment on selected topics in geometric concepts, the Geometry Achievements Test (GAT) Geometry Retention Test (GRT) and Geometry Test Anxiety (GTA) were administered to test their performance, retention and their level of anxieties. The result of the pilot study was analyzed using statistical techniques.

3.5.3 Reliability of the Instruments

The reliability of the instruments was determined using two (2) schools which were not part of the sample, i.e. Government Secondary School, Minna and Government Day Secondary School Kutigi. Forty (40) students were used and the researcher administered the instruments (GPT, GAT & GTA), students' scores were obtained. Then split-half reliability estimation was used in calculating reliability coefficient of the instruments. Geometry Performance Test (GPT) has reliability coefficient 0.79 while Geometry Achievement Test (GAT) has reliability coefficient 0.69. And Geometry Test-Anxiety Test (GTA) has reliability coefficient 0.87

3.6 Administration of the Treatment

The researcher has three groups: two experimental and control group. One experimental group was taught using scaffolding- enriched collaborative strategy; the other one was taught using collaborative learning strategy while the control group was taught using conventional approach. Three different lesson models were designed to teach the groups within six weeks.

Mathematics teachers from the sampled schools were trained on how to use the lesson models. Scaffolding Collaborative Lesson Model of Djwantoro (2010), Obioma (2011) and Bhutto et al. (2013) was adopted and modified for teaching students in the experimental group. Here, the teachers must be careful not to offer too much assistance for long, at risk of making student over dependent rather independent. The teacher should start a problem and help the students to finish it or perhaps give hints, when a student gets off track. The level of instruction should always be within the Zone of Proximal Development (ZPD). The adopted and modified scaffolding collaborative lesson model has the following steps, the steps are as follows:

Step 1: introduction: it refers to assessing the previous knowledge or skill of the learner through discussion or questioning.

Step 11: task discussion: introducing the new task to arose learners' interest and presentation of task through traditional method of teaching.

Step 111: collaborative learning: Students' are carefully divided into groups and they are presented with a task to achieve a common goal.

Step IV: number head: each team member discusses their works to large group.

Step V: apprenticeship: student work individually.

Step VI: assessment: students exchange their works to assess their works to know their ZPD.(See Appendix E) for other detail lesson plan.

Now here is scaffolding collaborative lesson model presented in a flow chart in Figure 3.2:

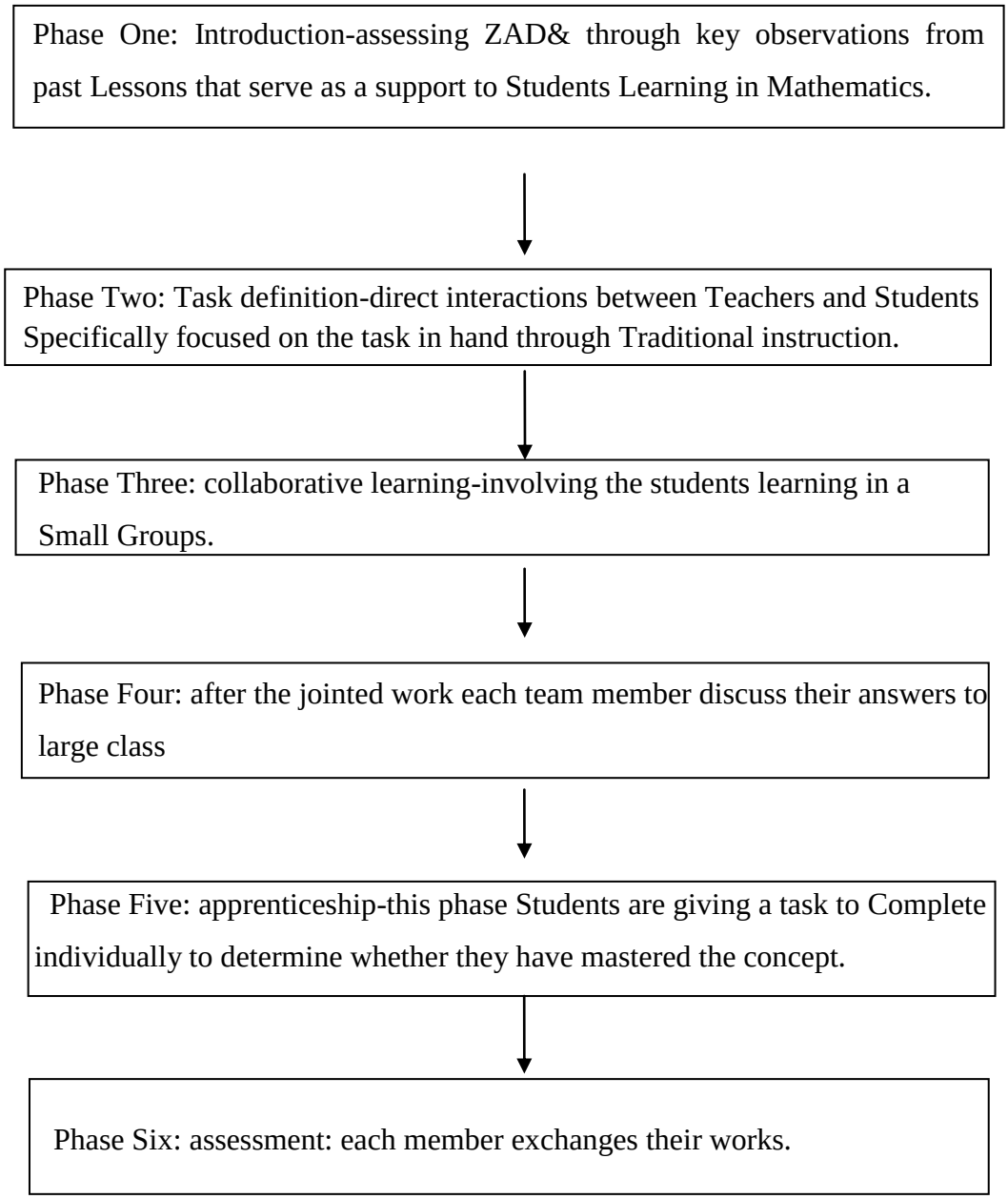


Figure 3.2 Flow Chart of Scaffolding Collaborative Lesson Model (SCLM) adopted and modified from Jenna et al. (2009), Obioma (2011) and Bhutto et al. (2013) .

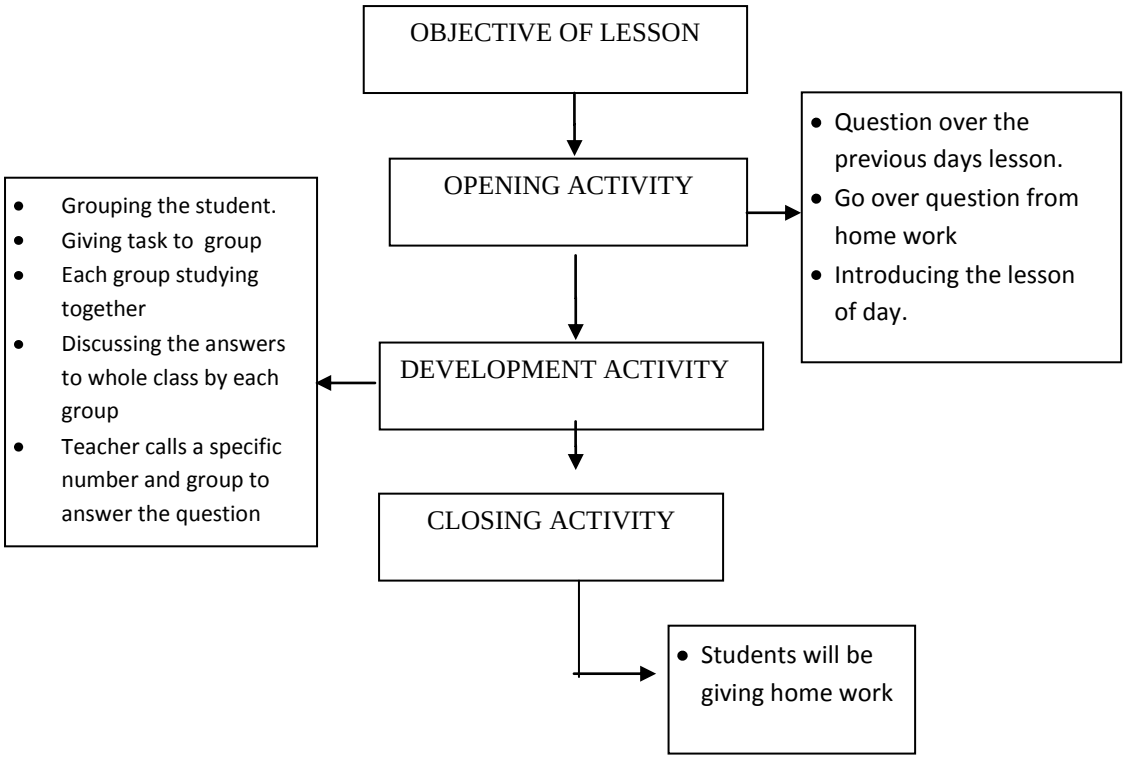
The Experimental Group Two (EG_2) exposed to collaborative learning strategy has the following lesson model steps:

Step I: Opening Activity: assessing the previous lesson, going over questions from home work and introducing the new task.

Step II: Development Activity: grouping the student into small group and giving them a task, discussing the answer to whole class and teacher calls for specific number and group to answer a question.

Step III: Closing Activity: students are giving home work be to submit next class.

The figure 3.3 shows a flow chart of Collaborative Lesson Model (CLM) adopted from Jenna et al.(2009).



While students in the control group, the conventional lesson model designed by National Teacher of Institute (N.T.I, 2010) was adopted and modified. The model has the following features or elements:

- General information: This comprises of date, time of day and length of the lesson, age and sex.
- Objective: stating the objective of lesson that must be obtainable in a particular lesson.
- Previous knowledge: the knowledge that has be acquired by the students before the new task.
- Introduction: a good introduction makes a good lesson, a rouse students curiosity and interest at the beginning of the lesson.
- Presentation: usually in phases or steps.
- Conclusion: this is the part of the lesson where the its behavioral objective is realized.
- Assignment: Students' activities to be carried out after the lesson taught.

3.6b Administration of Test

At the beginning, the groups were tested with Pre-test, this made to test their initial knowledge, and then after teaching, the groups were subjected to post-test. Then, Post-post test was administered to the students. Two weeks gap was given between the tests, because the researcher assumed that after two weeks the students may have forgotten the items in post- test (Mamman & Isah, 2014). The GTA was administered on the groups before teaching and after teaching to ascertain their level of anxiety. For each test, the following precaution was taken to ensure that the students put their true effort as much as possible:

The researcher:

I. Explain to the student the content of the test before distributing it.

II. Instruct them to do all rough work in the answer sheet and across it .out but do not make it illegible.

III. Appeal to them to have sense of responsibility and register their sincere reaction.

IV. That the research will benefit not only themselves but also their colleagues.

V. Assure the student that their responses will be kept in confidence, and that it is having nothing to do with their examination results either at present or in future.

3.7 Data Collection Procedure

GPT, GAT and GRT were marked by the researcher along to minimize deviation and to bring uniformity. For correct answer to each question one mark was awarded while zero was be for wrong answer. Thus, total of scores obtained for each test was converted to percentage. GTA requires the students to respond by indicating his/her degree of feeling using five point scale: 5 means extremely highly or always true, 4 means high or usually true, 3 means moderately or sometimes true, 2 means slightly or seldom true and 1 means not at all or never true. The data collected for the study was classified into four:Pretest- GPT data,Post-test- GAT data,Post-Post Test-GRT data and GTA Data

3.8 Procedure for Data Analysis

The data obtained were analyzed using various statistical techniques to arrive at decisions for null hypotheses. The t-test was used to analyze the null hypotheses.

-+CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 Introduction

The purpose of this study was to investigate the Impact of Scaffolding-enriched Collaborative Strategy on Test-anxiety, Performance and Retention towards Geometry among Secondary School Students in Niger State. This chapter was presented under the following subheadings: Data Presentation, Hypotheses Testing, and Summary of findings and Discussion of the findings.

4.2 Data Presentation

The study was conducted among Senior Secondary Two (SS II) students in Niger state with a sample size of three hundred and eighty (380) students. Three (3) groups were selected for the study, these were experimental group one, experimental group two and control group. The groups were subjected to pre-test (Geometry Performance Test), post-test (Geometry Achievement Test), post-post test (Geometry Retention Test) and Geometry Test-Anxiety. The data collected were analyzed using statistical methods such as mean, standard deviation and t-test for hypotheses testing at α= 0.05 level of significance for unrelated or independent samples. The details are as follows:

4.2.1. Data on Performance

The Table 4.01-4.03 presents a summary of post-test mean scores, standard deviation and mean difference among students in Experimental Group One exposed to (Scaffolding enriched Collaborative Strategy), Experimental Group Two exposed

to (Collaborative Learning Strategy) and Control Group exposed to (Conventional Teaching Strategy).

Table 4.01: Means and Standard Deviations of Experimental One and Control Group in Post test

Groups	N	Mean	S.D	Mean Difference
Exp gp I	135	63.42	15.75	
				31.16
Control gp	125	32.26	16.55	

Source: Statistical Package for Social Sciences in Appendix H

Result in Table 4.01 showed that the mean scores of experimental group one was 63.42 and control group was 32.26. The large mean difference (31.16) was recorded between the groups.

Table 4.02: Means and Standard Deviations of Experiment Group Two and Control Group in Post-test

Groups	N	Mean	S.D	Mean Difference
Exp. gp I I	120	50.47	14.94	
				18.21
Control gp	125	32.26	16.55	

Source: Statistical Package for Social Sciences in Appendix H

Table 4.02 showed that mean performance scores of experimental group two was 50.47 and mean performance scores of control group was 32.26. The mean difference was (18.21).

Table 4.03: Means and Standard Deviations of Experimental Group One and Experimental Group Two in Post-test

Groups	N	Mean	S.D	Mean Difference
Exp. gp I	135	63.42	15.75	
				12.95
Exp.gp II	120	50.47	14.96	

Source: Statistical Package for Social Sciences in Appendix H

The Table 4.03 showed that the mean score of the experimental group one was 63.42 and experimental group two was 50.47. The recorded mean difference was 12.95

4.2.2. Data on Retention

The Table 4.04-4.06 presents a summary of post- posttest mean scores, standard deviation and mean difference among students in Experimental Group One exposed to (Scaffolding enriched Collaborative Strategy), Experimental Group Two exposed to (Collaborative Learning Strategy) and Control Group exposed to (Conventional Teaching Strategy).

Table 4.04: Means and Standard Deviations of Experimental One and Control Group in Post- posttest

Groups	N	Mean	S.D	Mean Difference
Exp. gp I	135	52.74	14.44	
				20.31
control gp II	125	32.43	11.59	

Source: Statistical Package for Social Sciences in Appendix H

Table 4.04 showed that the mean score of the experimental group one was 52. 74 and the mean score of the control group were 32.43. The mean gain scores were 20.31.

Table 4.05: Means and Standard Deviations of Experimental Two and Control Groups in Post-posttest

Groups	N	Mean	S.D	Mean Difference
Exp. gp II	120	50.00	16.17	
				17.57
Control gp	125	32.43	11.59	

Source: Statistical Package for Social Sciences in Appendix H

Table 4.05 revealed that the mean performance score of the experiment group two was 50.00 and mean score of the control group was 32.43. The difference in the mean gain scores of two groups was 17.57.

Table 4.06: Means and Standard Deviations of Experimental Group One and Experimental Group Two in Post-post test

Groups	N	Mean	S.D	Mean Difference
Exp. gpI	135	52.74	14.44	
				2.74
Exp. gp II	120	50.00	16.17	

Source: Statistical Package for Social Sciences in Appendix H

Table 4.06 indicated that experimental group one has mean score 52.74 with standard deviation 14.44, while experimental group two has mean score 50.00 with standard deviation 16.17. The recorded mean difference was 2.7

4.2.3. Data on Test-anxiety

The Table 4.07-4.09 presents a summary of Geometry Test-anxiety mean scores, standard deviation and means difference among students in Experimental Group One exposed to (Scaffolding enriched Collaborative Strategy), Experimental Group Two exposed to (Collaborative Learning Strategy) and Control Group exposed to (Conventional Teaching Strategy).

Table 4.07: Means and Standard Deviations of Experimental One and Control Group in Geometry Test-anxiety

Groups	N	Mean	S.D	Mean Difference
Exp.gp I	135	46.70	16.65	
				-17.04
Control gp	125	63.74	16.51	

Source: Statistical Package for Social Sciences in Appendix H

From the result in Table 4.07 showed that the mean score of the experimental group one was 46.70 and mean score of the control group was 63.74. The recorded mean difference was (-17.04).

Table 4. 08: Means and Standard Deviations of Experimental Group Two and Control Group in Geometry Test-anxiety

Groups	N	Mean	S.D	Mean Difference
Exp. gp II	120	47.93	16.32	
				-15.81
Control gp	125	63.74	16.51	

Source: Statistical Package for Social Sciences in Appendix H

Table 4.08 revealed that the mean score of the experimental group two was 47.93 and that of the control group was 63.74. The mean difference between the two groups was -15.81.

Table 4.09: Means and Standard Deviations of Experimental Group One and Experimental Group Two in Geometry Test-anxiety

Groups	N	Mean	S.D	Mean Difference
Exp.gp I	135	46.70	16.65	
				-1.23
Exp.gp II	120	47.93	16.32	

Source: Statistical Package for Social Sciences in Appendix H

The result in Table 4.09 indicated that the mean score of the experimental group one was 46.70 and the mean score of the experimental group two was 47.93. The mean difference (-1.23) was found between the groups

4.3 Hypotheses Testing

This section showed the result of the data analyses obtained from the study. Nine (9) hypotheses was formulated and all were tested using independent sample t-test statistic at α= 0.05 level of significance. The samples are: Experimental Group One is students exposed to Scaffolding enriched Collaborative Strategy (SCS), Experimental Group Two are students exposed to Collaborative Learning Strategy (CLS) and Control Group is students exposed to Conventional Teaching Strategy (CTS). Now the details are as follows:

Null Hypothesis One: There is no significance difference between the mean performance scores of students taught geometry concept using Scaffolding- enriched Collaborative Strategy and those taught using Conventional Teaching Strategy.

To test this hypothesis, an independent sample t-test statistic was used and Table 4.10 shows the results.

Table 4.10: t-test Analysis of Experimental One and Control Group in Post-test

Groups	N	Mean	S.D	DF	T- cal	P-value	Remark
Exp.gp I	135	63.42	15.75				
				258	15.56	.00	Sig
Control gp	125	32.26	16.55				

Source: Statistical Package for Social Sciences in Appendix H

To evaluate the effectiveness of the instructions, a post-test was administered to both groups at the end of the treatment. The data in Table 4.10 revealed that 0.05 is greater than P-value (0.00); the null hypothesis was therefore rejected. It was concluded that there was significant difference in the performance scores of the two groups taught geometry concepts.

Null Hypothesis Two: There is no significance difference in the retention ability of students taught geometry using Scaffolding- enriched Collaborative Strategy and those taught using Conventional Teaching Strategy.

To test this hypothesis an independent sample t-test statistic was used. Table 4.11 was the summary of the results.

Table 4.11: t-test Analysis of Experimental Group One and Control in Post-post test

Groups	N	Mean	S.D	DF	T- cal	P-value	Remark
Exp. gp I	135	52.74	14.44	258	12.45	.00	Sig
Control gp	125	32.43	11.59				

Source: Statistical Package for Social Sciences in Appendix H

The result of Table 4.11 indicated that $\alpha = 0.05$ is greater than p-value (.00). The result revealed that there was significant difference in the retention ability of students exposed to Scaffolding- enriched Collaborative Strategy and those exposed to Conventional Teaching Strategy. Thus, the null hypothesis was rejected.

Null Hypothesis Three: There is no significant difference in the level of test-anxiety of students taught geometry using Scaffolding- enriched Collaborative Strategy and those taught using Conventional Teaching Strategy.

To test this hypothesis an independent sample t-test statistic was used. Table 4.12 was the summary of the result.

Table 4.12: t-test Analysis of Experimental One and Control Group in Geometry Test-anxiety scores

Groups	N	Mean	S.D	DF	T- cal	P-value	Remark
Exp.gp I	135	46.70	16.65				
				258	- 8.28	.00	Sig
Control gp	125	63.74	16.51				

Source: Statistical Package for Social Sciences in Appendix H

Results Table 4.12 showed that P-value= 0.00 less than 0.05, this indicated that there was significance difference in the level of test-anxiety of two groups, thus, the null hypothesis was rejected.

Null Hypothesis Four: There is no significance difference between the mean performance scores of students taught geometry concept using Collaborative Learning Strategy and those taught using Conventional Teaching Strategy.

To test this hypothesis an independent sample t-test statistic was used and the result presented in Table 4.13.

Table 4.13: t-test Analysis of Experimental Two and Control Groups in Post-test

Groups	N	Mean	S.D	DF	T- cal	P-value	Remark
Exp. gp I I	120	50.47	14.96				
				243	9.02	.00	Sig
Control gp	125	47.14	16.55				

Source: Statistical Package for Social Sciences in Appendix H

It was observed in Table 4.13 that there was significant difference in the performance scores of students in the experimental group two and control group. The result indicated that there was significant difference in the performance mean scores of the two groups. Hence the null hypothesis was rejected.

Null Hypothesis Five: There is no significant difference in the retention ability of students taught geometry using Collaborative Learning Strategy and those taught using Conventional Teaching Strategy.

To test the stated hypothesis the post-post test scores were subjected to an independent sample t-test statistic and the result in Table 4.14 was presented as follows:

Table 4.14: t-test Analysis of Experimental Two and Control Groups in Post-posttest

Groups	N	Mean	S.D	DF	T- cal	P-value	Remark
Exp. gp II	120	50.00	16.17				
				243	9.81	.00	Sig
Control gp	125	32.43	11.59				

Source: Statistical Package for Social Sciences in Appendix H

Results presented in Table 4.14 revealed that there was significant difference in the retention ability of the students in experiment group two than control group as recorded by p-value (.00) is less than alpha 0.05 level of significance. That confirmed that there was significant difference in the post-post test scores of the two groups and the null hypothesis was rejected.

Null Hypothesis Six: There is no significant difference in the level of test-anxiety of students taught geometry using Collaborative Learning Strategy and those taught using Conventional Teaching Strategy.

To test the hypothesis an independent sample t-test statistic was used. The result in Table 4.15 was presented as follows.

Table 4.15: t-test Analysis of Experimental Two and Control Groups in Geometry Text-anxiety Scores

Groups	N	Mean	S.D	DF	T- cal	P-value	Remark
Exp. gp II	120	47.93	16.32				
				243	7.53	.00	Sig
control gp	125	63.74	16.51				

Source: Statistical Package for Social Sciences in Appendix H

The result in Table 4.15 proved that the collaborative learning strategy was significant in reducing geometry test-anxiety; therefore the null hypothesis six was rejected.

Null Hypothesis Seven: There is no significant difference between the mean performance scores of students taught geometry concepts using Scaffolding- enriched Collaborative Strategy and those taught using Collaborative Learning Strategy.

To test this hypothesis an independent sample t-test statistic was used. The results were presented in Table 4.16.

Table 4.16 t-test Analysis of Experimental Group Two and Experimental Group One in post-test

Groups	N	Mean	S.D	DF	T-cal	P-value	Remark
Experiment I	135	63.42	15.75				
				253	6.71	0.00	Sig
Experiment II	120	50.47	14.96				

Source: Statistical Package for Social Sciences in Appendix H

Result of Table 4.16 showed that P-value was 0.00 which was much less than α =0.05. This showed there was significance difference in the mean performance scores of students taught using scaffolding- enriched collaborative strategy and students taught using collaborative learning strategy. The null hypothesis was therefore rejected.

Null Hypothesis Eight: There is no significant difference in the retention ability of students taught geometry using Scaffolding- enriched Collaborative Strategy and those taught using Collaborative Learning Strategy.

In order to test the hypothesis the post-post test scores of the students in Experimental One and Experimental Two Groups were subjected to an independent sample t-test statistic and the result was presented in Table 4.17

Table 4.17: t-test of Analysis Experiment Group One and Experiment Group Two in Post-post test

Groups	N	Mean	S.D	DF	T- cal	P-value	Remark
Exp. gpI	135	52.74	14.44				
				253	1.43	.15	Not Sig
Exp. gp II	120	50.00	16.17				

Source: Statistical Package for Social Sciences in Appendix H

From the results of the analysis in Table 4.17, the p-value obtained (0.15) was greater than 0.05, which was an indication that there was no significant difference in the retention ability of the experimental group one and experimental group two. Therefore, the null hypothesis was retained.

Null Hypothesis Nine: There is no significant difference in the level of test-anxiety of students taught geometry using Scaffolding- enriched Collaborative Strategy and those taught using Collaborative Learning Strategy.

In order to test the hypothesis the geometry test-anxiety scores of the students were subjected to an independent sample t-test statistic and the result was presented in Table 4.18.

Table 4.18: t-test Analysis of Experimental Group One and Experimental Group Two in Geometry test-anxiety

Groups	N	Mean	S.D	DF	T- cal	P-value	Remark
Exp. gp I	135	46.70	16.65	253	-0.60	.55	Not Sig
Exp. gp II	120	47.93	16.32				

Source: Statistical Package for Social Sciences in Appendix H

From the result in Table 4.18 indicated that there was no significant difference in the test-anxiety level of the experimental group one and experimental group two as supported by p-value is much greater than 0.05. It can be concluded that the null hypothesis was retained.

4.4 Summary of Findings

All students in the sample numbering three hundred and eighty (380) were involved in the study; the study sought to access Impact of Scaffolding-enriched Collaborative Strategy on Test-anxiety, Performance and Retention towards Geometry among Secondary School Students in Niger State.

Data was collected for pre-test, post test, post-post test and geometry test-anxiety. The summary of findings is as follows:

1. To control any differences between the groups at the beginning of the study, pre-test was administered; the results showed that the critical values are higher than the t-calculated, at 0.05 alpha level of significance. These shows that students in both groups are found to be equivalent with respect to their initial knowledge.

2. The first null hypothesis was rejected. Therefore, there was significant difference between the mean performance scores of students taught geometry concepts using Scaffolding-enriched Collaborative Strategy (SCS) and those taught using Conventional Teaching Strategy (CTS).

3. The second null hypothesis was rejected. Hence, there was significance in the retention ability of students in geometry using Scaffolding-enriched Collaborative Strategy (SCS) and those taught using Conventional Teaching Strategy (CTS)

4. The third null hypothesis is said to be rejected. Therefore, there was significant difference in the level of test-anxiety of students taught geometry using Scaffolding-enriched Collaborative Strategy (SCS) and those taught using Conventional Teaching Strategy (CTS).

5. The forth null hypothesis is said to be rejected, because there was significant difference between the mean performance scores of students taught geometry concepts using Collaborative Learning Strategy (CLS) and those taught using Conventional Teaching Strategy (CTS).

6. The fifth null hypothesis was rejected because there was significant difference in the retention ability of students in geometry using Collaborative Learning Strategy (CLS) and those taught using Conventional Teaching Strategy (CTS)

7. The sixth null hypothesis is said to be rejected, therefore, there was significant difference in the level of test-anxiety of students taught geometry using Collaborative Learning Strategy (CLS) and those taught using Conventional Teaching Strategy (CTS) The seventh null hypothesis was rejected. Therefore, there was significance difference between the mean performance scores of students taught geometry concepts using Scaffolding-enriched Collaborative Strategy (SCS) and those taught using Collaborative Learning Strategy (CLS).

8. The eighth null hypothesis was retained. Therefore, there was no significant difference in the retention ability of students in geometry using Scaffolding-enriched Collaborative Strategy (SCS) and those taught using Collaborative Learning Strategy (CLS).

9. The ninth null hypothesis was retained. Hence, there was no significant difference in the level of test-anxiety of students taught geometry using Scaffolding-enriched Collaborative Strategy (SCS) and those taught using Collaborative Learning Strategy (CLS).

4.5 Discussion of the Findings

The study sought to investigate the impact of Scaffolding-enriched Collaborative Strategies on Test-anxiety, Performance and Retention in Geometry among Secondary School Students in Niger state. The explanations of findings based on the hypotheses were presented as follows:

The result revealed that there was a significant between the mean performance scores of students taught geometry concepts using scaffolding-enriched collaborative strategy and those taught using conventional teaching strategy. The result was in favour of experimental group one as shown in their mean scores and t-value. This

finding supports those of Hmelo-silver (2006), and Clare (2012) that students learn content and performed heavily through collaborative solving problems, reflecting on their experience and engaging in self-directed inquiring. Both collaborative and scaffolding place heavy emphasis on collaborative learning activity, so students are connectivity engaged in sense making, developing evidence based explanations and communicating their ideas. The teachers plays a key role in facilitating the learning process and may provide content knowledge on a just in time basis.

The findings of the study showed that there was significant difference in the retention ability of students in geometry using scaffolding-enriched collaborative strategy and those taught using conventional teaching strategy. The result was in favor of experimental group one, because the collaborative and scaffolding allows students' active participation than conventional which is teacher center, and that mode of instruction as one of the major short coming affecting performance and retention in mathematics (Kajuru and Popoola 2010). According to Abraao (2006) when students work together to construct a collective mathematics view within zones of proximal development, they act to discuss solution strategies using collaborative conversations to construct and reconstruct their reasoning and that gives them higher retention ability. Agreement with those of Clay (2005) and Clare (2012) that scaffolding students has opportunities to learn mathematics through social interaction; they perform heavily and retain more knowledge of mathematics concepts.

In addition, the result showed that there was significant difference in the reduction of test-anxiety of students taught geometry using scaffolding-enriched collaborative strategy and those taught using conventional teaching strategy, the findings was in, favour of the scaffolding-enriched collaborative strategy. This

supports Remalyn (2013) who stated that students demonstrate successful performance and avoiding unnecessary frustration and encouraging students' independent learning. In the study conducted by Remalyn (2013) observed that the scaffolding strategy was found to be effective in improving the performance and had an impact on the anxiety of the participants towards mathematics. He made conclusion that scaffolding teaching strategy can improved mathematics performance of high school students and can result of meaningful personal connection with the teacher and peer in the classroom. Scaffolding strategy can affect the anxiety of the students towards mathematics. A low level of anxiety towards mathematics can result to higher performance in the subject as confirmed in the major findings of the study supported by (Andrew & Wilson, 2004, Putwain, Woods & Symes, 2010).

The finding revealed that there was significance difference between the mean performance scores of students taught geometry concepts using collaborative learning strategy and those taught using conventional teaching strategy. This observation shows that the collaborative learning strategy is in favor of students exposed to it. The superiority of collaborative learning strategy over the conventional teaching strategy has been attributed to numbers of things, which includes, enhancing problem-solving, critical thinking skills, values diversity, group discussions and reaching a consensus, all these provide opportunity for good performance and are vital variables for promoting effective teaching and learning in the classroom(Miriam, 2011).

The results confirmed the finding of Abdullahi (2009) and Oloyede, et al. (2013) that collaborative learning strategy improved achievement in the academic and social aspects. It has become an appropriate substitute for the conventional method which do not focus on spreading the spirit of collaboration, group discussion,

clarification of ideas and evaluation of others ideas. The study findings supports those of Jenna et al. (2009), Chiason et al. (2010) and Kajuru & Popoola (2010).

The result revealed that there was significant difference in the retention ability of students in geometry using collaborative learning strategy and those taught using conventional teaching strategy. The findings are in agreement with that of Oloyede et al. (2012) and Mamman and Isah, (2014) who reported that students taught using collaborative strategy tend to have better and longer information retention, higher grades, more highly developed critical thinking and problem –solving skills towards the subjects and greater motivation to learn it. Grouping students in the mathematics setting is very substantial and higher retention ability according to many sources (Lai & Law, 2008). They stated that when people pull together their knowledge, they can outperform the brightest test of individuals with longer information retention.

The result also showed that there was significant difference in the reduction of test-anxiety of students taught geometry using collaborative learning strategy and those taught using conventional teaching strategy. The findings show that the use of collaborative learning strategy favours the students. Researches in collaborative have documented many desirable out comes (Kajuru and Popoola, 2010). According to them, grouping students are highly motive and their critical thinking skills are enhanced as well, students becoming more familiar with their peers while still enjoying mathematics. The study revealed that there was significant difference between the mean performance scores of students taught geometry concepts using scaffolding-enriched collaborative strategy and those taught using collaborative learning strategy. This in line with positions Ugwuda (2008) and Obioma (2011) who found that students taught with scaffolding strategy performed better than those taught

with another strategy because the scaffolding strategy is a useful strategy that makes learners to be independents and a problem solver. Remalyn (2013), observed that students' participation by interacting with others and interpreting activities plays a fundamental role of cognitive development.

The findings revealed that, there was no significance in the retention ability of students in geometry taught using scaffolding-enriched collaborative strategy and those taught using collaborative learning strategy. This proved that the scaffolding-enriched collaborative strategy did favor neither the experimental group one nor experimental group two, the issue of teacher- students' interaction as well as student-students interactions which are vital variable for promoting learning and retention. This disagrees with finding of Abraao (2006) and Mariam (2011) that social learning made students to attain higher level thinking and preserve information for longer times than students working individually. Mamman and Isah, (2014) reported that information discussed and clarified in the classroom are retained. So lack of significant difference could not be by chance, because the collaborative and scaffolding strategies allows student active participation but it may be due to students poor rehearsal or previous unpleasant experience.

It showed that there was no significant difference in the reduction of test-anxiety of students taught geometry using scaffolding-enriched collaborative strategy and those taught using collaborative learning strategy. The finding was not in favor of the scaffolding-enriched collaborative strategy. The findings disagree with that of Clare (2012) and Remalyn (2013), that the expert not only helps motivate learners by providing just enough support to enable them to accomplish the goal, but also provides supports in affective components. They also emphasizing that learning

occurs in a rich social context, marked by interaction, negotiation, reduction of frustration, articulation, and collaboration. Students in experimental one group fully have attention on the task than other groups because they believes that evaluative situation, such as assessment, exceeds his or her intellectual, motivational, and social capabilities. These causes' differences in performance of high anxious test students compared to low anxious test students. Due to the differences in their ability to focus on the task, students with low anxious is able to focus attention on the task required of them when taking the test, while a high-anxious student focused in their internal self, and the anxiety they are feeling (Salend, 2012). Anxious students do not perform adequately on the test as their attention is divided between themselves and the test. Therefore students with low test anxiety are able to focus their attention on the task as supported by the finding and in line with report of (Andrew & Wilson, 2004).

According to 12 year old student in mathematics class that their teacher, Williamson, who is the author of Group and Individual work (2006), concluded that group work increased the opportunities for communication and made problem solving a richer experience for students. Her research process was to have half of her class work as a team for the lesson, and the other half work individually. She found that the teams that worked together were very confident and felt less frustrated with the material. The groups that worked together also had no problem with reporting to the class on something they had produced as a group (Williamson, 2006).

Finally, Atencio (2004) examined the classroom dynamics occurring in a collaborative mathematical laboratory activity in a third-grade collaborative classroom activity impacted children learning and motivation. In a study Baker and Campbell (2005) aimed to generate more interest in Mathematics. They tend to reduce

Mathematics anxiety and make mathematics more enjoyable for students through the use of collaborative learning. Results indicated that the use of collaborative learning generated more interest in mathematics and made it more enjoyable for both students and teachers. Students improved academically, socially and in self-esteem (Kajuru and Isah, 2014).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This study investigates the Impact of Scaffolding-enriched Collaborative Strategy on Test-anxiety, Performance and Retention in Geometry among Secondary School Students in Niger State. This chapter has the following subheadings: Summary, Conclusions and Contribution to knowledge, Recommendations, Limitation of the study and Suggestions for further studies

5.2 Summary

The aim of this study was set to investigate the Impact of Scaffolding-enriched Collaborative Strategy on Test-anxiety, Performance and Retention in Geometry among Secondary School Students in Niger State. Nine (9) research questions and null hypotheses were raised with objectives of assessing the effectiveness of scaffolding-enriched collaborative strategy on test-anxiety, performance and retention.

The reviews of literatures were carried out on scaffolding strategy, collaborative learning strategy, test-anxiety, performance and retention in geometry. A quasi experimental design was adopted for the study involving pre-test, post test and post-post test as described by (Sambo, 2008). Three senior secondary schools from three (3) educational zones were randomly selected from population of two hundred and eighteen (218) schools, having sixty-two thousand, two hundred and forty-nine (62,249) students. Three hundred and Eighty (380) students were sampled from the sampled schools. Experimental group one (Sample A): 135 students, Experimental group two (Sample B) : 120 students and Control group (Sample C):

125 students. Four instruments were developed and pilot tested to ascertain their reliability. Split-half procedure was used in calculating reliability coefficient of the instruments. The validity of each instrument was checked by experts from N.S.S.E.B Minna, and A.B.U. Zaria. The data collected for the study was classified into four:

a. Pre-test: Geometry Performance Test (GPT) data.
b. Post-test: Geometry Achievement Test (GAT) data
c. Post-post-test: Geometry Retention Test (GAT) data
d. Geometry Test-Anxiety (GTA) data

Descriptive statistical mean and standard deviation were used to answer research questions and inferential statistical of t-test was used to test the null hypotheses at 0.05 level of significance for retaining or rejecting. The results summaries are provided in Table 4.01-4.18 and the research findings indicate are as following:

1. There was significant difference between mean performance scores of students taught geometry concepts using scaffolding-enriched collaborative strategy and those taught using conventional teaching strategy.
2. There was significant difference in the retention ability of students taught geometry using scaffolding-enriched collaborative strategy and those taught using conventional teaching strategy.
3. There was significant difference in the reduction of test-anxiety of student taught geometry using scaffolding-enriched collaborative strategy and those taught using conventional teaching strategy.

4. There was significant difference between the mean performance scores of students taught geometry concept using collaborative learning strategy and those taught using conventional teaching strategy.
5. There was significant difference in the retention ability of students taught geometry using collaborative learning strategy and those taught using conventional teaching strategy.
6. There was significant difference in the reduction of test-anxiety of students taught geometry using collaborative learning strategy and those taught using conventional teaching strategy.
7. There was significant difference between mean performances scores of students taught geometry concepts using scaffolding-enriched collaborative strategy and those taught using collaborative learning strategy.
8. There was no significant difference in the retention ability of students taught geometry using scaffolding-enriched collaborative strategy and those taught using collaborative learning strategy.
9. There was no significant difference in the reduction of test-anxiety of students taught geometry using scaffolding-enriched collaborative strategy and those taught using collaborative learning strategy.

Discussion was carried out step by step according the nine hypothesis tested. At the end, the results tend to be in conformity with Vygotsky's idea of the zone of proximal development and socio- constructivism. He stated that what a child can do in cooperation today, he or she can do alone tomorrow. Vygotsky's (1978) claims that a child mental function need to be fostered and assessed through collaboration with a teacher. He proposed that scaffolding

strategy enable the teacher to determine the distance between actual development and the potential development of the child. The abilities of the child are developed and strengthened through quality social interaction between the child and the teacher.

5.3 Conclusions

The study investigated the Impact of Scaffolding-enriched Collaborative Strategy on Test-anxiety, Performance and Retention in Geometry among Secondary School Students in Niger state. It can therefore be concluded that although collaborative, scaffolding and conventional strategies can be used in teaching and learning processes but scaffolding- enriched collaborative strategy was found to be the most effective. It facilitates the achievement of academic goals and is highly effective at producing harmony among students.

It also revealed that students with quality social interaction between teacher-students, student-students proved to bring reduction in level of test-anxiety, developing teachers' positive attitudes towards the education process and students' retention on learning task is enhanced.

5.4 Contribution to Knowledge

The study investigated the Impact of Scaffolding-enriched Collaborative Strategy on Test-anxiety, Performance and Retention in Geometry among Secondary School Students in Niger State. The study has established the following contributions to knowledge:

1. The study has brought with it teaching module designed to put together collaborative and scaffolding strategies in teaching geometry. It enhances students' performance compared to when they are exposed to CTS. That is

those exposed to Scaffolding enriched Collaborative Strategy had high performance.

2. The teaching strategy (SCS) used in the study has reduced students anxiety. The used of the adopted model (think, pair and share), has significantly contributed to reducing the students' test-anxiety in geometry.
3. The lesson model developed by the researcher on SCS has made the students to understand and fully participated in the class interaction.

5.5 Recommendations

Referring to the results of the study, some recommendations are as follows:

1. Teaching style by mathematics teachers should be on the students existing knowledge (ZAD) and characterized by communicating meaning and significance of subject of matter.
2. Mathematics teachers should be exposed to two strategies (collaborative & scaffolding) with special emphasis on area of scaffolding- enriched collaborative strategy through conferences, seminars, symposium and in-service training.
3. Students should be made aware of the vital roles in social interaction in classroom. Working together assists in understanding the task, reducing anxiety, building trust and open communication such awareness could be encourage through teachers emphasis on group work.
4. Students should be encouraged to attend mathematics lesson regularly this could make students becomes familiar with their peer while still enjoying mathematics.

5. Mathematics curriculum planners should inculcate collaborative ideas in their plans that will allow meaningful classroom interaction patterns necessary for promoting academic performance and reducing level of anxiety among students.

5.6 Limitation of the Study

The followings were observed to be some of the limitation of the study:

1. An insurgent (Boko Haram) was a challenge that affected the study because during the study any unusual sound attracted the attention of the students. As a result of these there may be poor performance.
2. Atmospheric condition was another challenge that affected the study and students' performance because during heavy sun or rainfall many students found it difficult to attend their lessons.
3. Day students were trapped by traffic congestion; they came in late or miss the classes, which in turn may affect their performances.
4. Intact classes were used for study, there was too many groups, and there was inattentiveness and non responsive from team mates in some groups. As a result of these there may be poor performance.
5. Some students fell shy to ask questions especially the female. This was due to the fact that a some students see mathematics as a subject of selected few or gifted.

5.7 Suggestions for Further Studies.

The study was conducted to investigate the Impact of Impact of Scaffolding-enriched Collaborative Strategy on Test-anxiety, Performance and Retention in Geometry among Secondary School Students in Niger State.

This study maintains that further studies should be conducted in the following areas:

1. Study can be directed to cover all the units of studies in mathematics, since the present study is restricted to geometry.
2. Also similar study could be conduct in junior secondary school level to investigate Impact of collaborative strategy enriched with scaffolding on test-anxiety, retention and academic performance in geometry.
3. Impact of collaborative strategy enriched with scaffolding on test-anxiety, retention and academic performance at post secondary level.
4. This study can be replicated in some other part of Nigeria.

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APPENDIX A

Pre-test: Geometry Performance Test
Section A

1. Introduction

The aim of this test is to collect information which will be used in a research study to improve the teaching and learning of geometry and mathematics in general at senior secondary school level, every information you give is, therefore, strictly for academic purpose and will be treated confidentially. Your name is not required.

2. Instructions
   - (i) Please read the questions carefully and respond appropriately
   - (ii) Choose the most appropriate alternative from the options A to D given for each item
   - (iii) Shade only one answer for each question.
   - (iv) Attempt all the questions.
   - (v) Time allowed: 60 minutes.

3. Bio-data

Male: Female:
Name of school:
Class: Date:

Section B

Multiple choice objective tests

1. A triangle with three sides 4cm, 13cm and 15cm. find the area using Hero's formula.
   a. $24cm^2$
   b. $26cm^2$
   c. $28cm^2$
   d. $25cm$
2. Find the areas of a circle of radius 10cm. (leave your answer in terms of π).
   a. $350cm^2\pi$
   b. $650cm^2\, n$
   c. $100\pi cm^2$
   d. $400cm^2$
3. Calculate the area of a rectangle 6cm by 3.5cm.
   a. $13.1cm^2$
   b. $21cm^2$
   c. $14.1cm^2$
   d. $11.5cm^2$
4. Calculate the area of square advertising board length, 5cm
   a. $65m^2$
   b. $25m^2$
   c. $155m^2$
   d. $45m^2$
5. A circular wire ring has diameter of 20cm. what is the length of the wire.
   a. 13.65cm
   b. 31.65cm
   c. 62.8cm
   d. 21.88cm
6. Calculate the area of a parallelogram, if its base is 9.2cm and its height is 6cm.
   a. $55.2cm^2$
   b. $86.3cm^2$
   c. $47.5cm$
   d. $40.2cm^2$
7. A room of the length 12cm, breadth 8cm and height 5cm was filled with sand. What is the volume of sand used?
   a. $653cm^3$
   b. $545cm^3$
   c. $480cm^3$
   d. $665cm^3$
8. Find the area of triangle with dimension a=4cm b=13cm and c=15cm.
   a. $16cm^2$
   b. $24cm^2$
   c. $28cm^2$
   d. $27cm^2$

9……is a triangle in which all three sides are of different length.

   a. Right angle triangle

b.Obtuse triangle
c. Scalene triangle
d. Isosceles triangle.

10.……is a triangle in which two sides are equal in length.
a. Vertex triangle
b. Isosceles triangle
c .Obtuse triangle
d. Acute triangle

11 If L is the length of rectangle and b is the breadth then the perimeter of rectangle is given as.
a. $2c^2$
b. $2b^2$
c. L+b
d. 2(L+b)

12. The parallel sides of trapezium are 11cm and 13cm. if the area of the trapezium is 84cm2, calculate the distance between the parallel sides.
a.8cm
b.7cm
c.9cm
d.6cm

13. A triangle is equal in area to a rectangle which measures 10cm by 9cm. if the base of the triangle is 12cm long, find its altitude.
a. 13cm
b. 12cm
c. 15cm
d. 21cm

14. Calculate the perimeter of a sector of a circle of radius 7cm the angle of the sector being 108° if π is 22/7
a. 28cm
b. 27.2cm
c. 18.5cm
d. 18.7cm

15. What angle does an arc 6.6cm in length subtend at the centre of a circle of radius 14cm? use π=22/7
a. 20^0
b. 27^0
c. 21^0
d. 30^0

16. ……..is a polygon in which the sides are all equal in length and the angles are all equal to each other.
a. Irregular polygon
b. regular polygon
c. square polygon
d. sphere

17. The perimeter of a circle is known as
a.Circumference
b. diameter

c. radius
d.Arc

18. Find the area of a circle whose radius is 21cm (π=22/7).
    a. $1113.40cm^2$
    b. 1231.40cm
    c. $1386cm^2$
    d. $1445cm^2$
19. The area of a square is r cm. Write down an expression for half its perimeter in terms of r.
    a. $2\sqrt{rcm}$
    b. $\sqrt{rcm}$
    c. $3\sqrt{rcm}$
    d. Rcm
20. The length of a rectangle is three times its width. If the perimeter is 72cm, calculate the width of the rectangle.
    a.9cm
    b.15cm
    c.8cm
    d.10cm
21. The area of trapezium is $14.7cm^2$cm. If the parallel sides are 5.3cm and 3.1cm long. Find the perpendicular distance between them.
    a.4cm
    b.2.5cm
    c. 3cm
    d.3.5cm
22. Calculate the area of circle with radius 7cm. use the value 22/7 for π
    a.$150cm^2$
    b.$185cm^2$
    c.$154cm^2$
    d.$185cm^2$
23. Find the area of triangle with a side 22cm and height 8cm
    a. $66cm^2$
    b. $86cm^2$
    c. $88cm^2$
    d. $84cm2$

24.ABCD is trapezium in which AB\\DC. AB=12cm BC=9cm, CD=6cm and angle B= 46, calculate the area of ABCD.
    a. $34.6cm^2$
    b.$58.3cm^2$
    c.$64.9cm^2$
    d.$53.7cm^2$

25. Find the perimeter of a parallelogram whose length is 8cm and breadth is 7cm.
    a. 25cm
    b. 50cm
    c. 36cm
    d. 10cm

26. A parallelogram has an area of $54cm^2$. if the base is 9cm; find the perimeter of the triangle.

a.6cm
b.8cm
c.9cm
d.10cm

27. The sides of a triangle are 12cm, 9cm and 7cm long. Find its perimeter of the triangle.

a.18cm
b.10cm
c.24cm
d.28cm

28.A triangle has a base 8cm long and a vertical height of 12cm. calculate its area.

a. $48cm^2$
b. $50cm^2$
c.$38cm^2$
d.$28cm^2$

29. The parallel sides of a trapezium are 24cm and 16cm long. The distance between the parallel is 8cm. what is the area of the trapezium.

a. $157cm^2$
b. $145cm^2$
c. $130cm^2$
d. $160cm^2$

30. The area of a trapezium is $180cm^2$ end parallels are 16cm and 14cm. find the attitude of the trapezium.

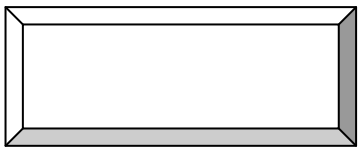
a.15cm
b.16cm
c.12cm
d.13cm

31. An office 7.5 long and 6.5m wide is to be carpeted so as to leave a surrounding of 50cm wide as shown in figure below. Find the area of the surrounding

7.5cm

$a.\ 7.5m^2$
$b.\ 12m^2$
c.$14m^2$
$.d.\ 13m^2$

6.5cm



32.A rectangle measured 7cm by 9cm. what is its area?

a.$53cm^2$
b.$64cm^2$
c.$63cm^2$
d. $60cm^2$

33.Find the area of a piece of land 164cm by 7300cm. express the answer in square meters

$a.\ 11975m^2$
$b.\ 11972m^2$
$c.\ 9741m^2$
d.$20195m^2$

34.The radius of a circle is 130mm. what is the circumference.

a.816mm

b.815.92mm

c.816.92mm

d.820.92mm

35.Find the radius of a circle whose circumference is 90.65cm

a.14.43cm

b.24.44cm

c.12.45cm

d. 10.45cm

36. Find the area of a circle whose radius is 20cm (π=3.142).

a. 13.5m

b. $24.44m^2$

c. 12.45cm

d. 10.45cm

37. The line from the centre of the circle to be circumference is known as

a. arc

b. vertex

c. angle

d. radius

38. The straight line joining two points on the circumference passing through the centre is called……

a.Light

b.arc

c.diameter

d. radius

39. A point or corner where three or more edges meet is called

a.Sharp point

b.plane

c.vertex

d.angle

40. To determine the area of square is

a . l^2

b. lxb

$c. b^2$

d. m^2

Pre Test: Answers

1. A	11.D	21. D	31.D
2. C	12.B	22. C	32.C
3. B	13.C	23. C	33.B
4. B	14.B	24. B	34.C
5. C	15.B	25. B	35.A
6. A	16.B	26. A	36.B
7. C	17.A	27. D	37.D
8. B	18.C	28. A	38.C
9. C	19.A	29. D	39.C
10. B	20.A	30. C	40.B

APPENDIX B

Post test: Geometry Achievement Test1

Section A

1. The aim of this test is to collection information, after giving treatment to know effect of instructions. Every information will be treated confidentially. Your name is not required.
2. Instruction.
   i. Answer all the questions
   ii. Use HB pencil throughout for the multiple choice questions
   iii. The use of calculator is not allowed
   iv. Shade the correct option in the space provided.
3. Bio-data

   Male: Female:

   Name of school:

   Class: Date:

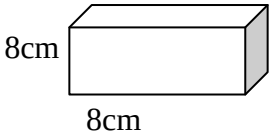
Section B

Multiple choice objective Test.

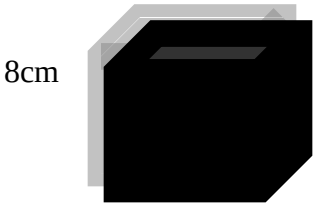
1. An arc AB of a circle subtends an angle of 80° at the centre O of a circle of radius 10cm. find the length of the arc Ab take π to be 3.142
   a. 24cm
   b. 14cm
   c. 12cm
   d. 17cm
2. Calculate the perimeter of the sector POQ, if subtends angle is 120° at the centre O with radius of the circle 120°cm. take π to be 3.142.
   a. 47cm
   b. 49cm
   c. 29cm
   d. 45cm
3. What is the height of cuboids whose cross sectional area is $48cm^2$ and volume is $216cm^3$?
   a. 3.8cm
   b. 2.5cm
   c. 3.6cm
   d. 4.5cm
4. Which of the formulae is correct in determine the surface area of cube of side "A" cm?
   a. $3a^2cm^2$
   b. $6a^2cm^2$
   c. $8a^2cm^2$
   d. $4a^2cm^2$
5. ……..is a solid shape with rectangular base and sides with six rectangular faces.
   a. Cube
   b. Cuboids
   c. Cone
   d. Cylinder
6. A hemisphere has a radius of 5cm. calculate its curved surface area.
   a. $157.1cm^2$
   b. $167.3cm^2$
   c. 184.50cm
   d. 135.4cm
7. Identify the formula of a curved surface area of a cone.
   a. $\overline{\pi rl}$
   b. nπh
   c. πrh
   d. πrl^2
8. The total surface area of a cone is given below.
   a. πrh + π
   b. πr(l+r)

c. $\pi r 2_l + \pi r$
d. $\pi r l^2$

9. Which of the formula is correct in determine the volume of a cylinder.
   a. πrl
   b. πr2h
   c. nr
   d. $\pi r h^2$
10. A hemisphere has a radius of 9cm. calculate its total surface area. If π=22/7
    a. $438.5cm^3$
    b. $563.8cm^3$
    c. $662.7cm^3$
    d. $763.7cm^3$
11. Calculate the diagonal of the cube shown in the figure below.
    a. 13.8cm
    b. 11.3cm
    c. 27.6cm
    d. 16.0cm



12. Calculate the volume of the cube shown in the figure.
    a. $384cm^3$
    b. $512cm^3$
    c. $288cm^3$
    d. $216cm^3$



13. If the volume of cube is 216cm, find the length of the side of the cube.
    a. 6cm
    b. 12cm
    c. 18cm
    d. 29cm
14. If the total surface area of a cube is 384cm, find the length of one of the faces.
    a. 0.8cm
    b. 8cm
    c. 18cm
    d. 28cm
15. Calculate the length of an arc of circle of radius 8cm if the angle it subtends at the Centre of the circle is 30^0
    a. 4.2cm
    b. 8.5cm
    c. 6.3cm
    d. 8.5cm
16. Calculate the length of a chord of a circle of radius 12cm if the angle it subtends at the center of the circle is 136°.
    a. 16.2cm
    b. 19.3cm
    c. 21.5cm
    d. 22.3cm
17. Calculate the length of an arc of circle of radius 8cm if the angle it subtends at the center of the circle is 120°
    a. 16.8cm

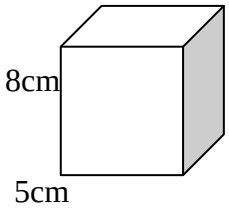
b.17.5cm
c.18.3cm
d.15.5cm

18. If the radius of circles is 12cm and the angle it subtends at the centre of the circle are 150°. Find the length of a chord of a circle.
a.18.6cm
b.20.3cm
c.23.2cm
d.21.3cm

19. Calculate the volume of cuboids with dimension 8cm by 3cm by 7cm.
a.118cm
b.156cm
c.168cm
d.180cm

20. Calculate the length of the diagonal in the figure below

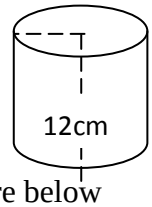
a.2.24cm
b.4.24cm
c.6.24cm
d.8.24cm



21. If volume of cuboids is given by 120cm, calculate the length of the cube if the breath and height are given as 5cm and 3cm respectively.
a. 0.8cm
b. 8.0cm
c. 26cm
d. 36cm

22. Calculate the height of cuboids if the volume is 210cm and the length and breadth are 5cm and 7cm respectively.
a.6cm
b.16cm
c.26cm
d.36cm

23. Find the curved surface area of the cylinder in figure below, Given that the radius is 8cm
a.602.88cm^2
b.401.92cm^2
c.200.96cm^2
d.1004.80cm^2

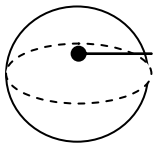


24. Calculate the volume of the cylinder in the figure below
a.153.68cm^2
b.175.84cm^2
c.183.14cm^2
d.2411.52cm^2

25. A cylinder tank has its base radius of 3cm and height of 7cm, calculate the total surface area.
a.188.40cm^2

b.198.44cm^2
c.206.14cm^2
d.218.52cm^2

26. A bucket in a form of a container has a volume of 1908.75cm; calculate the height of the container given that the based radius is 9cm.
    a.170.55cm
    b.75.50cm
    c.17.54cm
    d.7.50cm
27. Calculate the depth of a cylindrical whose capacity is 17325cm, if the radius is 7cm
    a.112.5cm
    b.102.5cm
    c.12.5cm
    d.11.2cm
28. A sector of a circle radius 7cm which subtends an angle of 75° at the centre is used to form a cone, calculate the base radius of the cone, and calculate the base radius of the cone.
    a.1.92m
    b.1.98m
    c.1.89m
    d.1.70m
29. A cone of a base diameter 12cm slant height of 10cm, calculate the total surface
    area.
    a.113.40cm^2
    b.213.04cm^2
    c.301.44cm^2
    d.414.48cm^2
    30. Calculate the volume of cone of slant height 10cm and base diameter 12cm.
    a.904.32cm^2
    b.804.34cm^2
    c.708.14cm^2
    d.608.52 cm^2
    31. Find the curved surface area of a cone of base radius 6cm and slant height 10cm.
    a.1884.04cm^2
    b.188.40cm^2
    c.18.84cm^2
    d.8.18cm^2
    32. Calculate the volume of sphere with radius 9cm
    a.4156.24cm^2
    b.3052.08cm^2 r = 9 cm
    c.2017.36cm^2
    d.1138.04cm^2



    33. Calculate the surface area of a sphere with radius 11cm.

a. $1512.64cm^2$
b. $1515.46cm^2$
c. $1519.76cm^2$
d. $1516.67cm^2$

34. A sphere of radius 7cm is cut into two equal parts; calculate the volume of one of the parts.
a. $918.04cm^2$
b. $718.09cm^2$
c. $518.06cm^2$
d. $418.08cm^2$

35. A hemisphere of radius of 4cm, calculate it surface area in terms of π.
a. 588π
b. 438π
c. 328π
d. 3218π

36. A sphere has a radius of 8cm, find the surface area and volume.
a. 603.84, $2143.57cm^2$
b. 613.44, $4234.72cm^2$
c. 523.41, $5334.78cm^2$
d. 70.87, $343.57cm^2$

37. Calculate the perimeter of a sector of a circle of radius 7cm, the angle of a sector being 108^0 if π is 22/7
a. 64cm
b. 36cm
c. 18cm
d. 27.2cm

38. An arc PQ of a circle O and radius 10cm subtends an angle of 80 at the center of the circle. Calculate the perimeter of the sector OPQ.
a. 36cm
b. 34cm
c. 30cm
d. 33cm

39. An arc of circle centre O and radius 8cm subtends an angle of 120° at the center of the circle. Calculate the perimeter of the minor segment on chord AB.
a. 31.5cm
b. 30.4cm
c. 29cm
d. 30.7cm

40. A chord PQ of circle of radius 5cm subtends an angle of 100 at the centre of the circle. Find the perimeter of the major segment on chord PQ.
a. 30.4cm
b. 35.4cm
c. 31.2cm
d. 29.6cm

Post Test: Answers

1. B	11. C	21.B	31.A
2. B	12. A	22.A	32.B
3. D	13. A	23.D	33.C
4. B	14. B	24.D	34.B
5. B	15. A	25.A	35.A
6. A	16. D	26.D	36.D
7. A	17. A	27.A	37.D
8. B	18. C	28.D	38.A
9. B	19. C	29.C	39.D
10. D	20. B	30.A	40.A

APPENDIX C

Post-post test: Geometry Achievement Test 11

Section A

The aim of this test is to collection information, after giving treatment to know effect of instructions. Every information will be treated confidentially. Your name is not required.

Instruction.

v. Answer all the questions
vi. Use HB pencil throughout for the multiple choice questions
vii. The use of calculator is not allowed
viii. Shade the correct option in the space provided.

4. Bio-data

Male: Female:

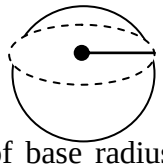
Name of school:

Class: Date:

Section B (Multiple Choice Questions)

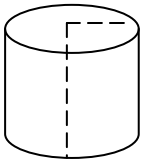
1. A chord PQ of circle of radius 5cm subtends an angle of 100 at the centre of the circle. Find the perimeter of the major segment on chord PQ.
   a. 30.4cm
   b. 35.4cm
   c. 31.2cm
   d. 29.6cm
2. An arc of circle centre O and radius 8cm subtends an angle of 120° at the center of the circle. Calculate the perimeter of the minor segment on chord AB.
   a. 31.5cm
   b. 30.4cm
   c. 29cm
   d. 30.7cm
3. An arc PQ of a circle O and radius 10cm subtends an angle of 80 at the center of the circle. Calculate the perimeter of the sector OPQ.
   a. 36cm
   b. 34cm
   c. 30cm
   d. 33cm
4. Calculate the perimeter of a sector of a circle of radius 7cm, the angle of a sector being 108^0 if π is 22/7.
   a. 64cm
   b. 36cm
   c. 18cm
   d. 27.2cm
5. A sphere has a radius of 8cm, find the surface area and volume.
   a. 603.84, 2143.57cm^2
   b. 613.44, 4234.72cm^2
   c. 523.41, 5334.78cm^2
   d. 70.87, 343.57cm^2
6. A hemisphere of radius of 4cm, calculate it surface area in terms of π
   a. 588n
   b. 438n
   c. 328n
   d. 218n
7. A sphere of radius 7cm is cut into two equal parts; calculate the volume of one of the parts.
   a. 918.04cm^2
   b. 718.09cm^2
   c. 518.06cm^2
   d. 418.08cm^2
8. Calculate the surface area of a sphere with radius 11cm.
   a. 1512.64cm^2
   b. 1515.46cm^2
   c. 1519.76cm^2
   d. 1516.67cm^2

9. Calculate the volume of sphere with radius 9cm
   e. $4156.24cm^2$
   f. $3052.08cm^2$
   g. $2017.36cm^2$
   h. $1138.04cm^2$

r= 9cm 

10. Find the curved surface area of a cone of base radius 6cm and slant height 10cm.
    a. $1884.04cm^2$
    b. $188.40cm^2$
    c. $18.84cm^2$
    d. $8.18cm^2$
11. Calculate the volume of cone of slant height 10cm and base diameter 12cm.
    a. $904.32cm^2$
    b. $804.34cm^2$
    c. $708.14cm^2$
    d. $608.52\ cm^2$
12. A cone of a base diameter 12cm slant height of 10cm, calculate the total surface area.
    a. $113.40cm^2$
    b. $213.04cm^2$
    c. $301.44cm^2$
    d. $414.48cm^2$
13. A sector of a circle radius 7cm which subtends an angle of 75° at the centre is used to form a cone, calculate the base radius of the cone, and calculate the base radius of the cone.
    a. 1.92m
    b. 1.98m
    c. 1.89m
    d. 1.70m
14. Calculate the depth of a cylindrical whose capacity is $17325cm^3$, if the radius is 7cm
    a. 112.5cm
    b. 102.5cm
    c. 12.5cm
    d. 11.2cm
15. A bucket in a form of a container has a volume of $1908.75cm^3$; calculate the height of the container given that the based radius is 9cm.
    a. 170.55cm
    b. 75.50cm
    c. 17.54cm
    d. 7.50cm
16. A cylinder tank has its base radius of 3cm and height of 7cm, calculate the total surface area.
    a. $188.40cm^2$
    b. $198.44cm^2$
    c. $206.14cm^2$
    d. $218.52cm^2$

17. Find the curved surface area of the cylinder in figure below



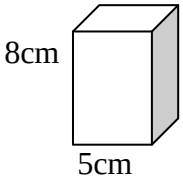
a.602.88cm^2
b.401.92cm^2
c.200.96cm^2
d.1004.80

18. Calculate the volume of the cylinder in the figure below
a.153.68cm^2
b.175.84cm^2
c.183.14cm^2
d.2411.52cm^2

19. Calculate the height of cuboids if the volume is 210cm^3 and the length and breadth are 5cm and 7cm respectively.
a.6cm
b.16cm
c.26cm
d.36cm

20. If volume of cuboids is given by 120cm, calculate the length of the cube if the breath and height are given as 5cm and 3cm respectively.
a.0.8cm
b.8.0cm
c.26cm
d.36cm

21. Calculate the length of the diagonal in the figure below
a. 2.24cm
b.4.24cm
c.6.24cm
d.8.24cm



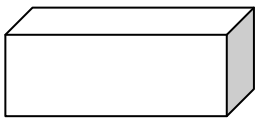
22. Calculate the volume of cuboids with dimension 8cm by 3cm by 7cm.
a.118cm
b.156cm
c.168cm
d.180cm

23. If the radius of circles is 12cm and the angle it subtends at the centre of the circle are 150°. Find the length of a chord of a circle.
a.18.6cm
b.20.3cm
c.23.2cm
d.21.3cm

24. Calculate the length of an arc of circle of radius 8cm if the angle it subtends at the centre of the circle is 120°
a.16.8cm
b.17.5cm
c.18.3cm
d.15.5cm

25. Calculate the length of a chord of a circle of radius 12cm if the angle it subtends at the centre of the circle is 136°.
    a. 16.2cm
    b. 19.3cm
    c. 21.5cm
    d. 22.3cm
26. Calculate the length of an arc of circle of radius 8cm if the angle it subtends at the centre of the circle is 30^0
    a. 4.2cm
    b. 8.5cm
    c. 6.3cm
    d. 8.5cm
27. If the total surface area of a cube is 384cm, find the length of one of the faces.
    a. 0.8cm
    b. 8cm
    c. 18cm
    d. 28cm
28. If the volume of cube is 216cm, find the length of the side of the cube.
    a. 6cm
    b. 12cm
    c. 18cm
    d. 29cm
29. Calculate the volume of the cube shown in the figure.
    A. $384cm^3$
    b. $512cm^3$
    c. $288cm^3$
    d. $216cm^3$8 cm

30. Calculate the diagonal of the cube shown in the figure below.
    a. 13.8cm
    b. 11.3cm
    c. 27.6cm
    d. 16.0cm



31 A hemisphere has a radius of 9cm. calculate its total surface area. If π=22/7
    a. $438.5cm^3$
    b. $563.8cm^3$
    c. $662.7cm^3$
    d. $763.7cm^3$
32. Which of the formula is correct in determine the volume of a cylinder.
    a. π rl
    b. π r2h
    c. π r
    d. π rh^2
33. The total surface area is given as
    a. π rh + πr^2
    b. π r(l+r)
    c. π r2$_l$ + πr

d.π rl^2

34. Identify the formula of a curved surface area of a cone.
    a.$\overline{\pi r l}$
    b.nπh
    c.π rh
    d.π rl^2
35. A hemisphere has a radius of 5cm. calculate its curved surface area.
    a.157.1cm^2
    b.167.3cm^2
    c.184.50cm
    d.135.4cm
36. ……..is a solid shape with rectangular base and sides with six rectangular faces.
    a.Cube
    b.Cuboids
    c.Cone
    d.Cylinder
37. which of the formulae is correct in determine the surface area of cube of Side "a" cm?
    a.3a^2cm^2
    b.6a^2cm^2
    c.8a^2cm^2
    d.4a^2cm^2
38. What is the height of cuboids whose cross sectional area is 48cm^2 and volume is 216cm^3?
    a.3.8cm
    b.2.5cm
    c.3.6cm
    d.4.5cm
39. Calculate the perimeter of the sector POQ, if subtends angle is 120° at the centre O with radius of the circle 120°cm. take n to be 3.142.
    a.47cm
    b.49cm
    c.29cm
    d.45cm
40. An arc AB of a circle subtends an angle of 80° at the centre O of a circle of radius 10cm. find the length of the arc Ab take n to be 3.142
    a.24cm
    b.14cm
    c.12cm
    d.17cm

Post-Posttest Answers

1. A	11.A	21.B	31.D
2. B	12.C	22.C	32.B
3. A	13.D	23. C	33.B
4. D	14.A	24.A	34.A
5. A	15.D	25.D	35.A
6. A	16.A	26.A	36.B
7. B	17.D	27. B	37.B
8. C	18.D	28.A	38.D
9. B	19.A	29. A	39.B
10. A	20.B	30.C	40.B

APPENDIX D

Geometry Test-Anxiety (GTA)

Section A

1. Introduction

Each of the statement of this questionnaire express a feeling towards geometry concepts in mathematics, against each statement there are five-point scale, the extent of agreement between the feeling expressed in each statement and your own personal feelings.

- 5 means extremely highly or always true
- 4 means high or usually true
- 3 means moderately or sometimes true
- 2 means slightly or seldom true
- 1 means not at all or never true

2. Instruction

Please indicate your personal feeling by making a mark (✓) in the appropriate column.

3. Bio-Data

Male ☐ female ☐

Name of school……

Class……..Date…….

Section B.

		1	2	3	4	5
1.	The closer I am to a major geometry exam, the harder it is for me to concentrate on the material.					
2.	When I study, I worry that I will not remember the material on the geometry exam.					
3.	During important geometry exams, I think that I doing awful or that may fail.					
4.	I lose focus on important geometry exams, and I cannot remember material that I knew before the geometry exam.					
5.	I finally remember the answer to geometry exam questions after the geometry exam is already over.					
6.	I worry so much before a major geometry exam that I am too worn out to do my best on the geometry exam.					
7.	I feel out of sorts or not really myself when I take important geometry exam.					
8.	I find that my mind sometimes wanders when I am taking important geometry exam.					
9.	After a geometry exam, I worry about whether I did well enough.					
10.	I struggle with writing geometry assignments, or avoid them as long as I can. I feel that whatever I do will not be good enough.					

Sources: Adopted from Richard Driscoll (2004) and Modified

APPENDIX E

Experimental One Group: Scaffolding Collaborative Lesson Model (SCLM)

Components of the model	Remark
Introduction	This refers to assessing students' prior knowledge (ZPD) of the skill or concept through class discussion or pretest assessment.
Task Definition	Introducing the new concept to raise students' interest on the topic, as well as assisting them to connect with prior knowledge. It is then follows by the delivery normally performed in traditional lecture format. After providing those with working examples then equipped them with procedures or hints or steps.
Collaborative Learning	In this type of environment students assist students in small group settings but still have some teacher assistance. This can serve as a step in the process of decreasing the scaffolds provided by the teacher and needed by students.
Number Head	Each team member discusses the answer to a question to large group.
Apprenticeship	An expert models and activity, provides the learner with advice and examples, guide the student in practice and then tapers off support until the students can do the task alone.
Assessment	Student exchange their exercise books for assessment

EXPERIMENTAL ONE GROUP: LESSON ACTIVITY ON SCS

Topic: Surface Area and Volume of Solid Shapes
(Cubes & Cuboids)

Lesson Objectives: By the end of the lesson students should be able to find:

i.The surface area, and

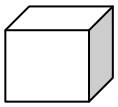
ii. The volume of cubes of cuboids.

Procedure:

(Applying the Stages of the Model).

S**tage One**: The teacher assesses the students' previous knowledge by asking questions on the features and area of square and rectangle.

Stage Two: The teacher introduces the new lesson by explaining what solid shape is, cube and cuboids with their surface areas and volumes.

Fig. a 

1. **Solid figure** is a shape whose sectional body cannot be wholly shown on a plane or flat surface. A cube has six faces of equal dimension, this means that is has length, breadth (width) and height all of which are equal to each other.

Surface area: 6 faces x area of one face

= 6 squares

- S = $6x^2$ $(square\ units)$

Length of diagonal: Q D =$\sqrt{x^2 +}\ x^2 + x^2$

=$\sqrt{3x^2}$

=$\sqrt[x]{3}$

Volume of a cube = base area x height

V= x^3 (cube units)

Now, the teacher provided the students with direct instruction on working examples.

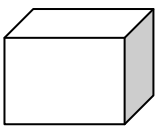
Example 1

A cube has a length of 5cm, calculate.

I. Surface area

II. Length of diagonal

III. Volume.

Solution: 

(I) Surface area= $\sqrt{6x^2}$ where x=5cm

= 6 x5^2

=6 x 25

= 150 cm^2

(ii) Length of a diagonal =BS

/BS/= $\sqrt{(x\text{^}2+)}\ x\text{^}2 + x\text{^}2$

$=\sqrt{3x^2}$

$=\sqrt[x]{3}$

$=\sqrt[5]{3}$

= 5 x 1.7321 = 8.7cm.

(iii) Volume of the cube $=x^3$

$=5^3= 125cm^3$.

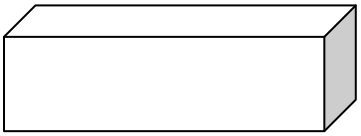
Example 11

Find the surface area and a volume of a cube of side 12cm

2. **Cuboids**

Cuboids are a solid shape with rectangular base and sides. It has six rectangular facer if all sides are closes.

Fig b.



(i) **Surface area** = 6 rectangles

= 2 x y + 2xy + 2yz

= 2 (xy + xz + yz) square units.

(ii) Length of a diagonal: BH= $\sqrt{x^2 + y^2 + z^2}$ unit

(iii) Volume = base area x height

=xy + z

= xyz cuboids units.

Example 111

A cuboids has the length 13cm, width 9cm and 8cm calculate

(a) Surface area

(b) Length of its diagonal

(c) Volume.

Solution

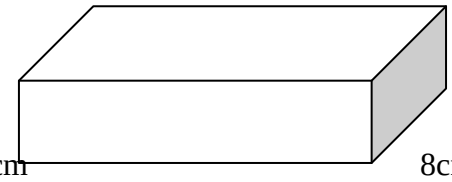


Figure b.

(a) Surface area= 2(xy + xy + yz)

= [(9x13) + (13x8) + (9x8)]

= 2(117 + 104 + 72)

= 2 (293)

= $586cm^3$

(b) Length of diagonal = $\sqrt{x^2 + y^2 + z^2}$

$=\sqrt{9^2 + 13^2 + 8^2}$

$=\sqrt{314}$ = 17.72cm

(c) Volume = base area x height

=xy x z

=9 x 13x $8cm^3$.

= $936cm^2$.

Now the teacher give hints on how solve similar problems in cube and cuboid.

Stage Three: the teacher groups the students into small group with a team leader and engages them into collaborative learning. While the teacher goes round to assist when necessary. The process is a way to decrease the scaffoldings provided. The group work:

1. A cube has a side of 13cm, calculate:
   I .Surface area
   ii. Length of a diagonal
   iii. Volume

2. A cuboids whose length is 10cm, width 8cm and height 3cm. calculate:
   (a) Surface area
   (b) Length of a diagonal
   (c) Volume.
3. The total area of the amount of wood used in building a box is dm. if the length and breadth of base are 8dm and 6dm respectively, find the height of the box.
4. A cube has a length of 7cm, calculate the
   (a) Surface area (b) volume.

Stage four: Each team member is called to present their works one after the order

Stage five: The teacher gives the student's class works to do individual with some guided and goes round to assist the student were necessary.

1.A cube has a length of 10cm, calculate the
   (a) Surface (b) length of a diagonal
   (b) Volume

2.Cuboids has the length 10cm; width 5cm and height 8cm. find the surface area, its diagonal and volume.

Stage six: teacher made the students to exchange their books for marking.

Lesson 2

Topic: Surface Area and Volume of Cylindrical Shapes

Lesson objectives: By the end of the Lesson Students should be able of find:

(i) The surface Area, and

(ii) The Volume of Cylindrical Shapes.

Procedure:

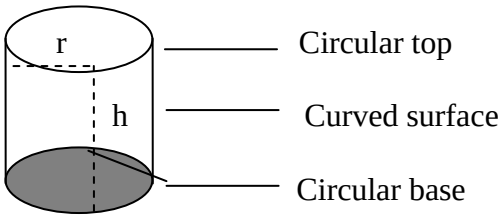
(Applying the stages of the model)

Stage One

The teacher assess the students previous knowledge by asking them questions on circle and using milk tin to assist them to recall the concept of a cylinder. Showing it to them and asking whether if it occupies space like the other prism, cuboids and triangle prism. After all, the teacher gives direct instruction on working examples.

Cylinder

A cylinder is a solid whose cross section is a circle. Example of objects with cylindrical shapes is pipe, milk ting bourn vita tin rock and a log of wood.



(a) Curved surface area

= base circumference x height

= $2\pi rh\ square\ units.$

(b) Total surface area = area of all the faces

(i) When both tops are closed:

= area of base + area of top + curved surface area

=$\pi r^2 + \pi r^2 + 2\pi rh$

=2 πr^2 + 2πrh

=$2\pi r\ (r + h) square\ unit$

(c) Volume = base area x height

= $\pi r^2\ x\ h$

= $\pi r^2 h\ cubic\ units.$

Example 1

A cylinder container has a base radius of 6cm and its height is 17cm. calculate its:

(a) Total surface area

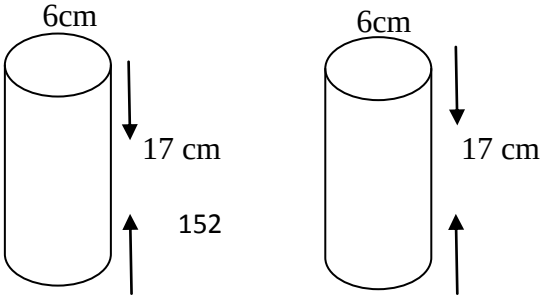
(b) Curved surface area

(c) Volume.

Solution

Considering both when the two tops are closed and only one top is closed

Fig i.Fig ii



Total surface area when both tops are closed:

Total surface area = $2\pi r\ (r + h)$

=2 x 22/7 x 6(6 x 17)

= 264/7 (23)

= $\frac{264\ x\ 23}{7}$ = $\frac{6072}{7}$ = 867.43

= 867.4 cm^2

(a) Total surface area when one top is closed total surface area = $\pi r(r + 2h)$

= $\frac{22}{7}$x 6 (6 + 2 x 17)

= $\frac{22\ x\ 6}{7}$ $(6 + 34)$

= $\frac{132\ x\ 40}{7}$ $x\ 754.3cm^2$

(b) Volume = $\pi r^2 h$

= 22/7 6 x 6 x 17

= $\frac{22\ x\ 36\ x\ 17}{7}$ = $\frac{13464}{7}$ = $1923.4cm^2$.

(2) Find the surface area of cylinder height is 63cm and the diameter of the cross section 12cm. ($\pi = 22/7$)

Stage Three

Participants are engage in collaborative learning and the teacher gives problems to solve in every group with their team leaders. Also guides are provided and the teacher goes round to assist.

Q1. Find the total surface area of the cylinder whose height is 16cm and radius 6cm.

Q2. A cylinder has a base radius 10cm and height 21cm. $\pi = 3.14. calculate$:

(a) Total surface area
(b) Curved surface area
(c) Volume.

Q3. Calculate the curved surface area and volume of a cylindrical container with height 30cm diameter 14cm (takeπ $22/7$

Stage four: each team member is called to present their works one after the order.

Stage five: The teacher gives the students individual work and goes round to assess their performance.

1. Find the total surface area and volume of the cylinder whose height is 10cm and radius 3cm (take$\pi = 3.14$).
2. Find the curved surface area of a tine pipe 15cm long and radius 7cm.
3. A cylinder has a base radius of 6cm and height 9cn calculate its
    a. Volume
    b. Curved surface area
    c. Total surface area

Stage six: teacher made the students to exchange their books for marking.

Lesson 3

Topic: surface area and volume of a cone

Lesson objective: by the end of the lesson participants should be able to find:

1. The surface area; and
2. The volume of cone.

Procedure: (apply the stage of the model)

Stage One:

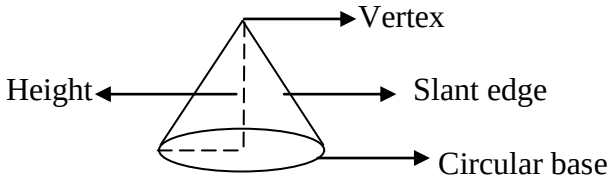
The teacher asked the participants on their previous knowledge on sector of a circle and circle itself.

Stage two:

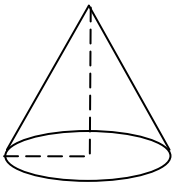
The teacher explains on formation of a cone and gives direct instruction on working examples on the topic.

CONE

A cone is a solid shape with curved body, circular base and a pointed end. Earlier on, we learnt about a sector of a circle. This sector can be folded to form a cone.



The following are the menstruation of a cone



r=radius
l= slant edge
h= height

(a) Curved surface area = $\pi rl \; square \; units$

(b) Total surface area= area of circular base + curved surface area

$$= \pi r^2 \; + \; \pi rl$$

$$= \pi r \; (r + l) square \; units.$$

(2) volume = 1/3 $\pi r^2 h \; cubic \; units$

Slant height (L)=$r^2 \; + \; h^2$

$l^2 = r^2 + \; h^2$

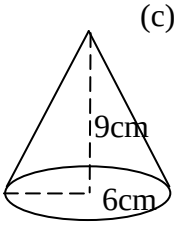
$$l = \sqrt{l^2} = \; \sqrt{r^2} + \; h^2$$

Example 1

A cone has base radius of 6cm and height 9cm. calculate its:

(a) Volume
(b) Curved surface area
(c) Total surface area

Solution



(a) Volume = 1/3 $\pi r^2 h$

= 1/3 x 22/7 x 6 x 6 x9

= $\frac{22\ x\ 36\ x\ 9}{7\ x\ 3}$ = $\frac{7128}{21}$ = 339.43

= 339.4cm^3

(b) Curved surface area = πrl

$l^2 = 6^2 + 9^2$

= 36 + 81

= 117 = $\sqrt{117}$ = 10.82 = 10.8cm

Curved surface area = πrl

= 22/7 x 6 x 10. 82

=$\frac{132\ x\ 10.82}{7}$ = $\frac{1428.24}{7}$= 204.03

= 204cm^2

(c) Total surface area: $\pi r^2 + \pi rl$

= $\pi r\ (r + l)$

= 22/7 x 6 (6 + 10.82)

= $\frac{132\ x\ 16.82}{7}$= $\frac{2220.20}{7}$= 317.18

= 317.2cm^3

Example11: the surface area of a cone with base radius 21cm and slanted 20cm. Ans: 1320cm^2

Example 111

A sector of a circle of radius 7cm subtending an angle 210° at the center of the circle, is used to form a cone. Calculate to the nearest whole number the:

(a) Base radius of the cone r= 4cm
(b) Height of the cone h= 6cm
(c) Total surface area of the cone =142cm
(d) Volume of the cone. =99cm^3

Stage Three

Participants are group and then involve in collaborative learning with the following working problems. The teacher also provides them with guidelines.

Q1. A cone has a base radius of 6.5cm and height 7.2m.

Calculate its:

(a) Total surface area
(b) Volume take $\pi = 3.14$

Q2. A right circular cone whose base radius is 3cm has height 6cm. find

(a) Curved surface area.
(b) Volume.(assuming $\pi = \frac{22}{7}$)

Q3. A sector of a circle of radius 7cm subtending an angle 270° at the centre of the circle is used to form a cone.

(i) Find the base radius of the cone

(ii) Calculate the total surface area of the cone.

(iii)What is the volume of the cone?

Stage four: each team member is called to present their works one after the order.

Stage Five: The teacher gives the participants works to be done individually, and goes round to see their performances.

Q1. Calculate in terms of π, the total surface area of a cone of base diameter 12cm and height 10cm.

Q2. Calculate the volume of a cone of base diameter 14cm and height 5cm. (take$\pi \ to \ be \ 22/7$).

Stage six: teacher made the students to exchange their books for marking.

Lesson 4

Topic: Length of Arc

Lesson objective: By the end of the lesson participants should be able to find

1. The length of arc

Procedure (Apply the Stages of the Model)

Stage one: the teacher asked questions on previous knowledge:

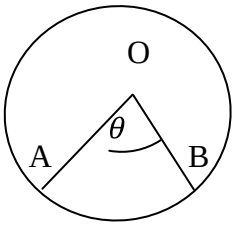
(i) State the formula of finding area of circle and its circumference.

(ii) If r = 14cm find the area of circles and circumference with $\pi = 22/7$

Stage two: the teacher introduces the new lesson by explaining length of arc of circle and sector of a circle.

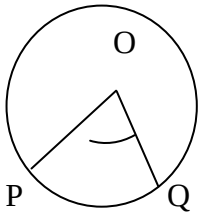
Arc of a circle: an arc of circle is a portion of the circle of circle that is cut-off from the part of a circle by two radii of the circle itself or by a chord of the circle

figi,



In above figure AB is an arc of a circle centre O cut-off by radii OA and OB. The circumference of a circle depends on the radius of the circle itself and the circumference in given as $2\pi r$. In determining the length of an arc of a circle, you must know two basic dimensions. One the radius of the circle and the second in the angle subtended by the arc.

fig ii,

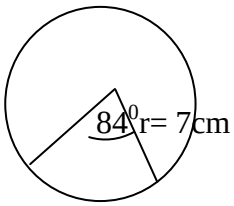


In figure ii the length of arc PQ=$\theta/360^o$ x $2\pi r$

Now the teacher gives working examples.

Example 1: find the length of an arc of a circle of radius 7 cm which subtend an angle 84° at the centre of the circle.

Solution: drawing the sketch of the area.

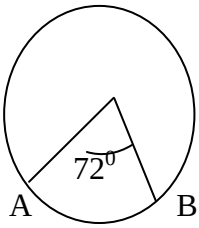


Length of arc PQ= $\theta/ 360$ x $2\pi r$

= $84^o/360$ x 2 x 22/7 x 7

= 84 x 11 / 90 = 10.3cm

Example 2: an arc of a circle is 17.6cm. if the angle subtended at the centre by the arc is 72^o, calculate the radius of the circle



Let the radius be r cm

Length of the arc AB=$\frac{\theta}{360}\ x\ 2\pi r$

= 72/360 x 2 π r = 17 .6cm

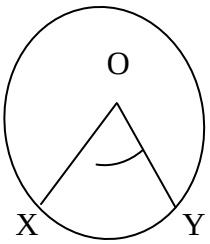
= 72/360 x 2 x 22/7 x r = 17.6cm

= 3168/ 2520r =

R = 17.6 x 2520/ 3168 = 14cm

Example 3. Find the angle subtended by an arc of length 19.8cm at the centre of a circle radius 10.5cm

Solution.



Let the angle be θ

Length of arc XY = θ/360 x 2 π r

θx 2 x 22/7 x 10.5 = 19.8

462/2520 = 19.8

θ = 19,8 x 2520/462 = 108^o

Stage three: The teacher groups the students and engages them into collaborative learning, while he goes round to assist when necessary.

The group work:

1. An arc of a circle radius 13dcm subtends angle 105^o at the centre, calculate the length of arc.
2. A sector of a circle radius 7cm subtends angle 270^o at the centre. Calculate the length of an rc.
3. Complete the table below:

	Radius	Angles centre	Length of arc
A	9cm	102^0	
B	15cm		56cm
C		215^0	39cm
D	21cm	72^0	
E	15.4cm		134cm
F		105^0	72cm

Stage four: Each team member discusses the answer to a question to large group.

Stage five: Class works given to individual and the teacher goes round to assist the students were necessary

1. Find the length of arc with angle subtended at centre 40^0 and at radius 14cm.

2. An arc, AB, subtends and angle of 120^0 at the centre O of a circle of radius 12cm. find the length of arc AOB.
3. Calculate angle subtended at centre of circle with radius 10cm and length of arc 14cm

Stage six: the teacher made the students to exchange their exercise books for marking

Lesson 5

Topic: Area and Perimeter of Sector of a Circle

Lesson objectives: By the end of the lesson participants should be able to calculate:

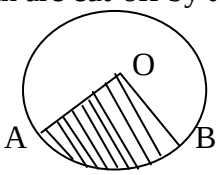
(i) Area of sector of a circle

(ii) Perimeter of sector of a circle

Stage one: the teacher assesses the participants' previous knowledge by asking questions on the area, circumference and length of arc of a circle.

Stage two: the teacher introduces the new lesson by explaining a sector of a circle and how to calculate it.

Sector of circle: a sector of a circle is a plain surface which is a part of the circle bounded by two radii and an arc cut-off by two such radii



Given that: radii $\overline{O}A$, $\overline{O}B$ and arc AB

Two calculations are associated with the sector of a circle which is

a. Area of a sector
b. Perimeter of a sector

Both the area and perimeter of a sector of a circle depend on

- The radius of the circle of which the sector is a portion.
- The angle subtended at the centre of the circle by the sector itself.

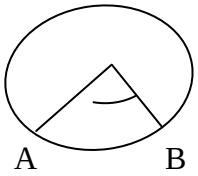
Area of sector will be: $\theta/360 \times 2\pi r$

Perimeter of a sector will be

Now working examples:

Example 1: find area of a sector of a circle of radius 10.5 if the angle of the sector at centre is 108^0

Solution



Let the B the area of the sector OAB

$A = \emptyset/360 \times nr$

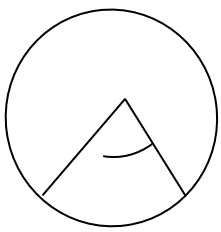
$= 108/360 \times 22/7 \times 10.5 \times 10.5$ cm $= 103.95$cm

$= 108/360 \times 22/7 \times 3.5 \times 3.5$

$= 565.95$

Example 2: calculate the perimeter of a sector of a circle radius 10.5 whose angle at the centre is 140^0

Solution



Q 140 P

Perimeter $= 2r \times 0/360 \times 2\pi r$

$= (2 \times 10.5) + 140/360 \times 2\ 22/7 \times 10.5$

= 21 + 44/18 x 10.5
= 21 + 44/18 x 21/2
= 21 + 25.7 = 46.7cm

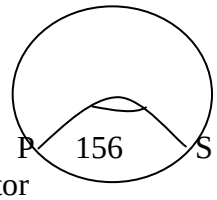
Example 3: calculate the perimeter of a sector and its area with radius 3.5cm has an angle 108 at the centre

Answer : area = 565. 9cm and perimeter = 13.6cm.

Stage three: grouping the participants and giving them a task.

Now the group work:

1. The area of a sector of a circle is 246cm if the radius of the circle is 14cm find the angle subtended at the centre.
2. A sector of a circle radius 8.5 has an angle 280 at the centre find the perimeter
3. In the figure below:



Calculate the

(i) Area of the sector

(ii) Perimeter of the sector

4. An arc of a circle radius 13cm subtends angle 105 at the centre, calculate the:
   (i) Perimeter
   (ii) Area of sector

Stage four: Each group discusses the answer to the whole classes.

Stage five: the participants are given class work as individual work

(1) Complete the table below.

	Radius	Angle of centre	Area of sector
A	11.5cm	150^o	
b	13cm		64.6cm
c	10.5cm	144	
d	17cm		75cm
e	176		112cm

(2) Complete the table below

	Radius	Angle	perimeters
A	9cm	102	
b	11.5cm	150	
c	10.5cm		46.7cm
d		108	13.6cm

Stage six: the teacher made the students to exchange the exercise books for marking.

Lesson 6

Topic: Length of a Chord

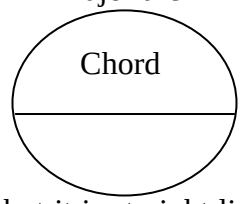
Objective: At the end of lesson, the participants should be able to calculate the length of a chord.

Procedure: (Applying the Stages of Model)

Stage one: The teacher assess the participants' previous knowledge by asking questions on the length of an arc and sector a circle.

Stage two: The teacher introduces the new lesson by explaining length of a chord and direct instruction on how to calculate the length of chord after grouping them.

Major arc

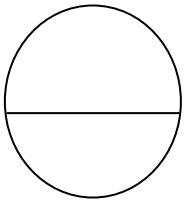


Minor arc

A chord (which is not a diameter) but it is straight line joining any two points on the circumference of a circle. A chord divides the circumference of the circle into two arcs of difference sizes. The bigger arc is called the major arc where as the smaller one is the minor arc. Also the chord divides the area of a circle into two segments. The segments are different sizes. The bigger segment is the major while the smaller one is the minor segment

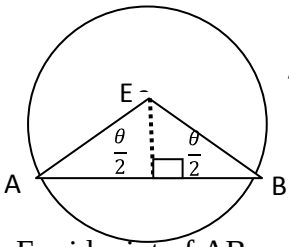
Majorsegment

.



Minor segment

Assuming the chord AB subtends an angleθ at the centre of the circle. The angle θ has been bisected to become$\theta/_2$each.



/AB/=/AE/+/EB/

But /AE/= /EB/ B/C is E midpoint of AB

Therefore /AB/ = 2 /AE/

△AEOtrig metric ratios:

AE/r = sinθ /2

AB = 2 r sin $\theta/2$ units

The formula 2rsinθ /2is used to find the length of a chord when the angle subtended is θ and the radius of the circle r.

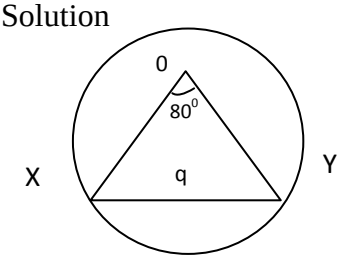
Alternative method:

Using AOB is a triangle. To find /AB/= $r^2 + r^2 – 2r$ x cos θ

AB= $\sqrt{2r^2 - 2r^2 = \cos\theta}$

Example 1: find the length of a chord of a circle with radius 6cm if the chord subtends angle 80^0 at the centre

Solution



Let q be the length of chord XY then

$q = 2r \sin \theta/2$

$= 2 \times 6 \times \sin 80/2$

$= 12 \sin 40$

$= 12 \times 0.6428 = 7.7cm$

Alternative method: using the cosine method

$q = 2r^2 - 2r^2 \cos 80$

$= 2 \times 6 - 2 \times 6 \times 0.1737$

$= 72 - 72 \times 0.1737$

$= 72 - 12.51$

$q^2 = 59.49$

$q = \sqrt{q^2} = 59.49^2$

$q = 7.713$

$q = 7.7cm$

Example 2. The circle with angle at centre 106^0 and radius 15cm calculate, the length of the chord, correct to three significant figures

Stage three: The teacher groups the participants into small group with a team leader and engages them into collaborative learning. While, the teacher goes round to assist when necessary. The process is a way to decrease the scaffolding provided.

The group work:

1. Calculate the length of the chord if the minor arc subtends an angle 170^0 at the centre of the circle of radius 16cm. correct the answer to 3 significant figure.
2. An arc PQ of a circle subtends an angle of 80^0 at the centre O of a circle of radius 10cm. find
   (a) The length of the arc PQ
   (b) The length of the chord PQ (take π to be 3.142)
3. Calculate the length of a chord of a circle of radius 12cm if the angle it subtends at the centre of the circle is

   A 40 B 136 C 150 (take π to be 3.142)

   Stage four: Each team member discuss the answer to a question to whole class.

   Stage five: The teacher gives the participants' class work to be done individually with some guides and goes round to assist.

   1.Calculate the length of a chord of a circle of radius 8cm if the angle it subtends at the centre of the circle is

   A 40 B 80 C136 D150 E180

   Stage six: the teacher directed all the participants to exchange their exercise books for marking.

Lesson 7

Topic: Perimeter and Area of Segment of a Circle

Objectives: By the end of the lesson students should be able to find:

e. Perimeter of a segment ii. Area of segment

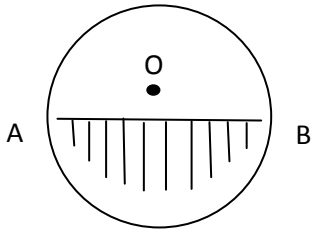
Procedure: (Applying the stages of the model)

Stage one: The teacher assess the student's previous knowledge by asking questions on the length of an arc and chord.

Stage two: the teacher introduces the new lesson by explaining perimeter& area of a segment of a circle

Perimeter of a segment of a circle

The perimeter of a segment is the distance round the segment. This distance consists of the chord and length of the arc forming the segment.



In the segment of X cle above, the perimeter is the sum of the chord AB and arc A X B.

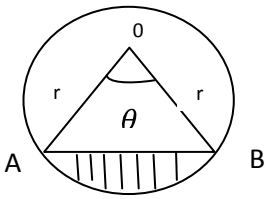
Therefore perimeter of a segment will be

Chord + length of arc

$2r\sin \theta/2 + \theta/360 \times 2\pi r$

$2r\ (\sin \theta/2 + \pi\theta/360)$ units

Area of a segment of a circle



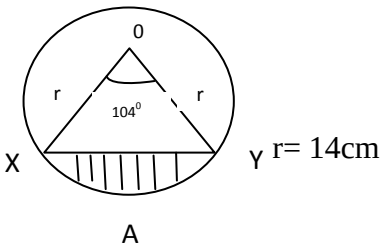
Area of a segment = Area of sector – Area of triangle on top of the sector

$= [\frac{\theta}{360} X \pi r^2 - \frac{1}{2} r^2 \sin\theta]$ square units

Now working examples.

Example1: find the perimeter of the segment of a circle of radius 14cm if the chord subtend angle 104^0 at the center.

Solution:



Let p represent the perimeter of the segment

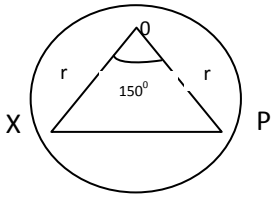
P = length of chord XY+ length of arc XAY

$= 2r\ (\sin \theta/2 + \pi\theta/360)$

= 2 x14 (sin 104/7 + 22/7 x 104/360)
= 28 (sin 52 + 22 x 104/ 7 x 360)
= 28 x 1.6959
= 47.485
= 47.5 approximately.

Example 2: Calculate the perimeter of the segment of a circle of radius 8cm if the chord subtends angle 98^0 at the centre.

Example 3. A chord of a circle of radius 12cm subtends an angle 150^0 at the centre of the circle. Find the area of the segment bounded by the chord and the minor arc.



r= 12cm

Let A be the area of the segment:

$A = \theta/ 360 \times \pi r^2 - ½ r^2 \sin \theta$

= 150/360 x 22/7 x 12 x 12 - ½ 12 x 12 sin 150
= 150 x 22 x 144/360 x 7 - ½ x 144 x sin 30
= 188.57 - 36
= 152.57cm

Stage three: Grouping of students into small group and engaging them into group studies. The teacher goes round to assist when necessary.

Group work:

1. A sector of a circle radius 7cm subtends and 270^o at the centre, calculate (i) length of arc
   (ii) area of sector
   (iii) perimeter of sector
   (iv) area of segment
   (v) perimeter of segment.
2. A chord of a circle of radius 14cm subtends an angle 160^0 at the centre of the circle. Find the area of the segment bounded by the chord and the minor are.
3. Find the perimeter of the segment of a circle of radius 16cm if the chord subtends angle 108^o at the centre
4. Calculate the perimeter of the segment of a circle of radius 10cm if the chord subtends angle 100^o at the centre.

Stage four: Each team member is asked to present their works.

Stage five: the teacher gives the students class work to be done individually.

1. Calculate the area of the segment if chord of a circle of radius 13cm subtends angle 150^0 at the centre of the circle.
2. Find the perimeter of the segment of a circle of radius 9cm if the chord subtends angle 110^0 at the centre.
3. A circle of radius 5cm if the chord subtends angle 103^0 at the centre. Calculate.
   a. Perimeter of the segment
   b. Area of the segment

Stage six: the teacher made the students to exchange their book for evaluation

APPENDIX F

EXPERIMENTAL TWO GROUP: COLLABORATIVE LESSON MODEL (CLM)

PART ONE: OBJECTIVES

Objective: state the objective of lesson.

PRE- REQUISITE KNOWLEDGE

Recall previous lesson that would serve as back group of the newly task.

PART TWO: TEACHING MODEL

Opening activity/beginning of class-

- Question that go over the previous day's lesson
- Go over questions from home work.
- Introducing the lesson of day

Development activity-

- Students will be divided into groups
- Each group will be given some questions
- Each group will now work on their own.
- Each group will discuss their answer to the whole class.
- Teacher calls a specific number and group to answer the question.

Closing Activity-

Student will be giving Home work

EXPERIMENTAL GROUP TWO LESSON ACTIVITY ON CLS

Topic: Surface Area and Volume of Solid Shapes (Cubes and Cuboids)

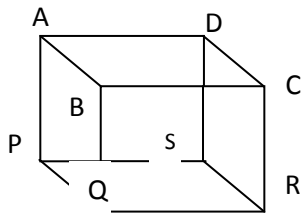
Objectives: By the end of the lesson, students should be able find: the surface areas and volume of cubes & cuboids.

Procedure: Applying the Stages of the Model

Stage one: Opening Activity

The teacher goes over the previous lesson on features and area of square and rectangle. He then, introduces the new task.

1. **Cube**: it has six faces of equal dimension this means that is has length, breadth (width) and height all of which are equal to each other.



Surface area= 6square

$S= 6x^2$ (square units)

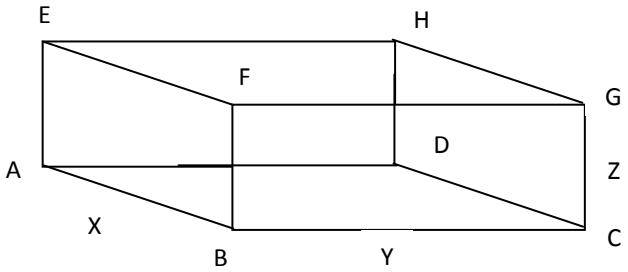
Length of diagonal $QP=\sqrt{x^2+ x^2 + x^2}$

$= \sqrt{3x^2} \quad = x \sqrt{3}$

Volume of a cube = base area x height

$V = x^3$ (cubic units)

2. **Cuboids**: it is a solid shape with rectangle base and sides it has six rectangular faces if all sides are closed



i. Surface area = 6 rectangles

$= 2 \times y + 2 \times z + 2yz$

$= 2 (xy + xz + yz)$ square

Ii.Length of a diagonal:$BH= \sqrt{x^2 +y^2 +z^2}$units

ii. Volume = base area x height

$= xy + z$

$= xyz$ cubic unit.

Stage two: Development Activity

Students are grouped into small group to study together and latter teacher calls a specific number and group to answer the question. That is after presentation by each group.

Group work:

1. A cube has a length of 5cm, calculate
   (i) Surface area
   (ii) Length of a diagonal
   (iii) Volume
2. A cube has a side of 13cm, calculate:
   (i) Surface area
   (ii) Length of a diagonal
   (iii) Volume
3. A cuboids whose length is 10cm, width 8cm and height 3cm. calculate
   a. Surface area
   b. Length of a diagonal
   c. Volume.
4. The total area of the amount of wood used in building a box is dm. if the length and breadth of base are 80m and 6dm respectively; find the height of the box.

Stage three: Closing Activity

The teacher gives the students home work:

1. A cube has a length of 10cm, calculate the
   a. Surface area
   b. Length of a diagonal
   c. Volume.
2. A cuboids has the length 10cm, width 5cm and height 8cm. find the surface area, its diagonal and volume.

Lesson2

Topic: Surface Area and Volume of Solid Shapes (Sphere and Hemisphere)

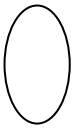
Objectives: By the end of the lesson, students should be able to calculate: surface area and volume of sphere and hemisphere.

Procedure: Apply the Stages of the Model

Stage one: Opening Activity

The teacher goes over the assignment with the students, and then after that, he introduces the new lesson.

Sphere: it is a solid shape with perfectly round surface examples are orange, shot-put e.t.c


sphere


hemisphere

a. Surface area of a sphere (S) = $4\pi r^2$ square units
b. Volume of a sphere (V) = $4/3\ \pi\ r^3$ cubic units

Hemisphere

This is half a sphere it is got by cutting a sphere cross-section ally (a) Curved surface Area = ½ ($4\ \pi\ r^2$)

= $2\pi\ r^2$ square units.

b. total surface area when the hemisphere is covered = the curve surface area + area of the lid = $2\ \pi r^2 + \pi r^2 = 3\ \pi r^2$ square units

(b) Volume of a Hemisphere= $2/3\pi r^3$ cubic units

Stage two: Development activity

Grouping & studies together, Presentation and Questioning)

1. A sphere has a radius of 8cm, find its surface area and volume
2. A hemisphere has a radius of 9cm calculate its curved surface area, total surface and volume.
3. Calculate the surface area and volume of a sphere of radius 7cm
4. A hemispherical bowl whose diameter is 21cm calculate its: surface area and volume.

Stage three:Closing Activity

Students are giving assignment to be submitted for marking next lesson:

1. Calculate the surface area and volume of a sphere of radius 21cm (take π= 3.142)
2. A hemisphere has a radius 14cm; calculate the curved surface area, total surface and volume.

Lesson 3

Topic: Surface Area Volume of Solid Shapes (Cone)

Objective: By the end of the lesson, students should be able to calculate:

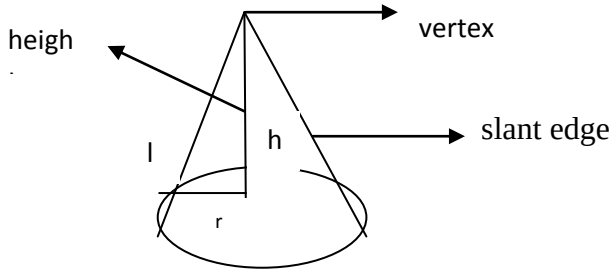
a. Curved surface area
b. Total surface area
c. Volume of a cone

Procedure: Apply the Stages of the Model

Stage one: Opening Activity

Now, the teacher revises the assignment with student and after that introduces the new task.

Cone: it is a solid shape with curved body, circular base and a pointed end.



The following are menstruation of a cone

a. Curved Surface Area (C.S.A) = π rl square unit
b. Total Surface Area (T.S.A)= $\pi r^2 + \pi$ r l (r + l) square units
c. Volume (V) = 1/3 $\pi r^2 h$ cubit unit
d. Slant Edge (L) = $t^2 = r^2 + h^2$ $t = \sqrt{r^2 + h^2}$

Step two: Development Activity

Now the teacher groups the students into small group, and gives them group work. Later each team member presents their answers to large group. Teacher calls a specific number and group to answer the question.

Group work:

1. A cone has a base radius of 6cm and height 9cm. calculate its: volume, curved surface area and total surface area
2. A cone has a base radius of 7cm and height 6cm. calculate its curved surface and volume
3. A cone has a base radius of 6.5cm and height 7.2cm find its total surface area and volume take π=3.14
4. A right circular cone whose base radius is 3cm has height 6cm find curved surface area and volume.
5. A sector of a circle of radius 7cm subtending an angle 210^0 at the center of the circle of the circle is used to form a cone. Calculate to the nearest whole number: base radius, height, total surface area and volume.

Stage three: Closing Activity

The teacher gives the student assignment

1. Calculate in terms of n the total surface area of a cone of base diameter 12cm and height 10cm
2. Calculate the volume of a cone of base diameter 14cm and height 5cm. (take n to be 22/7).

3. A sector of a circle of radius 7cm subtending an angle 270^0 at the centre of the circle is used to form a cone.

28. Find the base radius of the cone

ii. Calculate the total surface area of the cone

Iii. What is the volume of the cone?

Lesson4

Topic: surface Area Volume of Solid Shape (cylindrical shapes)

Lesson objective: By the end of the lesson, students should be able to calculate: (i) total surface area
(ii) curved surface area
(iii) volume of cylindrical shapes

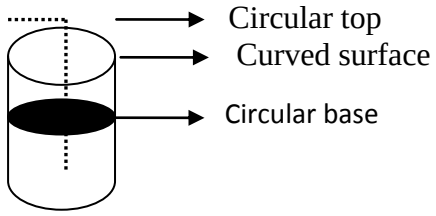
Procedure: (Applying the Stages of the Model)

Stage one: Opening Activity

The teacher question on previous knowledge and goes over last homework. After all, introduces the new lesson.

Cylinder

A cylinder is a solid whose cross section is a circle example of objects with cylindrical shapes is pipe, milk tin and a log of wood.



(a) Curved Surface Area (C.S.A) = Base circumference x height
$= 2\pi$ r h square units

(b) Total Surface Area= Area of all the faces
$=\pi r^2 + \pi r^2 + 2\pi rh$
$= 2\pi r^2 + 2\pi rh$
$=2\pi r (r+h)$ square units

(c) Volume = Base area x height
πr^2 x h
$=\pi r^2 h$ cubic units

Stage two: Development Activity

The teacher gives the group work, after that each group present their works to large group. Again teacher calls a specific number and group to answer the question.

1. A cylinder container has a base radius of 6cm and it height is 17cm. calculate its: total surface area, curved surface area and volume.
2. Find the total surface area of the cylinder whose height is 16cm and radius 6cm
3. A cylinder has a base radius 10cm and height 21cm. π=3.14 calculate: total surface area, curved surface area and volume.
4. Calculate the curved surface area and volume of a cylindrical container with height 30cm, Demeter 14cm.(take π=22/7)

Stage three: Closing Activity

The teacher gives the students home work

1. Find the total surface area and volume of the cylinder whose height is 10cm and radius 3cm (take π = 3.14)
2. Find the curved surface area of a line pipe 15cm long and radius 7cm.
3. A cylinder has a base radius of 6cm and height 9cm. calculate its: volume, curved surface area and total surface area.

Lesson 5

Topic: Length of Arc

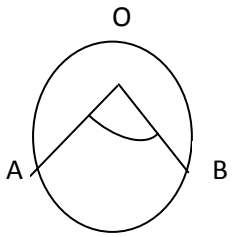
O**bjectives**: By the end of the lesson, students should be able to find: length of arc of a circle.

Procedure :(Applying the Stages of the Model)

Stage one: Opening Activity

The teacher asks on the previous lesson and reviews the last assignment. And then, introduces the new lesson.

Arc of a circle: it is a portion of the circumference of a circle that is cut off from the part of a circle by two radii of the circle itself or by a chord of the circle.



In the above figure AB is an arc of a circle centre O cut-off by radii OA and OB. The circumference of a circle depends on the radius of the circle itself. This circumference is calculated using the formula $2\pi r$

Now, the length of arc AB will be

Length of arc AB= $\emptyset/360 \times 2\pi r$

The formula $\emptyset/360 \times 2\pi r$ is generally used to calculate

The length of any arc L of a circle.

Stage two: **Development Activity**

Grouping the students in small group for cooperative studies and later present their solution to all whole class. After all, the teacher calls a specific number and group to answer the question.

1. Find the length of an arc of a circle of radius 7cm which subtends an angle 84^0 at the center of the circle.
2. An arc of a circle is 17.6cm. if the angle subtended at the centre by the arc is 72^0, calculate the radius of the circle.
3. Find the angle subtended by an arc of length 19.8cm at the centre of a circle radius 10.5cm
4. Find the length of an arc of a circle of radius 14cm which subtend an angle 105^0 at the centre of the circle (take π. 3.14).

Stage three: **Closing Activity**

The teacher gives the students homework

1. Find the length of arc with angle subtended at centre 40 and radius 14cm
2. Calculate angle subtend at centre of circle with radius 10cm and length of arc 14cm

3. Complete the table below

	Radius	Angles at centre	Length of arc
A	9cm	102^0	
B	15cm		56cm
C	21cm	72^0	
D		105^0	72cm

Lesson6

Topic: Perimeter and Area of Sector

Lesson objectives: By the of the lesson students should be able to calculate:

(i) Area of sector of a circle

(ii) Perimeter of sector of a circle

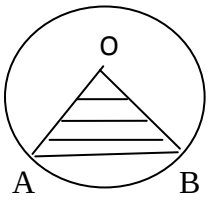
Procedure (Applying the Stages of the

Model)

Stage one: **Opening Activity**

The teacher goes over the assignment and after all introduces new topic by explaining perimeter and area of sector of a circle, and how calculate the two items.

Sectors of a circle: a sector of a circle is a plain surface which is a part of the circle bounded by two radii and an arc cut-off by two such radii.



Given that: radii and OA and OB and arc AB. Both the area and perimeter of a sector of a circledependence.

(i) The radius of the circle of which the sector is a portion.

(ii) The angle subtended at the centre of the circle by the sector itself

The formula $\frac{\theta}{360}$ X πr^2 for area of sector and perimeter is 2r + $\frac{\theta}{360}$ X2πr

Stage two: Development Activity

Students are divided into small groups for group studies after that, they are made to discuss their answers to whole class.

Group work:

1. Find the area of a sector of a circle of radius 10.5cm if the angle of the sector at centre is 108^o
2. Calculate the perimeter of a sector of a circle radius 10.5cm whose angle at the centre is 140^0.
3. The area of a sector of a circle is 245cm if the radius of the circle is 14cm. find the angle subtended at the centre.

a. A sector of a circle radius 8.5cm and angle at the centre 280^0. Find the perimeter of the sector.

4. Calculate the perimeter and area of a sector with radius 3.5cm and angle at centre 108^0 (take π= 3.142).

Stage three: **Closing Activity**

Student is giving assignment.

1. Complete the table below

	Radius	Angle at centre	Area of sector
A	11.5cm	150	
B	13cm		64.6
C	10.5cm	144	
D	17m		75m
E	196		112cm

2. Complete the table below

	Radius	Angle at centre	Perimeter
A	9cm	102	
B	11.5cm	150	
C	10.5cm		46.7cm
D		108	13.6cm

Lesson7

Topic: Length of Chord

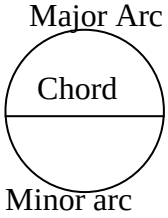
Objective: By the end of the students, the students should be able to calculate the length of a chord.

Procedure: (Applying the stages of the model)

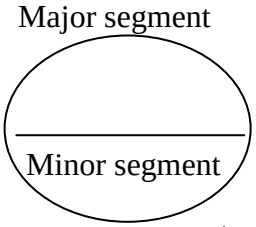
Stage one: **Opening activity**

The teacher goes over the last assignment and introduces the lesson of the day.

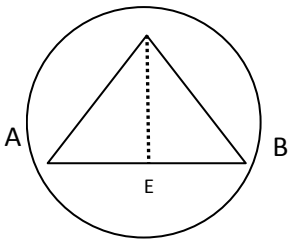
Length of a chord



A chord (which is not a diameter) but it is straight line join any two points on the circumference of circle. A chord divides the circumference of the circle into two arcs of difference sizes. The bigger are is called the major arc is called the major arc whereas the smaller one is the minor arc. Also the chord divided divider the area of a circle into two segments. The segments are different sizes. The bigger segment is known as major segment while the smaller one is the minor one is the minor segment.



Assuming the chord AB subtends an angle ∅ at the centre of the circle. The angle∅ has been bisected to became ∅/2 each.



/AB/ = /AE/ + /ED/

But /AE/ = /ED/ b/c E is midpoint of AB

Therefore /AB/ = 2 /AE/

AEO is a right – angled triangle.

By trigonometric ratio:

AE/r = sin ∅/2

AE = r sin ∅/2

AB= 2r sin ∅/2 units

The formulae of length of a chord a given is

2r sin ∅/2 while the ALTERNATIVE METHOD using AOB then /AB/ = $r^2 + r^2 – 2r$ x rcos∅

= $2r^2$-$2r^2$cos∅

$AB = \sqrt{2r^2 - 2r^2\cos\emptyset}$

Stage two: **Development Activity**

Students are groups into small groups for groups studies. Each group will discuss their answers to whole class, and the teacher calls a specific number and group to answer the question.

Group work:

1. Find the length of a chord of a circle with radius 6cm if the chord subtend angle 80^0 at the centre
2. The circle with angle at centre 106^0 and radius 15cm. calculate the length of the chord.
3. Calculate the length of the chord if the minor arc subtended an angle 170^0 at three centre with radius 16cm. correct the answer to 3 sig. figure.
4. An arc PQ of a circle subtends angle of 80^0 at the centre 0 of a circle of radius 10cm. find length of arc and length of the chord.

Stage three: **Closing Activity**

The teacher gives assignment to students

1. Calculate the length of a chord of a circle of radius 12cm if the angle subtend at the centre of the circle in

   a.40 b. 136 c. 150 (π = 3.142)

Lesson 8

Topic: Perimeter of a Segment of a Circle

Objective: By the end of the lesson, students should be able to calculate the perimeter of a segment of a circle

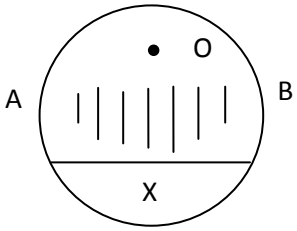
Procedure: (Apply the stages of model)

Stage one: Opening Activity

Teacher goes over last assignment with the students and introduces the lesson of the day.

Perimeter of a segment of a circle.

The perimeter of a segment is the distance round the segment. This distance consist of the chord and length of the arc forming the segment



In the segment of a circle above, the perimeter is the sum of the chord AB and arc AxB. Therefore perimeter of a segment will be: chord + length of arc

$= 2r \sin \emptyset/2 + \emptyset/360 \times 2\pi r$

$= 2r (\sin\emptyset/2 \times \emptyset\pi/360)$ unit.

Stage two: **Development Activity**

The teacher goes over pervious lesson and assignment. Grouping the students for group studies.

Group work:

1. Find the perimeter of the segment of a circle of radius 14cm if the chord subtends angle 104^0 at the centre.
2. Calculate the perimeter of the segment of a circle of radius 8cm if the chord subtend angle 98^0 at the centre
3. Find the perimeter of the segment of a circle radius of 21cm if the chord subtends angle 140^0 at the centre.
4. A sector of a circle radius 7cm subtends angle 270^0 at the centre. Calculate
   a. Length of arc
   b. Area of sector
   c. Perimeter of sector
   d. Perimeter of segment

Stage three: **Closing Activity**

The teacher gives the students homework.

1. An arc AB of a circle centre O and radius 8cm subtends and angle of 120^o at the centre of the circle. Calculate the perimeter of
   a. The sector OAB
   b. The minor segment on chord PQ
2. Find the perimeter of the segment of a circle radius 15cm if the chord subtends angle 210^0 at the centre.

Lesson 9

Topic: Area of a Segment of a Circle

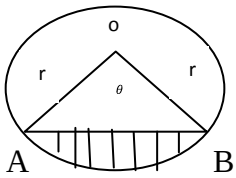
Objective: By the end of the lesson, students should be able to calculate area of a segment of a circle

Procedure: Applying the stages of model

Stages one: Opening activity

The teacher goes over the previous lesson and assignment. After that, introduces the new lesson.

Area of a segment of a circle



The above figure the area of the segment ABD is calculated using the method of subtracting the area of the triangle OAB from sector OADB. There is no difficulty finding the area of the sector.

Area of a segment= Area of Sector – Area of Triangle on Top of the Sector.

$\{\emptyset/360 \times \pi r^2 - \frac{1}{2} r^2 \sin \emptyset\}$ square units

Stage two: **Development Activity**

Students are grouped for group studies. And presentations were made by each group.

Group work:

1. A chord of a chord of radius 12cm subtends an angle 150 at the centre of the circle find the area of the segment bounded by the chord and the minor arc.
2. A chord of a circle of radius 6cm subtends and angle 80^0angle 100 at the centre.
3. Find the area of the segment of a circle of radius 14cm if the chord subtends angle 105 at the centre.
4. Calculate the perimeter and area of segment of a circle of radius 8cm if chord subtend angle 100^0at the center.

Stage three: **Closing Activity.**

The teacher gives the students assignment

1. Calculate the area of segment of a circle of radius 14cm if the chord subtend angle 104^0 at the centre
2. Calculate the area of segment of a circle of radius 8cm if the chord subtends angle 98^0 at the centre
3. A chord of a circle of radius 5cm subtends an angle of 120^0 at the centre. Find the area of segment.

APPENDIX G

Conventional Lesson Model (CLM)
Control Group (CG)

Lesson 1

Topic: Surface area and Volume of Solid Shapes (Cubes & Cuboids)
Class: SSII
Average Age: 16+
Sex: mixed
Duration: 60minutes
Objective: At the end of the lesson students should be able to:

(i)
(ii) Calculate the surface area,
(iii) Volume of cubes and cuboids

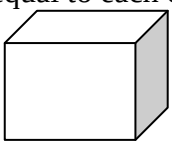
Previous knowledge: Students have learnt about properties and areas of square and rectangles.

Introduction: The teacher introduces his lesson by asking the students the following questions: what are properties of square, rectangles and also to state the formula of finding areas of the two shapes

Presentation:

Step1: the teacher explains the concept of solid shape and also the area, diagonal and volume of cube.

Shape: is a shape whose sectional body cannot be wholly shown on a plane or flat surface. A cube has six faces of equal dimension. This means that it has length, breadth (width) and height all of which are equal to each other.



Surface area: 6faces x area of one face
= 6squares.
S= 6x (square units)

Length of diagonal: QD = $\sqrt{x + x +}\ x^2$
$= \sqrt{3x^2}$ = x$\sqrt{3}$

Volume of a cube = base area x height
V= X^3 (cube units).

Step11: the teacher explains how to solve the following examples.

Example 1

A cube has a length of 5cm, find (i) surface area (ii) length of a diagonal (iii) volume.

Solution.

(i) Surface area = $6x^2$ where x = 5cm thus 6 x 5^2= 6 x 25 = 150 cm^2
(ii) Length of a diagonal = $\underset{BS}{\leftarrow}$ thus /BS/ = x$\sqrt{3}$ = 5$\sqrt{3}$ = 5 x 1.7 = 8.7cm
(iii) Volume = x^3 = 5^3 = 125cm^3

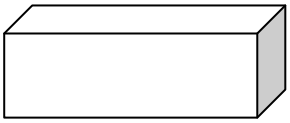
Example 11:

Find the surface area and volume of a cube of side 12cm.

Step111

The teacher also explains on cuboids' and the formula of finding its area, diagonal and volume cuboids.

A cuboids is a solid shape with rectangular base and sides' it has six rectangular faces if all sides are closed.



(i) Surface area = 6 rectangles
= 2xy + 2xz+ 2yz
=2xy + 2xz + 2yz
= 2(xy + xz + yz) square units

(ii) Length of a diagonal : BH = $\sqrt{x^2 + y^2 + z^2}$ unit

(iii) Volume = base area x height = xy + z = xyz cubic units.

Example iii

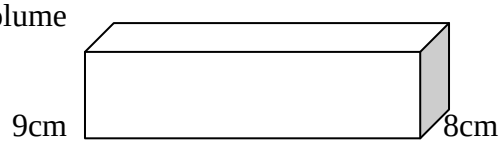
A cuboid has the length 13cm, 9cm and 8cm. calculate.

(a) Surface area

(b) Length of its diagonal

(c) Volume

Solution



(a) Surface area= 2 (xy + xz + yz)
= 2 ((9x13) + (13 x 8) + (9 + 8))
= (117 + 104 + 72)
= 2 (293)
= 586cm^2

(b) Length of diagonal = $〖\sqrt{x}〗$ ^2 + y^2 + z^2
=$\sqrt{9}^2 + 13^2 + 8^2$
= $\sqrt{314 =}$ 19.72cm

(c) Volume = base area x height
= xy + z
= 9 x 13 x 8cm^3
= 936cm^3

Example iv

A Cuboids whose length is 10cm, width 8cm and length 3cm. calculate: (a) surface area (b) length of a diagonal (c) volume

Evaluation:

The teacher evaluates his lesson by giving a class work and goes around to assist the average ones.

Conclusion/summary

Teacher concludes the lesson by highlighting on the main points. Such as definition of shapes and the formulae.

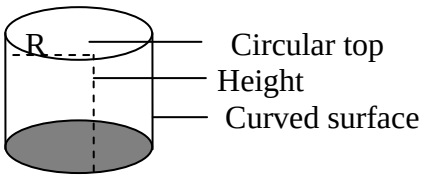
Lesson 2

Topic: surface area and volume of cylinder shapes
Class: SS II
Average age: 16+
Sex: mixed
Duration: 60minuates
Objective: At the end of the lesson students should be able to calculate: the surface area, the volume of cylinder shapes
Previous knowledge: Students have learnt about how to find areas and circumferences of circles.
Introduction: The teacher introduces his lesson by asking the students questions on their previous knowledge. Such as

1. What is a difference between radius and diameter of circle?
2. Find the areas and circumference of a circle radius 3cm with π = 3.142

Presentation:
Step I the teacher explains the shape and its parts.
Cylinder.

A cylinder is a solid whose cross section is a circle, example of objects with cylindrical shapes are pipe, milk tin, bournvita tin, rod and a log of wood.



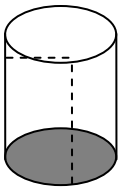
(a) Curved surface area = base circumference x height
= $2\pi rh\ square\ units$
(b) Total surface area= areas of all the faces
(i) When both tops are closed:
= area of base + area of top + curved surface area
= πr + $r2$ + $2\pi rh$
= $2\pi r2\ + 2\pi rh$
= $2\pi r\ (r + h)$ surface units

(c) Volume = base area x height
=$\pi\ r2\ x\ h$
= $\pi r2h\ cubic\ units$

Step ii the teacher gives working examples in class
Examples 1
A cylinder container has a base radius of 6cm and its height is 17cm. calculate its:
(a) Total surface area
(b) curved surface area
(c) volumes

Solution:

considering both when the two tops are closed and only top is closed.



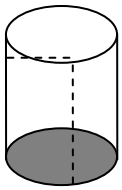


Figure i

(a) total a surface area when both tops are closed

total surface area = 2rh (r + h)

= 2 x 22/7 x 6 (6 + 17)

= 264/7 (23)

= 264 x 23/ 7 = 6072/7 = 867. 43

= 867. 4cm^2

Figureii

(b) total surface are when one top is closed

Total surface area = $\pi r\ (r + 2h)$

= 22/7 x 6 (6 + 2 + 17)

= 22 x 6/7 (6 + 34)

= 132 x 40/7 = 754.3cm^2

(c) volume = πr^2h

= 22/7 x 6 x6 x 17

= 22 x 36 x 17/7 = 13464/7 = 1923.4cm^3

Example II: find the surface area of cylinder height is 63cm and the diameter of the cross-section 12cm. ($\pi = 22/7$)

Step III

The teacher asked the student to working out the problem on their own and goes round to assist:

(i) a cylinder has a base radius 10cm and. Height 21cm using 3.142 for $\pi\ calculate$:

(a) total surface area
(b) curved surface area
(c) volume

Conclusion:

The teacher gives the students assignment:

Q_1 find the total surface area of the cylinder whose height is 16cm and radius 6cm.

Q_2 calculate the curved surface area and volume of cylindrical container with height 30cm and diameter 14cm (take$\pi = 22/7$)

Lesson 3

Topic: Surface area and Volume of a cone

Objective: By the end of lesson students should be able to find:

(a) The surface area, and b. the volume of cone

Previous knowledge: Student has learnt about surface area of cylinder and its volume.

Introduction: the teacher introduces his lesson by asking the students on their previous knowledge. (i) to state the formula of sector and area of circle

(ii) Calculate the area of circle with radius 5cm

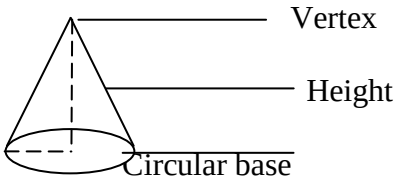
Presentation:

Step I

The teacher explains on formulation of cone and derived the formulae of surface area and volume of cone.

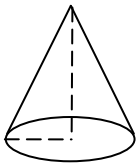
Cone:

A cone is a solid shape with curved body. Circular base and a pointed end.



Now, the menstruation of a cone

S



(a) Curved surface area = $\pi rl\ square\ units.$

(b) Total surface area = area of cylinder base + curved surface area

$= \pi r^2 + \pi rl$

$= \pi r\ (r + l) square\ units.$

(c) Volume = 1/3 $\pi\ r^2$h cubic units

(d) Slant height (c) = $r^2 + h^2$

$C^2 = r^2 + h^2$

$L = l^2 = r^2 + h^2$

Step II

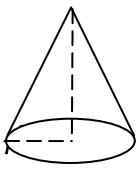
The teacher explains the following working examples.

Q_1: a car has radius of 6cm and height 9cm. calculate its (a) volume

(b) curved surface are

(c) Total surface area.

Solution:

(a) volume = 1/3 π 

= 1/3 x 22/7 x 36 x 9 = 7198/21 = 339.43cm^3

= 339.4cm^3

(b) curved surface area = $\pi\, r\, l$

$l^2 = 6^2 + 9^2$

= 36 + 81

= 117= 117 = 10.82 = 10.8cm.

(c) total surface area = $\pi r^2 + \pi r l$

$= \pi r\,(r + l)$

= 22/7 x 6 (6 + 10.82) = 2220.24/7 = 317.18cm^2

$Q_{1:}$ The surface area of a cone with base radius 10cm and slant edge 20cm. using $\pi = 3.14$

Q_2: A sector of a cone of radius 7cm, subtending an angle 210° at the centre of the circle is used to form a cone. Calculate to the nearest whole number

(a) base radius of the cone ans r= 4cm

(b) height of the cone ans h = 6cm

(c) total surface area ans 142cm^2

(d) volume ans 99cm^3

Step III

The teacher gives class work and goes to mark their exercise books.

Q_1 A cone has a base radius of 6.5cm and height 7.2m find

(i) total surface area

(ii) volume $\pi = \frac{22}{7}$

Conclusion: the teacher concludes his lesson by giving the summary of the lesson and also assignment.

Q1. A sector of a circle of radius 7cm subtending an angle 270 at the centre of the circle is used to form a cone.

(i) Find the base radius of the cone

(ii) Calculate the total surface area of the cone

(iii) What is the volume of the cone

Lesson 4

Topic: Surface Area and Volume of Solid (sphere and hemisphere)

Objectives: at the end of the lesson students should be able to calculate the surface area and volumes of sphere and hemisphere.

Previous knowledge: students here learnt about how to find area and volumes of cylindrical shapes.

Introduction: the teachers introduce his lesson by asking the students questions on their previous knowledge.

Presentation:

Step 1: the teacher explains the shapes and its parts

Sphere: is a solid shape with perfectly round faces examples are oranges, shot put etc.

Hemisphere: this is half of a sphere. It is gist by cutting a shape cross-sectional.

StepII: the teacher states and explains the formulae of finding area and volume of the two shapes.

Sphere

(a) Surface area of a sphere (s) = $4\pi r^2$square units

(b) Volume of sphere (V) = 4/3 πr^2 cubic units.

V is the volume, S is the surface area and r is the radius.

Hemisphere

(a) Curved surface area = ½ ($4\pi r^2$) ie half area of a sphere

= $2\pi r^2$ square units

(b) Total surface area when the hemisphere is curved= the curved surface area + area of the lid= $2r^2 + \pi r^2$

= $3\pi r^2$ square units

(c) Volume of hemisphere= 2/3 πr^2 cubic units

Step III: the teacher explains how to solve the examples.

1.A sphere has radius of 8cm, find its surface area and volume.

2.A hemisphere has a radius of 9cm. calculate its: curved surface area (b) volume (c) total surface area

Step IV: the teacher gives the students class work and goes round to assist.

1.A sphere has a radius of 12cm, find its (i) surface area (ii) volume

2.A hemisphere has a radius of 5cm, calculate its: (a) volume (b) total surface area (c) curved surface area

Conclusion: the teacher gives the students assignment.

1.A hemisphere has a radius of 13cm, calculate its:

(a) Total surface area (b) curved surface area (c) volume

Lesson 5

Topic: Length of Arc

Objective: at the end of the lesson, students should be able to calculate the length of arc

Previous knowledge: students have learnt how to calculate the surface areas and volumes of solid shapes

I**ntroductio**n: the teacher introduces his lesson by goes over previous lesson.

Presentation :

Step I: the teacher explains an arc of a circle and the formula of calculating the length of an arc.

Length of a circle: determine the length of and arc of a circle, two basic dimensions are necessary: these are (i) the radius of the circle (ii) the angle subtended by the arc at the centre.

Length of an arc = $\emptyset/360 \times 2\pi r$.

Step II: the teacher explains the following examples.

1. Find the length of an arc of a circle of radius 7cm which subtends an angle 84 at the centre of the circle
2. Find the angle subtended by an arc of length 19.8cm at the centre of a circle radius10.5cm.
3. An arc of a circle is 17.6cm. if the angle subtended at the centre by the arc is 72, calculated the radius of the circle.

Step III: the teacher gives the students class work.

1. Find the angle subtended by an arc of length 56m at the centre of a circle radius 15m
2. Find the length of an arc of a circle of radius 9cm which subtends an angle 102^o at the centre of the centre.

Conclusion: the teacher concluded his lesson by marking the students work.

Lesson6

Topic: Sector of a Circle

Objective: at the end of lesson, students should be able to calculate area and perimeter of a sector

Previous knowledge: students have learnt how to calculate the length of arc.

Introduction: the teacher introduces his lesson by asking questions on how length of arc

Presentation:

Step I: the teacher explains a sector of a circle and formulas calculating area and perimeter of a sector.

Sector of a circle: a sector of a circle is plain surface which is a part of the circle bounded by two radii and arc cut-off by two such radii. While its perimeter is the distance round the sector.

Area of a sector= $\emptyset/360\ \pi r^2$

StepII: the teacher explains on how to solve the following examples.

Example1: find the area of a sector of a circle of radius 10.5cm if the angle of the sector at the centre is 108^o

Example2: the area of a sector of a circle is 2446.4cm if the radius of the circle is 14cm find the angle subtended at the centre.

Example3. A sector of a circle radius 3.5cm has an angle 108% at the centre. Find the perimeter of the sector.

Example 4: calculate the perimeter of a sector of a circle radius 10.5 whose angle at the centre is 140^o

Step III: the teacher gives the students class work and goes round to assist.

1. Find the area of a sector of a circle of radius 11.5cm if the angle of the sector at the centre is 102^o.
2. Calculate the area and perimeter of a sector of radius 17cm if the angle of the sector at the centre is 150^o.

Conclusion: the teacher asked the students to exchange their books for marking.

Lesson 7

Topic: Length of Chord

Objective: At the end of lesson, student should be able to find the length of chord.

Previous knowledge: students have learnt about how to calculate the area and perimeter of a sector

Introduction: the teacher introduces his lesson by going over assignment of last lesson.

Presentation:

StepI: the teacher explains what length of a chord is.

StepII: the teacher gives out the formula and explains

Length of chord= $2r \sin \emptyset/2$ units.

Alternative method.

Length of chord=$\sqrt{2r^2 - 2r^2 \cos \emptyset}$

StepIII: the teacher explains how to work out the examples.

1. Find the length of a chord of a circle of radius 6cm if the chord subtend angle 80 at the centre.
2. A chord of length 9cm is drawn on a circle radius 16cm find the angle subtended by the chord to the nearest whole number

Step IV

The teacher goes over the examples again

Conclusion:

The teacher concluded his lesson by giving the students assignment.

1. The minor arc subtends an angle 170^0 at the centre of a circle of radius 16cm. calculate the length of the chord.
2. The major are subtends an angle 125^0 at the centre of a circle of radius 12.5cm. find the length of the chord

Lesson 8

Topic: Perimeter and Area of a Segment of a Circle.

Objectives: By the end of the lesson, students should be able to find: perimeter of a segment (ii) Area of a Segment

Previous knowledge: student has learnt about the length of a chord.

Introduction: the teacher introduces his lesson by asking the students questions on their previous knowledge.

P**resentation**:

StepI: the teacher explains perimeter and area of a segment.

StepII: the teacher states the formula of perimeter and of a segment.

The perimeter of a segment is the sum of the chord and length of arc

$= 2rsin\emptyset/2 + \emptyset/360 \times 2\pi r$

$= 2r (\sin \emptyset/2 + r\emptyset/360)$ units

Area of a segment= area of sector - area of triangle on top of the sector .

$= (\emptyset/360 \times \pi r^2 - \frac{1}{2}\pi^0 \sin \emptyset)$ square units

Step III: the teacher gives out working examples.

1. Find the perimeter of the segment of circle of radius 14cm if the chord subtends angle 104° at the centre
2. Calculate the perimeter of the segment of the segment of a circle of radius 8cm if the chord subtends angle 98^o at the centre.
3. A chord of a circle of radius 12cm subtends an angle 150^o at the centre of the circle find the area of the segment bounded by the chord and the minor arc.

Conclusion: the teacher concluded his lesson by summarizing all the contents taught during the study.

APPENDIX H

Statistical Package for Social Sciences

ANALYSIS
HYPOTHESIS ONE
POST TEST
SCS /CLS
RESULT
T-Test (1)

Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
SCORE	SCS	135	63.4222	15.74776	1.35535
	CLS	120	50.4667	14.96041	1.36569

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
SCORE	Equal variances assumed	.044	.835	6.713	253	.000	12.95556	1.92991	9.15481	16.75630
	Equal variances not assumed			6.733	251.869	.000	12.95556	1.92408	9.16621	16.74490

HYPOTHESIS TWO
POST POST TEST
SCS /CLS
RESULT

T-Test(2)

Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
SCORE	SCS	135	52.7407	14.44029	1.24282
	CLS	120	50.0000	16.16719	1.47586

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
SCORE	Equal variances assumed	.887	.347	1.430	253	.154	2.74074	1.91667	-1.03392	6.51540
	Equal variances not assumed			1.420	240.302	.157	2.74074	1.92944	-1.06004	6.54153

HYPOTHESIS THREE
ANZIETY TEST
SCS /CLS
RESULT

T-Test (3)

Group statistic

VARIABLE	N	Mean	Std. Deviation	Mean Difference
SCS	135	46.6963	16.64972	-1.23704
CLS	120	47.9333	16.31607	

Independent Samples Test

VARIABLE	N	Mean	Std. Deviation	Mean Difference	Df	t-test	p-value	decision
SCS	135	46.6963	16.64972	-1.23704	253	-0.598	0.551	Retain H_o
CLS	120	47.9333	16.31607					

HYPOTHESIS FOUR
POST TEST
CSS /CTS
RESULT

T-Test (4)

Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
SCORE	SCS	135	63.4222	15.74776	1.35535
	CTS	125	32.2560	16.55290	1.48054

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
SCORE	Equal variances assumed	.001	.979	15.557	258	.000	31.16622	2.00337	27.22118	35.11126
	Equal variances not assumed			15.527	253.907	.000	31.16622	2.00723	27.21329	35.11916

HYPOTHESIS FIVE
POST POST TEST
SCS /CTS
RESULT
T-Test (5)

Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
SCORE	SCS	135	52.7407	14.44029	1.24282
	CTS	125	32.4320	11.58582	1.03627

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
SCORE	Equal variances assumed	12.035	.001	12.446	258	.000	20.30874	1.63176	17.09547	23.52201
	Equal variances not assumed			12.550	252.962	.000	20.30874	1.61816	17.12195	23.49553

HYPOTHESIS SIX
ANZIETY TEST
SCS /CTS
RESULT
T-Test (6)

VARIABLE	N	Mean	Std. Deviation	Mean Difference
SCS	135	46.6963	16.64972	-17.03970
C TS	125	63.7360	16.51058	

VARIABLE	N	Mean	Std. Deviation	Mean Difference	Df	t-test	p-value	decision
SCS	135	46.6963	16.64972	-17.03970	258	-8.278	0.000	Reject H_o
C TS	125	63.7360	16.51058					

HYPOTHESIS SEVEN
POST TEST
CLS /CTS
RESULT
T-Test (7)

Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
SCORE	CLS	120	50.4667	14.96041	1.36569
	CTS	125	32.2560	16.55290	1.48054

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for EquSality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
SCORE	Equal variances assumed	.047	.828	9.022	243	.000	18.21067	2.01839	14.23489	22.18644
	Equal variances not assumed			9.041	242.128	.000	18.21067	2.01423	14.24303	22.17831

HYPOTHESIS EIGHT
POST POST TEST
CLS /CTS
RESULT
T-Test (8)

Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
SCORE	CLS	120	50.0000	16.16719	1.47586
	CTS	125	32.4320	11.58582	1.03627

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	(2-iled)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
SCORE	Equal variances assumed	15.689	.000	9.806	243	.000	17.56800	1.79149	14.03916	21.09684
	Equal variances not assumed			9.742	215.089	.000	17.56800	1.80333	14.01354	21.12246

HYPOTHESIS NINE
ANZIETY TEST
CLS /CTS
RESULT

T-Test (9)
Statistical group

VARIABLE	N	Mean	Std. Deviation	Mean Difference
CLS	120	47.9333	16.31607	-15.80267
CTS	125	63.7360	16.51058	

VARIABLE	N	Mean	Std. Deviation	Mean Difference	Df	t-test	p-value	decision
CLS	120	47.9333	16.31607	-15.80267	243	7.532	0.000	Reject H_o
CTS	125	63.7360	16.51058					

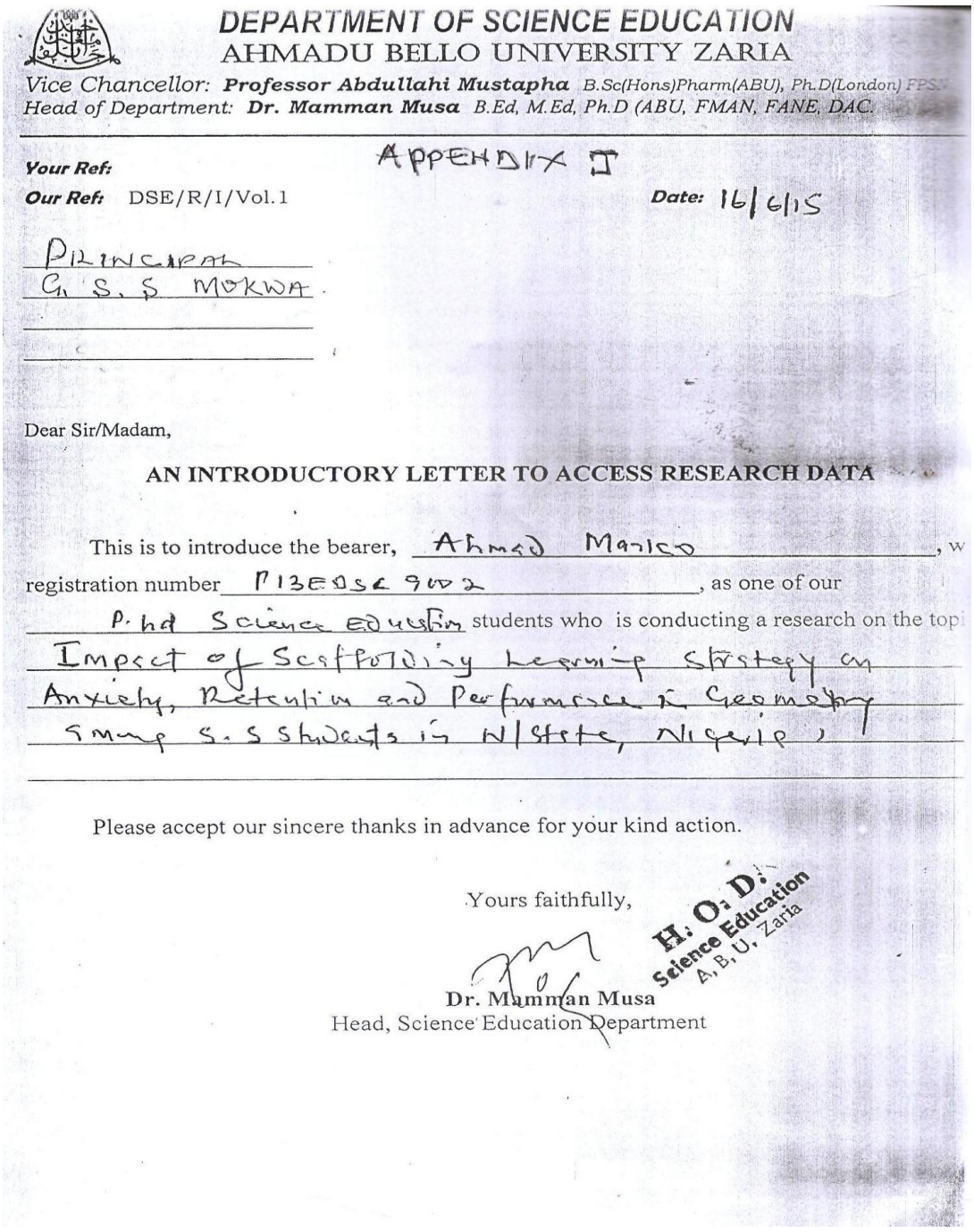
APPENDIX I

POPULATION TABLE

S/NO	LOCAL GOVT	NO OF SSS	MALE	FEMALE	TOTAL
1.	Agaie	8	907	433	1340
2.	Agwara	5	117	83	200
3.	Bida	9	3657	1910	5567
4.	Borgu	13	1886	918	2804
5.	Bosso	17	2430	2048	4478
6.	Chanchaga	7	2661	2046	4707
7.	Edati	6	673	466	1139
8.	Gbako	7	1358	199	1557
9.	Gurara	12	1686	848	2534
10.	Katcha	12	1353	579	1932
11.	Kontogora	10	1634	1606	3240
12.	Lapai	10	2189	681	2870
13.	Lavun	15	2268	798	3066
14.	Magama	9	952	608	1560
15.	Mariga	5	675	94	769
16.	Mashegu	3	968	209	1177
17.	Mokwa	14	1447	861	2308
18.	Munya	3	428	290	718
19.	Paikoro	1	1896	1349	3245
20.	Rafi	10	1348	538	1884
21.	Rijau	6	744	250	994
22.	Shiroro	18	2361	1367	3728
23.	Suleja	7	2112	1309	3421
24.	Tafa	7	838	1152	1990
25.	Wushishi	4	478	241	719
TOTAL		**218**	**41,266**	**20,983**	**62,249**

Source: Niger State Ministry of Education (2014)

APPENDIX J



DEPARTMENT OF SCIENCE EDUCATION
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Head of Department: **Dr. Mamman Musa** B.Ed, M.Ed, Ph.D (ABU, FMAN, FANE, DAC

APPENDIX I

Your Ref:
Our Ref: DSE/R/I/Vol.1 **Date:** 16/6/15

PRINCIPAL
G. S. S MOKWA

Dear Sir/Madam,

AN INTRODUCTORY LETTER TO ACCESS RESEARCH DATA

This is to introduce the bearer, Ahmed Manico, w
registration number PHED/SC/9002, as one of our
P.hd Science Education students who is conducting a research on the topi
Impact of Scaffolding Learning Strategy on
Anxiety, Retention and Performance in Geometry
among S.S Students in N/State, Nigeria.

Please accept our sincere thanks in advance for your kind action.

Yours faithfully,

H: O: D:
Science Education
A, B, U, Zaria

Dr. Mamman Musa
Head, Science Education Department