EFFECTS OF INFORMATION COMMUNICATION TECHNOLOGY ON SENIOR SECONDARY SCHOOL STUDENTS' GEOMETRY RETENTIONAND PERFORMANCEIN BAUCHI STATE NIGERIA

BY

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M.ED/EDUC/2231/2011-2012

DEPARTMENT OF SCIENCE EDUCATION,

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JUNE, 2016.

DECLARATION

I,Abiodun Isaiah OLOJEDE(M.Ed/Educ/2231/2011-2012) hereby declare that the work in this dissertation titled “Effects of Information Communication Technology on Senior Secondary School Students’ Geometry Retention and Performance in Bauchi State, Nigeria” was performed by me in the Department of Science Education under the supervision of Professor C. Bolaji and Dr. M. Musa. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this work has been presented for another degree or diploma at any institution.

Abiodun Isaiah OLOJEDE	____________________	____________________
M.Ed/Educ/2231/2011-2012	Signature	Date

CERTIFICATION

This dissertation titled "EFFECTS OF INFORMATION COMMUNICATION TECHNOLOGY ON SENIOR SECONDARY SCHOOL STUDENTS' GEOMETRY RETENTION AND PERFORMANCE IN BAUCHI STATE, NIGERIA" by Abiodun Isaiah OLOJEDE (M.Ed/Educ/2231/2011-2012), met the regulations governing the award of the degree of Masters in Mathematics Education of the Ahmadu Bello University and is approved for its contribution to knowledge and literacy presentation.

____________________ ____________________

Professor C. Bolaji Date

Chairman, Supervisory Committee

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Dr. M. Musa Date

Member, Supervisory Committee

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Dr. M. Musa Date

Head of Department of Science Education

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Professor K. Bala Date

Dean, School of Postgraduate Studies

DEDICATION

This work is dedicated to the Redeemer and Saviour of my soul JESUS CHRIST. I am so glad that you love me LORD and you gave to me all that I have.

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Ibowmyheart, in all sincerity and deepestsenseofgratitudetotheAlmighty God in whom I live, walk and have my being for the success of this research study. I am equally grateful to everyone who supported me and inspired me on this journey. First, to my wife, Felicia and children who kept me encouraged from the very beginning. Thanks for the sacrifices you made so that I could accomplish this goal.

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My love to you all!

ABSTRACT

This study investigated the "Effects of Information Communication Technology on Senior Secondary School Students' Geometry Retention and Performance in Bauchi State, Nigeria".The study, which adopted a quasi-experimental design and a non-equivalent, pretest, posttest, post posttest in nature have two intact classes assigned, one to control andthe other to experimental group in two coeducational schools as a fair representation of 24 schools comprising of 8200 students within the metropolis of Bauchi state. The sample groups consisted of 128 (SSII) students with 54 boys and 74 girls.The data generated using the instrument, Geometry Performance Test (GPT)which comprised of 76 items validated by three experts (professors in the Faculty of Education) andsubsequently pilot tested with reliability coefficient of 0.86 drawn from WAEC, NECO, JAMB and other relevant past questions. A total of four research questions were formulated and answered using descriptive statistics and their corresponding hypotheses tested using independent t-test with two-way ANOVA at 0.05 level of significance. The findings of the research revealed among others that the students who weretaughtusingICTmethodofteachingshowedsignificantimprovementintheir performance in geometrythanthestudentswhoreceivedinstructionthroughthetraditional lecture method.The reason being that the calculated p value of 0.001 is lower than the 0.05 alpha level of significance.The calculated mean performanceof students taught geometry using lecture method and those taught geometry using the ICT method were 36.85 and 46.20respectively, indicating a mean difference of 9.35which was confirmed by the test of the hypotheses andsuggestedthat ICT students performed significantly higher.The research also revealed that ICT usedin the teachingcontributedtowardsraisingtheperformanceofthe studentsingeometry and their retention ability. The finding was gender friendly in that male and female taught using ICT did not differ significantly both in performance and retention in geometry. Hence, the study recommendedthe use of ICT teaching strategy in all levels of secondary school mathematics and thatmathematics teachers needed to be trained and developed on this strategy to enhance teaching capability that accommodate no gender discrimination.

ABBREVIATIONS

CAI --------------Computer Assisted Instruction

CBL--------------Calculated-Based Laboratory

CLT -------------The Central Limit Theorem

DGS -------------Dynamic Geometry Software

DSP --------------Geometer's sketchpad software

GPT--------------Geometry Performance Test

ICMI-------------International Commission on Mathematical Instruction

ICT---------------Information and Communication Technology

IT-----------------Information technology

JAMB------------Joint Admissions and Matriculation Board

NCTM-----------National Council of Teachers of Mathematics

NIF----------------Non Intellectual Factor

PCK -------------Pedagogy Content Knowledge

STAN-------------Science Teachers Association of Nigeria

STEME ---------Science, Technology and Mathematics Education

TPACK ---------Technology Pedagogical and Content Knowledge

TSD--------------Theory of Didactical Situations)

UTME-----------Unified Tertiary Matriculation Examination

ZDP--------------Zone of Proximal Development

OPERATIONAL DEFINITION OF TERMS

In this study, a few terms have been frequently used that have got specificmeaning for the present investigation. Given below are the operational definitions ofsome of these terms.

Information technology (IT): deals with the use of electronic computers and computer software to convert, store, protect, process, transmit and retrieved information.

Information and Communication Technology (ICT): is defined as the term used to describe the tools and processes to access, retrieve, store, organize, manipulate, produce and/or exchange information by electronic and automatic means. These include hardware, software and telecommunication in the form of personal computer, scanners, digital canvass, Compact Disk and D.V.D. players and programs like data base system, multi-media applications, power point presentation mode among others.

Achievement/Performance: a measure of knowledge gained by Plan Programme as indicated in the test scores.

ICT in Education: means Teaching and Learning with ICT and this can be understood as the application of digital equipment to all aspects of teaching and learning.

Science,Technology and Mathematics Education (STEME): is the uniting themes that originate in the cognitive, pedagogical, historical, philosophical and socio-cultural aspects of Science, Technology and Mathematics Education.

Technology Pedagogical and Content Knowledge (TPACK): is the combination of content knowledge, pedagogical knowledge, and technological knowledge which a qualified mathematics teacher possesses to impact knowledge effectively.

Geometry: A branch of mathematics concerned with questions of shape, size, relative position of figures, and the properties of space.

Retention: The ability to retain and latter recall information or knowledge gained after learning. This can be in short term as used in this study or long term.

Théorie des Situations Didactiques(TSD): meaning Theory of Didactical Situations) which became the theoretical backbone of the French school of research in mathematical didactics.

Computer Assisted Instruction (CAI) is the design of individualized student- paced modules that were said to promote a more active form of student learning.

DVD Player: is a device that plays discs produced under both the DVD-Video and DVD-Audio technical standards, two different and incompatible standards.

Personal Digital Assistant(PDA): also known as a **palmtop computer**, or **personal data assistant**, is a mobile device that functions as a personal information manager. PDAs are largely considered obsolete with the widespread adoption of Smartphone. Nearly all current PDAs have the ability to connect to the Internet.

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CHAPTER ONE

THE PROBLEM

1.1 Introduction

The building blocks of any nation's development in terms of sciences, technology and humanities are anchored on the standard of Mathematics attained. The word Mathematics comes from the ancient Greek word *μάθημα* (*mathema or mathematika*), meaning "Concerning Learning". Mathematics is the Science of structure, order and relation that has evolved from counting, measuring and describing the shapes of objects (Vinner, 2002; Morgan, 2005). It deals with logical reasoning and quantitative calculations. Since the 17th century it has been an indispensable adjunct to the physical sciences and technology, to the extent that it is considered the underlined language of science. Mathematics as a universal subject is full of symbols and can be conveyed to others without any specific language. Olowojaiye (2004) described it as the language of science and technology and is fundamental to all other fields of study.

In our planetary model, the Sun is a star and the remaining planets revolve around it. Similarly, Mathematics is a star in the centre and all the subjects revolve around it. It plays a central role in all facets of modern human endeavour (Adegboye and Adegboye, 2003; Adetula 2012). According to the famous Philosopher Kant, "A Science is exact only in so far as it employs Mathematics". So, all scientific education which does not commence with Mathematics is said to be defective at its foundation. Neglect of mathematics works injury to all knowledge. In this modern age of science and technology, emphasis is given on science such as Physics, Chemistry, Biology, Medicine, Engineering and Mathematics, which is a science by any criterion, also it is an efficient and necessary tool being employed by all these sciences (Kuenzi, 2008). Mathematics includes all of human mind, ideas, processes and reasoning and more than a branch of knowledge, it is a way of thinking , a way of organizing a logical proof (Jöreskog and Sörbom, 2001; Gray and Tall, 2001; Salman, 2005).

As a way of reasoning, it gives insight into the power of human mind, so this forms a very valuable discipline of teaching-learning programmes of school subjects everywhere in the world of curious children. So the pedagogy of Mathematics should very carefully be built in different levels of school education. In the pedagogical study of mathematics two things are mainly of concerns: the manner in which the subject matter is arranged or the method, and the way, in which it is presented to the pupils or the mode of presentation (Reeves,1998: Ringstaff and Kelley, 2002).

Mathematics is intimately connected with everyday life and necessary to successful conduct of affairs. It is an instrument of education found to be in conformity with the needs of human mind. Teaching of mathematics has its aims and objectives which are incorporated in the school curricula. If mathematics is removed, the back-bone of our material civilization would collapse. So is the importance of Mathematics and its pedagogy (Iyekekpolor, 2007).Mathematics competence is a critical determinant of the Post-Secondary educational and career options available to young people. Barrow and Woods (2006), emphasized the need to make mathematics a compulsory subject at the primary and secondary levels, if scientists, technologists and engineers are to be produced. It has many branches which includes: Algebra, Analysis, Arithmetic, Combinations, Euclidean and Non-Euclidean Geometries, Game Theory, Number Theory, Numerical Analysis, Optimization, Probability, Set Theory, Statistics, Topology and Trigonometry among others.

Mathematics teaching and learning is crucial to the future of Nigeria knowledge economy and deserves a special focus in education (Adetula, 2012).

TheFederalGovernmentofNigeriahasforlongbeenawareofthepivotalnature and significance ofmathematicstoindividualfulfillmentsandnationaldevelopmentalgoalswithparticularreferencetoscientificandtechnologicalemancipationandbreakthrough.Thisunderstandinghasconsequentlybrought educationalpolicytoplace mathematicsasacompulsoryandoneofthecoresubjectsinprimaryandsecondarylevelsofeducation(FRN,2004; FRN, 20013).

However, mass failure in mathematics examinations is real and the trend of student's performance has been on the decline (Akpan, & Bryant, 2008). A cluster of variables has been implicated as responsible for the dismal performance of students. These include, government related variables, curriculum related variables, examination body related, teacher, student, home and text-book related variables. Apart from these variables, Amazigo, (2000) and Bolaji, (2005) have identified poor primary school background in mathematics, lack of incentives for teachers, unqualified teachers in the system, lack of learner's interest, perception that mathematics is difficult, large classes and psychological fear of the subject as factors responsible for the dismal performance of students in the subject. Several other concerted efforts (mathematics educators, parents and government)had been put up aimed at identifying the major problems associated with the teaching and learning of mathematics in the nation's schools.

Despite all these efforts, the problem of poor performance in mathematics particularly in geometry has continued to rear its head in the nation's public examinations. The chief examiners' annual reports in mathematics in the Senior School Certificate Examinations (SSCE) conducted by the West African Examination Council (WAEC) as shown in Tables 1.1 are true testimonies of the facts that students shy away from the study of mathematics even though it is the bed rock of science and technology.

This shows the negative attitude and poor performance of students in mathematics particularly in geometry, where students' performance has always been very low (Salau, 1995; Amazigo, 2000; Salau, 2002; WAEC 2006; 2014). It is this backdrop that prompted this research requiring special strategies to correct this unacceptable trend. Table 1.1 shows the trends of students' performance in WAEC examinations.

Table1.1: Trends of Students' Performance in SSCE General MathematicsWAEC (May/June 2003-2014)

Year	No of candidates that sat for the exams	No of candidates that passed at Credit and above (A1-C6)		No of candidates with ordinary passes and below	
2003	926,212	341,928	(36.35%)	584,284	(63.09%)
2004	832,689	287,484	(34.52%)	454,205	(65.04%)
2005	1,054,853	402,982	(38.20%)	651,871	(61.80%)
2006	1,149,277	472,674	(41.12%)	676,603	(58.88%)
2007	1,249,028	584,024	(46.75%)	665,004	(53.25%)
2008	1,268,213	726,398	(57.28%)	541,815	(42.72%)
2009	1,348,528	634,382	(47.04%)	714,146	(52.96%)
2010	1,306,535	548,065	(41.95%)	758,470	(58.05%)
2011	1,508,965	508,866	(40.35%)	900,099	(59.65%)
2012	1,658,357	838,879	(50.58%)	819,478	(49.42%)
2013	1,543,683	564,525	(36.57%)	979,158	(63.43%)
2014	1,692,435	529,425	(31.28%)	1,163,010	(68.72%)

Source: Statistics Division, WAEC Office, Yaba-Lagos (2006; 2014).

Among several factors that have been pinpointed as responsible for the inadequate performance of students, this research addresses the poor method of teaching and learning, which is in consonance with Obodo (2000), Adeniran (2011) and Salman *et al*. (2012), who attributed incessant failure and poor performance in mathematics to ineffectual teaching method. This research intended to investigate the core topics in geometry where students experience poor performance. Topics such as plane and solid shapes, measurement of plane and solid shapes, including surface areas and volumes of solids, polygons, geometrical ratio, geometrical transformation, latitude and longitude and so forth are topics that are generally identified to be difficult by both students and teachers. As statistics have shown that mass failure in mathematics, geometry in particular, is directly related to poor instructional method.

Geometry is a branch of mathematics concerned with questions of shape, size, relative position of figures, and the properties of space. As one of the oldest mathematical sciences, geometry forms the building blocks of engineering, technical graphics and the conic section of geometry which is purely locus, is of great importance to astronomy, mechanics and technology (Achor, Imoko and Uloko, 2009). Many different scientific and technological fields require the knowledge of geometry, especially in the more advanced and specialized fields of study.The use and knowledge of geometry is essential to excellence. That is why an effectual strategy is needed for better performance in geometry. Geometry helps to bring both sides of the brain together to make left and right brain think. It provides the knowledge of how to deal with measurements and relationships of lines, angles, surfaces and solids. Two and three Dimensional shapes are originated in geometry. The use of triangles and other shapes strongly influence this. In the fields of television, movies and even little things like puzzles or books all are influenced by geometry. Geometry is a good training ground for students to make use of concrete materials and activities in fluent harmony. The list of the importance of geometry in academic and daily life is endless.

The strategies and approaches for teaching and learning of mathematics particularly in our secondary schools call for concern as they are indicative of a serious gap between the expectations of the National Policy on Education (NPE) and the actual situation in terms of theperformance on the subject. One of the key synergisms of mathematics is with technology, and as technology advances it inevitably influences what happens in the mathematics classroom. In this study, a teacher who uses technology effectively is defined as one who is able to combine their content knowledge, pedagogical knowledge, and technological knowledge which is known as Technology Pedagogical Content Knowledge (TPACK) to facilitate classroom activities, using technology as a tool to support learning where students are able to understand, analyze, and synthesize information by constructing representations of their own knowledge (Mishra and Koehler, 2009b). Information Communication Technology as the necessary equipment of teaching and learning activities has a significant role in improving knowledge and skills of teachers and students apart from preparing them for the life in the education and training.The coverage of ICT goes beyond such activities as programming, networking and analyzing. It enables the usage of computers and related tools to enhance the quality of life (Benton *et al.,* 1983; Marshall, 2002; Prensky, 2005).

The role of ICT in this work was to investigate how it affects the academic performance and retention. Academic performance is the educational goal that is achieved by a student, teacher or what institution achieves over a certain period which is measured either by examinations or continuous assessments and the goal may differ from an individual or institution to another. Mathematics performance is therefore an aspect of academic performance and is the ability to manipulate mathematical concepts and to perform mathematical calculations accurately. It is usually related to a combination of mathematical ability and mathematics education (Morgan, 2005). Moreover, how much of this learning can be measured by the student's retention ability. Retention of knowledge is an important area of research that has the potential to inform instructional practices and school learning goals.It is the ability to retain and later recall information or knowledge gained after learning (Bahrick, 2000; Bichi, 2001; Desiree, 2009). Alsup (2004) found that constructivist method of teaching mathematics greatly reduced a student's mathematics anxiety and enhances retention in the classroom.

TheFederalGovernmentof Nigeria through National Information Technology Development Agency Act of 2007 has initiated effort to determining critical areas in Information Technology requiring research intervention and facilitating research and development in those areasin which teaching and learning in schools is paramount. Law cases have also been adjudicated to ensure, quality, safe and efficient ICT tools.Also in policy “Government shall provide necessary infrastructure and training for the integration of ICT insecondary schools” (FRN,2013; Obutte, 2014).However, with rapid advancements, teachers may be unprepared to take full advantage of new technology, with the types of technology use falling behind the learning possibilities demonstrated by international research studies (Smith, 2004; Thomas, Monaghan, and Pierce, 2004; FRN, 2013).According to Telima (2011), Science, Technology, Engineering and Mathematics Education (STEME) has been widely acclaimed to be the index of measuring any nation’s socio economic and geo-political development. Among science and Technology courses, according to the National Policy on Education (FRN, 2008), mathematics is one of the core subjects to be offered by all students till the tertiary levels of education.

1.2 Statement of the Problem

The incessant failure and poor performance in mathematics have been attributed to ineffectual conventional teaching method.Information Communication Technology as the necessary equipment of teaching and learning activities has a significant role in improving knowledge and skills of teachers and students apart from preparing them for the life through education and training.The coverage of ICT goes beyond such activities as programming, networking and analyzing. It enables the usage of computers and related tools to enhance the quality of life. TheFederalGovernmentof Nigeria through National Information Technology Development Agency Act of 2007 has initiated effort to determining critical areas in Information Technology requiring research intervention and facilitating research and development in those areasin which teaching and learning in schools is paramount. Law cases have also been adjudicated to ensure, quality, safe and efficient ICT tools.Also in policy “Government shall provide necessary infrastructure and training for the integration of ICT insecondary schools” (FRN,2013; Obutte, 2014).Therefore, this study intended to determine the probable effects that ICT can haveon the senior secondary school students’ geometry retention and performance in the metropolis of Bauchi, Bauchi state, Nigeria.

1.3 Objectives of the Study

The primary objective of this study was to investigate the effects of the ICT power point animated method on the senior secondary school students’ geometry performance and in more specific terms the study equally has the following objectives to;

1. determine the effect of ICT on students’ academic performance in geometry particularly in solid shapes
2. investigate the effect of ICT on retention ability of senior secondary schools’ students in geometry
3. determine the differential effect of gender on students’ geometry performance when taught using ICT(PowerPoint animated presentation) teaching strategy
4. determine the differential effect of gender on students’ retention ability in geometry

1.4 Research Questions

The following research questions were formulated to be answered:

1. What is the effect of ICT on the students’ performance in geometry compared to the performance of those exposed to lecture method?

2. Will there be difference in the retention level of SSII students that were taught with the ICT PowerPoint animation method and their counterparts that were taught with lecture method, in geometry?
3. What is the effect of ICT on gender of students' academic performance in geometry in senior secondary schools compared to lecture method?
4. What is the differential effect of gender on senior secondary school students' retention ability in geometry using ICT and lecture method?

1.5 Null Hypotheses

The following hypotheses were tested at $\alpha \leq 0.05$ level of significance.

H_{01}.There is no significant difference in the mean of students' academic performance scores in geometry taught using ICT and those taught using lecture method.

H_{02}.There is no significant difference in the retention ability of students taught with ICT PowerPoint animation strategy and those taught geometry with lecture method.

H_{03}.There is no significant differential effect of gender on the mean of students' performance scores in geometry of those taught using ICT PowerPoint animation strategy and that of lecture method.

H_{04}.There is no significant differential effect of gender on the retention ability of students taught geometry using ICT PowerPoint animation strategy and their counterparts taught with lecture method in senior secondary schools

1.6 Significance of the Study

1.6.1 Implications

The problem of low academic performance among the students has been plaguing our educational system completely right from the primary classes to university level. The traditional classroom environment in mathematics has been strongly oriented towards a syllabus-based delivery, using teacher control and textbook resources. This problem is responsible for the tremendous wastage of human potential and facilities for education apart from the finial wastage, which a developing country like ours can ill afford. The research also identified the benefits of technology integration as the technical aspects to enhance the quality of work, promote access of resources, positively impact student learning, and promote student metacognitive skills.The research may help us to provide the effective media to present the content matter among the large number of students in a classroom especially where smaller classroom size not in view. The study is designed to provide a deeper understanding of when and how to use technology with students in a middle grades mathematics classroom and the benefits it provides.

1.6.2 Applications

This study be of great benefit and invaluable to:

1. the teachers who need to be equipped not only with subject expertise and effective teaching methodologies but also with the capacity to assist students to meet demand of the emerging knowledge- based society with new forms of ICT and need to have the ability to use that technology to enhance the quality of learning. Saliently, this study may provide encouragement and motivation to the reluctant teacher on progressive measures to practice utilizing technology and provide new insights on what teachers think they do and what actually takes place in the classroom that is bridging the gap between curriculum intentions and actual practice. It would enhance the quality of work, promote access of resources, positively impact student learning, and promote student metacognitive skills.
2. the professional bodies such as Mathematics Association of Nigeria (MAN) and Science Teachers association of Nigeria (STAN) who have scores of educators and researchers deeply concerned with how our schools, largely the product of 19th century industrial society, are going to prepare students for the 21st century. Several researchers have produced a pointer of lists of the skills and

competencies for our students in the future. While the lists and frameworks are diverse, they all tend to recognize a few major competencies: creativity, critical thinking, cross-cultural communication and collaboration, and digital age literacy. To develop these skills, we need classrooms where students are working in teams and using technology to build creative, meaningful content that reflects their understanding and learning.

3. both the government and curriculum planners. The Higher Education Funding Council for England (HEFCE) on the 26th of March, 2012 published ‘Enhancing learning and teaching through the use of technology and the emphasis on enhancement is one that highlights how technology can be used in order to assist institutions or practitioners in achieving their strategic aims for enhancing learning and teaching through technology. Technology-enhanced strategies have become the unequivocal craving of the nations of the world for effective teaching and learning especially in Sciences and Mathematics. Nigeria cannot afford to be left out and particularly Bauchi state.
4. the students’ self-development and metacognitive skills rather than the technology or even teachers and will provide insights to educators and coordinators of professional development to make effective decisions about evaluative procedures and teacher training.
5. and equally of great expectation that fellow researchers will find the work as building block in relevant investigations search to update knowledge and make a real difference to the learning experience of students across all educational institutions.

1.7 Basic Assumptions of the Study

This study assumes that;

1. The senior secondary school students were familiar, friendly and motivated with the use of computers.
2. Students liked to extend their participation in the use of computers in learning mathematics and their parents and guardian gave collaborative support.

1.8 Scope/Delimitation of the Study

The present study focuses on the core topics of the senior secondary school mathematics curriculum in geometry, where the problems of teaching and learning occur most. The content areas covered are some solid shapes which are areas and volumes of cuboids, cube, cylinder, cone, sphere, hemisphere among others generally identified to be difficult by both students and teachers and are responsible for the unacceptable performance of the students in mathematics (Imoko & Uloko, 2009). These topics were equally chosen because they form the backbone of other geometry field. The study covers only the government senior secondary schools which comprise of public and special schools within the Bauchi metropolis, Bauchi state, in the North-Eastern region of Nigeria. Only senior secondary school two (SSII) intact classes students are used for the research from two co-educational schools of the population to investigate the effect of the ICT PowerPoint animation method with pedagogical content knowledge (Shulman, 1986; Koehler and Mishra, 2009b) on the performance of the students in geometry. The instruments used for the study are: the Intelligent Test to measure the ability level, the Geometry Performance Test referred to as Post test and Retention Test known as Post post test. Only the students in the experimental group were exposed to ICT PowerPoint animation method, the control group did not have awareness of the experimental group as the researcher had no intention of interrelationship between them.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents an overview of the research and literature pertaining to this study. The theoretical framework, the synergism between Information Communication Technology (ICT), academic performance and retention in geometry, gender inclination and performance. The literature review is presented in the following sub-headings;

2.2 Theoretical Framework

2.3 Teaching of Geometry at Senior Secondary Schools

2.4 Information Communication Technology and Mathematics Teaching

2.5 Retention and Performance of Geometry

2.6 Gender and Performance in Geometry

2.7 Gender and Information Communication Technology

2.8 Overview of Similar Studies and Computer Aided Instruction

2.9 Implications of Literature Reviewed on the Present Study

2.2 Theoretical Framework

This study adopted the constructivist theory of learning. The constructivist theory was chosen because it builds on prior knowledge: students use what they already know to make connections to new material. When students make these connections, they are learning new material and relating it to what they already know (Dewey, 1916). McClintock, Jiang, and July (2002) discussed how ICT is based on the constructivist theory of learning, because knowledge is actively constructed by the students while they are making constructions and analyzing figures instead of knowledge being passively received and accepted. Many educators today believe that the constructivist theory is a relatively new theory in education although the tenets of constructivism can be traced back to Socrates. Socrates was well known for asking his students questions that would stretch their minds and force them to think on a higher level (Tredennick and Tarrant, 1993).

John Dewey was the creator of the project method, a method that encourages students to work together in groups and to figure out the solutions to different problems that may arise as they continue to complete the assigned project (Dewey, 1916). John Dewey and Jean Piaget were the leading Progressive Education theorists of the last century. Dewey (1916) stated that the project method is a method of discovery and proof in so much as "all thinking results in *knowledge*, ultimately the value of knowledge is subordinate to its use in thinking" (p. 151). The way that we interpret things is the eye that we see them through. Dewey thought that the student is dynamically involved in the learning that is going on around him/her, and the instructor should only be considered a director of the learning and not an actor (Joyce, Weil and Calhoun, 2002).

Piaget (1971) stated that the mind's primary function is to create and to see things in a way that can be organized into a schema that helps the mind to see them as being real. Piaget was a strong proponent of cognitive development. He believed that as children grow older, they look at the world through different experiences, and that children have completely different perspectives than adults (Robinson, 2004). Piaget (1980) stated that, when knowledge is constructed within oneself, it is examined against what is happening in the real world in much the same way that a scientific idea is tested. Some modern day constructivist theorists are Vygotsky, Brunner, and Von Glasersfeld (Von Glasersfeld (1987). Von Glasersfeld (1987) has stated that the constructivist view involves two principles:

1. Knowledge is always being created, built up by learner. It is not inertly established;

2. Coming to know is a course of action based on the learner's constant adaptations to the experiences of the world. Examples presented in the power point animated package being used in this study caused students constructive and creative thinking.

Von Glasersfeld (1996) is a major proponent of abstract ideas that reflect one's situations to build conceptual structures through self-regulation. He has stated that real learning happens when one takes ownership of the problem. Huitt (2003) stated that, while Vygotsky was a social constructivist theorist, activity theory and situated learning, however, were the main tenets of his research. Vygotsky developed a "zone of proximal development," which is basically the difference between what a child knows and what that child is taught by others (Vygotsky, 1978). He believed that children learn through social interaction and by learning to solve problems with others. He called this process "scaffolding."

Thanasoulas (2008) stated that learning is a process that occurs through social interactions, and students generate new knowledge by building onto what they already know: The student selects information, constructs hypotheses, and makes decisions, with the aim of integrating new experiences into his existing mental constructs. It is cognitive structures that provide meaning and organization to experiences and allow learners to transcend the boundaries of the information given. For him, learner independence, fostered through encouraging students to discover new principles of their own accord lies at the heart of effective education.

Moreover, curriculum should be developed in a spiral manner so that students can build upon what they have already learned (Morgan, 2005). This review of literature includes the constructivist theory of learning because the students in this study actively built on what they already knew in order to gain an understanding of geometry. The instructor was actively engaged in leading the students as they encountered their zone of proximal development (ZPD). The students were also actively engaging in the process of scaffolding as they sought assistance from more advanced students in their geometry classes.

Harel (2008) discovered that through the use of ICT, students can construct medians of triangles and create conjectures that could eventually lead to the students writing proofs and thinking on higher levels. He contended that ICT teaches students through the vehicle of the constructivist theory. Mann (1994) stated that in the constructivist theory, students are in control of their learning, they do not just memorize facts. He contended that students learn through personal experience and must be actively engaged in the learning process. From a constructivist perspective, the roles are often reversed because teachers and students learn from one another. When learning through the constructivist theory, children learn from whole to part. The ideas and interests of children should drive the learning process.

According to Piaget (1971), the constructivist theory student activities must be learner-centered and not curriculum-centered. He believed that the needs of the student are the main concern when selecting activities and not what the teacher needs to teach. He believed that children need to acquire “schemas in order to obtain knowledge. He defined schemas as a set of ideas, perceptions, and actions. A schema can be considered forming relationships; it can be concrete or discrete. For example, a child recognizes a dog, and when that child sees different types of dogs, the child can then see that the dogs are different in some way. Because the child recognizes that the dogs are different, the child can learn that one is a bulldog and the other is a chow. As the child develops more, new schemas are developed. Piaget (1971) stated that this is how learning occurs. In the present study, students were required to form new schemas through the use of ICT as the students use the dynamic software to evaluate geometric properties.

According to Gray (1997), constructivist classrooms must have certain characteristics such as the following,

1. Constructivist classrooms are student-centered;

2. Constructivist teachers employ negotiation because the teacher is not just disseminating knowledge but facilitating learning;

3. Teachers in constructivist classrooms are researchers;

4. Power and control in constructivist classrooms are shared. She remarked that it is important to focus on the students because they are the “meaning makers” of the knowledge that is being disseminated. She stated that negotiation is important because it allies the students and teacher into a common purpose. She stated that it is important to individualize each class specifically for those students that are in class at that specific time. Constructivist teachers allow the students to provide input as to where to go next in the learning process. She indicated that constructivist teachers must research their students on a daily basis by monitoring their progress, assessing their needs, and digging in deeper to accommodate the way each student learns. She felt that giving the students the power is of the utmost importance in order for a classroom to be truly constructivist; children have to know that they are in control of what they are thinking (Gray, 1997).

Caine and Caine (1990) created 12 principles of constructivist teaching that will be quoted directly due to the complexity and the wideness in range of each individual principle.

1. "The brain is a parallel processor." It simultaneously processes many different types of information, including thoughts, emotions, and cultural knowledge. Effective teaching employs a variety of learning strategies.

2. "Learning engages the entire physiology.” Teachers can't address just the intellect.

3. "The search for meaning is innate." Effective teaching recognizes that meaning is personal and unique, and that students' understandings are based on their own unique experiences.

4. "The search for meaning occurs through 'patterning'." Effective teaching connects isolated ideas and information with global concepts and themes.

5. "Emotions are critical to patterning." Learning is influenced by emotions, feelings, and attitudes.

6. "The brain processes parts and wholes simultaneously." People have difficulty learning when either parts or wholes are overlooked.

7. "Learning involves both focused attention and peripheral perception." Learning is influenced by the environment, culture, and climate.

8. "Learning always involves conscious and unconscious processes." Students need time to process 'how' as well as 'what' they've learned.

9. "We have at least two different types of memory: a spatial memory system and a set of systems for rote learning." Teaching that heavily emphasizes rote learning does not promote spatial, experienced learning and can inhibit understanding.

10. "We understand and remember best when facts and skills are embedded in natural, spatial memory." Experiential learning is most effective.

11. "Learning is enhanced by challenge and inhibited by threat." The classroom climate should be challenging but not threatening to students.

12. "Each brain is unique." Teaching must be multifaceted to allow students to express preferences. (Caine and Caine, 1990, pp. 66-69) Teaching through the use of the constructivist theory requires hard work on the part of the classroom teacher, and it also requires the students to work in an active manner. Constructivist teaching and learning removes the direct burden of the teacher being the sole disseminator of information and

changes the role of the teacher into being the facilitator and not the primary source of all learning. One must, however, question the growth that each student is claiming at the end of the process (Brunner, 1973). The present study was based on the constructivist learning theory along with the use of ICT, so that the effects of the use of ICT on the Senior Secondary School student's performance and retention in geometry as well as gender differences could be investigated.

Over the last forty years science, technology and mathematics education have emerged as lively new research areas. The research activity in these areas has been reflected in the launching of literally hundreds of new journals, in science education, mathematics education and, more recently, in design and technology education. Much of this research is carried out at the primary, middle and secondary levels of schooling. Mathematics, science and technology are of course intimately connected: at theoretical as well as practical and application levels, science, technology, engineering and mathematics ***(STEM)*** are linked via intricate networks of concepts.

Now we find, in investigating the educational issues in ***STM***, that there are a multitude of further uniting themes that originate in the cognitive, pedagogical, historical, philosophical and socio-cultural aspects of Science, Technology and Mathematics Education ***(STME)***. With a view to consolidating research and development activity around these uniting themes, the Homi Bhabha Centre for Science Education (HBCSE) initiated, in December 2004, a series of biennial conferences, named ***epiSTEME***.

The units on "Science, Technology and Mathematics Education"***(STME)***held aimed among others at providing an overview of the developments in the forefront of learning and cognition, and educational researches and the trends in research in science, technology and mathematics education. Research in science, technology and mathematics education is of relatively recent origin; yet it has begun to contribute to the content of textbooks and classroom practices. A part of the remit for ICMI Study 17 was to look at what had been achieved over the previous decades in terms of theory development as well as what had been the actual impact of technology on the teaching and learning of mathematics (Hoyles and Lagrange, 2010).

Additionally the focus was almost exclusively on using computers to model and explore rather advanced mathematical ideas, for example using "symbolic manipulators" in courses of calculus or linear algebra in order to allow students to focus on conceptual rather than procedural or technical issues. Focus of concern was also broaden and in particular ICMI explicitly urged to consider the situation of developing countries: how technology could be used for the benefit of these countries rather than serve as yet another source of disadvantage.

Since the first ICMI Study in 1992, there have been major developments in digital technologies in terms of hardware: computers of all types, calculator and handheld technologies, digital technologies widely used in society at large such as mobile phones and digital cameras and of course the massive influence of the World Wide Web. Aligned to these hardware changes, new software have been developed with potential impact on all phases of education, and on informal contexts of education. By the time of ICMI study 17, digital technologies were becoming ever more ubiquitous and their influence touching most, if not all, education systems.

In many countries, it is hard to conceive of a world without high-speed interactivity and connectivity. These developments have spawned an increasing number and range of studies around the use of digital technologies in mathematics education, some focused on the impact of specific software, others looking more broadly at the interaction of teachers, students and technologies. The goals, objectives and orientations of these studies are broadened with the perspectives, theoretical frameworks and methodologies adopted. Their outcomes are challenging for the mathematics education community. As Hoyles and Noss (2003) claimed: “there are major research issues for mathematics education that are shaping and being shaped by the issues confronting ‘technologists’”.

In mathematics education, epistemological studies of mathematics and psychological approaches to learning mathematics have been extensively supplemented by investigations into teacher and classroom practices, but how far studies have taken on board the challenges of the use of digital technologies and their potential for the improvement of mathematics teaching, learning and the curriculum, remains a matter of debate. This was the background of ICMI Study 17, which aimed to achieve a balance between two, potentially contradicting, aims:

1. To reflect on actual uses of technology in mathematics education
2. To address the range of hardware and software with the potential to impact upon or contribute to mathematics teaching and learning (Hoyles and Lagrange, 2005).

The National Council of Teachers of Mathematics (NCTM) has led the movement for mathematics education reform. Unlike the top-down education reform efforts of the 1960s, NCTM began a grassroots discussion of issues in the mid-1970s. Subsequently, *An Agenda for Action* (1980) reflected input from *all* parties interested and involved in mathematics education, and set in motion much-needed discussion and debate. NCTM later published a series of documents which, appropriately, set criteria for excellence rather than singular prescriptions for implementing "new best ways." They included the NCTM Curriculum and Evaluation Standards (1989), the NCTM Teaching Standards (1991), and the NCTM Assessment Standards (1995). Collectively, these standards advocate methods that emphasize mathematical power: conceptual understanding, problem solving, reasoning, connection building, communicating, and self-confidence developing. Efforts continue throughout mathematics education community as standards evolve and are revised.

The NCTM Standards era was characterized by numerous efforts advanced by traditional publishers and researchers to improve mathematics curriculum. Virtually all mathematics curriculum projects, curriculum reform documents, and mathematics syllabi since 1989 have used the NCTM Standards as a basis or point of reference for their efforts. NSF funded five comprehensive middle-school mathematics curricula that are now widely available (Connected Mathematics Project, Seeing and Thinking Mathematically, Mathematics in Context, Six through Eight Mathematics, and Middle-school Mathematics through Applications Project). These materials (and some commercially-published materials) promote applications and problem solving, conceptual understanding, building connections across mathematics domains and uses, alternative assessment strategies, and mathematics communications skills.

In the Principles and Standards of School Mathematics the National Council of Teachers of Mathematics (NCTM) identified the "Technology Principle" as one of six principles of high quality mathematics education (NCTM, 2000). This principle states: "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (p. 24). There is widespread agreement that mathematics teachers, not technological tools, are the key change agents to bringing about reform in mathematics teaching with technology (Kaput, 1992; NCTM 1991, 2000). Yet, preparing teachers to use technology appropriately is a complex task for teacher educators (Mergendoller, 1994). Waits and Demana (2000) argue that adoption of technology by teachers requires professional development that focuses on both conceptual and pedagogical issues, ongoing support in terms of "intensive start-up assistance and regular follow-up activities" and a desire to change from within the profession (p. 53). In addition, studies of teachers' implementation of educational technology document that at least three to five years are needed for teachers to become competent and confident in teaching with technology (Sandholtz et al., 2000).

More recently, work has begun on a National Voluntary 8th Grade Mathematics Test (NVMT). The draft recommendations (Management, Planning, and Research Associates, 1997) to the National Test Panel underscore the need for assessments that reflect the emerging consensus of mathematical power in the standards. Meaningful reform and genuine change will result only if it is manifested within mathematics classrooms. The role of the teacher is essential. The growing nearly universal availability of technology tools provides a grand opportunity to assist teachers in teaching well and in improving the mathematics experiences of students. Technology can provide mechanisms to sustain assistance to mathematics teachers in their use of technology to implement mathematics education reforms in their classes.

Technology enables mathematics education reform, but it is not reform per se (compare Kaput, 1992). We must provide mathematics teachers extended opportunities to experience and do mathematics in an environment supported by diverse technologies (Dreyfus and Eisenberg, 1996). The heart of our approach is the development of mathematical power-- understanding, using, and appreciating mathematics. Our interest is in empowering teachers through the use of technology in mathematics exploration, open-ended problem solving, interpreting mathematics, developing understanding, and communicating about mathematics (see Silver, 1987; Schoenfeld, 1982, 1989, 1992; Bransford et al, 2005).

The schemes or topics shall be organized using sets of open-ended problems grouped into Study Guides (Assignments). The schemes information, syllabus, and study guides shall be implemented the model developed by the author for secondary mathematics teacher education (<http://jwilson.coe.uga.edu>). Participants can access these Web resources via Netscape or Explorer from any site with Internet access, including home and school sites. Mathematics topics relevant to School Mathematics are used and problems posed to enable teachers to experience mathematics with technology *as a learner*. The extension into the next course shifts the focus from experiencing mathematics as a learner to communicating, organizing, and teaching mathematics with the aid of technology tools. These courses present mathematics problems, open-ended mathematics investigations, challenges to organize and communicate information from these investigations, and selected technology tools to support such tasks. The mathematics content is consistent with the focus of school mathematics curriculum, but not necessarily from a specific curriculum.

The underlying psychological theme is the use of visual reasoning in mathematical discourse (Parzysz, 1988; Zimmerman and Cunningham, 1991; Presmeg, 1993). The technology tools enable students to construct visual and symbolic representations of ideas and incorporate these into their approaches and thinking about problems. The technology-enabled visualizations are not the end-product but rather a means to facilitate student's mental images that help them to form, relate, and organize mathematical concepts. The underlying pedagogical theme is to experience mathematics as problem solving, communication, reasoning, and building connections (President's Committee of Advisors on Science and Technology, 1997). Conceptual knowledge and procedural knowledge are emphasized together and technology tools reinforce their mutual development.

2.3 Nature and Teaching of Geometry at Senior Secondary Schools

Geometry as an aspect of mathematics deals with the study of different shapes which may be plane or solid. A plane shape is a 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. Geometry forms the building blocks of engineering and technical graphics. Moreover, the conic section of geometry which is purely locus is of great importance to astronomy, mechanics and technology (Achor, Imoko and Uloko, 2009). Many different scientific and technological fields require knowledge of geometry. Especially in the more advanced and specialized study fields the use and knowledge of Geometry is essential to excelling. Geometry helps you to bring together both sides of your brain.

In the fields of television, movies and even little things like puzzles or books all are influenced by geometry. Geometry is a good training ground for students to make use of concrete materials and activities. Those same experiments now will become stepping stones later in life. It will prepare you to use many different types of materials and textures together in fluent harmony.

The core topics in geometry where the problems of teaching and learning occurs most in mathematics are such as plane and solid shapes, measurement of plans and solid shapes, polygons, Geometrical ratio, geometrical transformation, latitude and longitude etc are topics that are generally identified to be difficult by both students and teachers. Statistics have shown difficulty in teaching and learning of mathematics, geometry in particular, has resulted in mass failure in examinations. The mass failure in mathematics examinations is real and the trend of student's performance has been on the decline (for example , Salau, 1995; Betiku, 2001; Korau, 2006). Obodo (2000), lamented the poor state of mathematics instruction in Nigeria and averred that the problem of quality of mathematics instruction and learning are from diverse sources.

2.4 Information Communication Technology (ICT) and Mathematics

In today's world, teachers need to be equipped not only with subject expertise and effective teaching methodologies but with the capacity to assist students to meet demand of the emerging knowledge based society with new forms of ICT and need to have the ability to use that technology to enhance the quality of learning. The search for ways to integrate technology into mathematics education is influenced by two main factors. First is the explosion of technologies that is influencing all aspects of life and the development of human resource. Knowledge-based workers need to be technology savvy as well as having critical and creative thinking skills. Second is the mathematics education reform that is now emphasizing the development of mathematical processes. With the emphasis on mathematical process, the scope of the use of technology in the mathematics classroom has, in fact, widened. With technology, tedious computations are easily performed, multiple examples of geometric figures effortlessly produced. Coupled with vivid visuals, technology thus provides an approach of realizing classrooms lessons that encourage mathematics thinking.

ICT as the necessary equipment of teaching and learning activities has a significant role in improving knowledge and skills of teachers and students apart from preparing them for the life in the education and training (Harrison et.al, 2002; Aşkar and Olkun, 2005). It is necessary to understand how ICT is used in the classrooms, which educational purposes it serves, what role it plays for the success of the learning process, educational program and educational policy (Papanastasiou, Zembylas, and Vrasidas, 2005). The frequency of ICT use is related to student's achievement, socioeconomic status, and the level of technology infra-structure in schools (for example, Papanastasiou, 2002; Papanastasiou, and Ferdig, 2003). The findings of most of studies (for example, Kim et al., 2008; Kubiatko and Vlckova, 2010) show a positive and significant relation between the frequency of ICT use and the achievement of students, while the results of the few studies demonstrate a negative (for example, Papanastasiou, 2002; Papanastasiou and Ferdig, 2003; Şahinkayası, 2008) or insignificant (for example, Papanastasiou et al., 2003; Wittwer and Senkbeil, 2008) association between the frequency of ICT use and the achievement of students.

Mishra and Koehler (2009) opined that the effective use of technology, however, is not dependent solely on the technology. The teacher must also be knowledgeable of the curriculum standards and demonstrate an acceptable level of competence in the content area, as well as know the appropriate methods and pedagogical strategies to implement. All combined, this is known as Technological Pedagogical Content Knowledge, or TPACK. Moreover, human beings are social and emotional. We had realized that the way teachers interacted with us may not be stable and consistent; we often had difficulties to reach teachers. Our observation indicated that some non-intellectual factors have big impact on our collaboration with the teachers. This study adopted and redesigned a framework based on a study on middle school students (Luo, Yang, and Shen, 2008) and another study on college students (Larose, Robertson, Roy, and Legault, 1998) with measurement on student non-intellectual factors (NIF).

There seems to be little literature on this aspect for teachers, but in higher education, non-intellectual factors have been identified to be as important as intellectual factors and they can predict college student retention and achievements (Larose, Robertson, Roy, and Legault, 1998). TPACK is the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technology; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones (Mishra and Koehler, 2009, pp. 66).

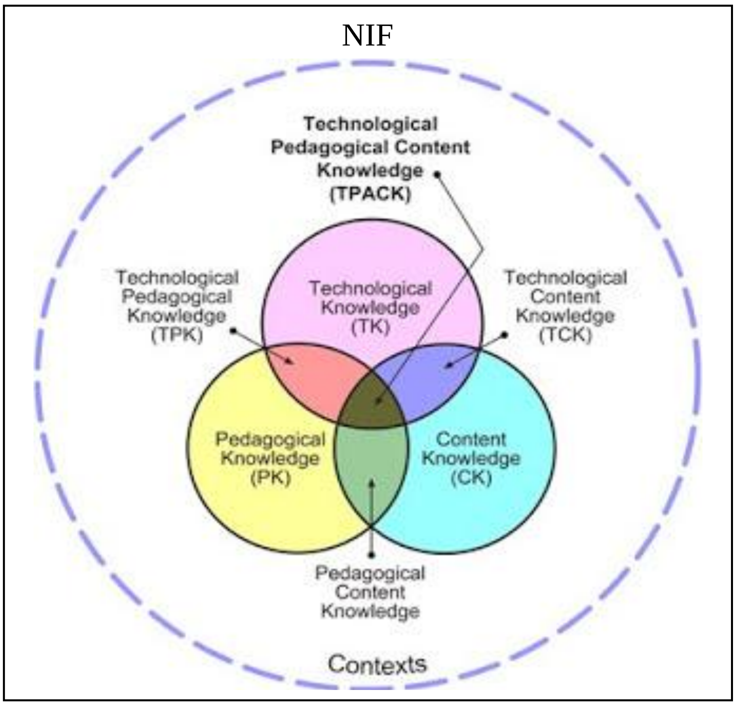

Figure 2.1: Framework for Technological Pedagogical Content Knowledge

In the model shown (Figure 2.1) the TPACK framework and its knowledge components, with the overlapping subsets adapted from Mishra and Koehler, (2009). Teachers use three main bodies of knowledge (content, pedagogy, technology) as well as non-intellectual factor (NIF) in sustaining the suitability of the innovation. Although each has its own significance, the overlapping of them increases the variety and quality of instruction for teachers and students. At the center of the model is where these successful teachers operate. In this study a teacher who 'uses technology effectively' is defined as one who is able to combine their content knowledge, pedagogical knowledge, and technological knowledge (TPACK) to facilitate classroom activities, using technology as a tool to support learning where students are able to understand, analyze, and synthesize information by constructing representations of their own knowledge.

2.4.1 The Place of ICT in Secondary Schools

The role of technology in teaching and learning and is rapidly becoming one of the most important and widely discussed issues in contemporary education policy (McFarlane and Sakellariou, 2002). In 2001, the Federal Government of Nigeria published the National Policy on Information Technology, and established the National Information Technology Development Agency (NITDA) to serve as the umpire in the implementation of the policy. However, this document failed to adequately address the issue of the integration of ICT into the Nigerian education system. The document presented the issue of ICT in education though so vaguely. The policy listed nine major strategies for realizing the objectives of applying Information Technology (IT) in human resources development, one of which is 'making the use of IT mandatory at all levels of educational institutions through adequate financial provision for tools and resources'. While these noble strategies are applauded, the implication of the inadequacies in the document is that the National Information Technology policy is yet to adequately take care of the need of the Nigerian education system (Yusuf, 2005).

2.4.2 ICT and Geometric Shapes

In recent years, the use of PowerPoint in the classroom has significantly increased globally (Bartsch and Cobern, 2003; Connor and Wong, 2004).Since, in a PowerPoint presentation, topics are presented in a hierarchical fashion with graphics, color and animation, students could "use a mental image of that outline to study, to retrieve the information on a test, to organize their answer for an essay question, and to perform other educational tasks (Clark and Paivio, 1991. p. 176)." Rose (2001), also noted that presentation of learning materials in graphical form is beneficial for students.

Hanna and Remington (1996) found that color, as a stimulus, is a part of memory representation or as imaginary. Mishra, in a pilot study of 161 students taking a General Psychology Course, found that students performed better (roughly 4 percentage points) with PowerPoint presentations as opposed to lectures with overhead transparencies, and the liked PowerPoint better than transparencies .Lowry (1999), in a study of 390 students enrolled in three sections of an Environmental Science course, found an 8% point increase in the students in the PowerPoint cohorts. Lowry did not give the same test to all three sections, only in the same format of the test, the students preferred PowerPoint over transparencies.

The study of Bartsch and Cobern (2003) noted that students preferred PowerPoint over the use of TOHP, but that in some instances the content of the PowerPoint presentation distracted students and they performed less well on tests compared with a control group. Szabo and Hastings (2000) carried out an extensive study comparing PowerPoint and OHP and observed no difference in student performance in tests. The most important factor was lecture subject difficulty in determining the students' performance in these tests. They concluded that the efficacy of using PowerPoint was case specific rather than universal.

More recently, Blokzijl and Naeff's (2004) surveyed 69 Dutch students' reactions to PowerPoint as a tool and to lectures using PowerPoint instead of overhead transparencies. These students preferred PowerPoint over transparencies and liked the slides with large font sizes, unity in layout, and easy-to view color contrasts. Not surprisingly, these are the same features that teachers and authors emphasize when teaching effective PowerPoint presentations.

Nouri and Shahid (2005) conducted a study to test whether using PowerPoint in an accounting course enhanced student short-term memory, long-term memory, and attitudes toward class presentation and the instructor. An experiment was conducted which includes a treatment-control design, in a classroom setting throughout a semester. In one section of an accounting principles II (Managerial Accounting) course, PowerPoint was used as the delivery system, while the second section was taught using the traditional delivery system. The results showed that Power-Point presentation may improve student attitudes towards the Instructor and class presentation. The results did not provide conclusive evidence that PowerPoint presentations improved short-term or long-term memory. The latter results are consistent with other media comparison studies that show the medium alone does not influence learning.

Apperson, Laws, and Scepansky (2006) showed that college students enrolled in classes in which the professors used PowerPoint with lectures reported more interest in the class, an easier time paying attention, and greater learning when compared to the same classes in which the same professors used only chalkboards. Nouri and Shahid (2008), conducted a study to explore whether providing lecture notes when Power Point is used for class presentation affected student performance and attitudes toward instructor. This study was conducted in a classroom setting throughout the semester. The experiment involved two sections of an Accounting Principles I course. The results showed that students who did not receive PowerPoint lecture notes indicated that the instructor was more effective and efficient than students who received PowerPoint lecture notes. No differences were found between the two groups in evaluating the instructor on such attributes as preparedness, caring about students and feedback. The results further indicated that providing lecture notes did not appear to affect the performance.

Nicole (2009) analyzed the performance and attitudes of technical writing students in PowerPoint-enhanced and in non-PowerPoint Lectures. Four classes of upper level undergraduates (n = 84) at a mid-sized, Southern University taking a one-semester technical writing course were surveyed at the beginning and end of the course about their perceptions of PowerPoint. Of the four sections, two classes were instructed using traditional lecture materials (teacher at podium, chalkboard, and handouts); the other two sections were instructed with PowerPoint presentations. All four classes were given the same pre- and post-test to measure performance over the course of the semester. Traditional lecture or PowerPoint presentations consisted of at least 50% of the course, with the remaining time spent on exercises and small group work. Results revealed that while most students preferred PowerPoint, performance scores were higher in the sections with the traditional lecture format which could be the effect of variables uncontrolled.

2.4.3 ICT and Achievement in Geometry

For over two decades, many stakeholders have highlighted the potential of digital technologies for mathematics education. The U.S. National Council of Teachers of Mathematics, for example, in its position statement claims that "Technology is an essential tool for learning mathematics in the 21st century, and all schools must ensure that all their students have access to technology" (NCTM, 2008). ICMI devoted two studies to the integration of ICT in mathematics education, the second one expressing that "…digital technologies were becoming ever more ubiquitous and their influence touching most, if not all, education systems" (Hoyles and Lagrange, 2010, p. 2).

However, the integration of digital technology still confronts teachers, educators and researchers with many questions. What exactly is the potential of ICT for learning and teaching, how to exploit this potential in mathematics education, does digital technology really work, why does it work, which factors are decisive in making it work or preventing it from working? What does a quarter of a century of educational research and development have to offer here? Of course, these questions are not clearly articulated. What do we mean by “it works”? Does this mean that the use of digital technology improves student learning, invites deeper learning, motivated learning, more efficient or more effective learning? Does it mean that ICT empowers teachers to better teach mathematics? And, concerning the effect of educational research, do studies on digital technology “work” in the sense that they provide answers to these questions, or do they just help the researcher to better understand the phenomenon, and as such contribute only indirectly to improving mathematics education? My interpretation of “why it works” in the title of this contribution includes both learning and teaching, and also refers to learning on the part of the researcher.

This research will explore the question of “why digital technology works or does not” by briefly revisiting a number of leading studies in the field, that are paradigmatic for a theme, approach, method, or type of results. For each of these studies, the focus is on what they offer on identifying decisive factors for learning, teaching and research progress. As such, this contribution reports on a concise and somewhat personal journey through - or a helicopter flight over- the landscape of research studies on technology in mathematics education. Despite the abstract nature of mathematics, its teaching is to bring about scientific thinking in students; a mindset that requires students to test out, through experiential practice. However, through the use of ICT, whether CD-ROM, PowerPoint, and so forth, the teaching and learning of mathematics particularly geometry is interesting.

According to Osunade (2003) internet is a valuable source of information for students looking for ideas for project and assignments. Supporting this, Agommuoh and Nzewi (2003) believed that secondary students who are exposed to video-based instructions in science had significantly better results than those who were taught using the lecture method. It is against this background of looking at ICT as a medium of instruction in teaching and learning in secondary schools that this study is conceived. Therefore, the study is an attempt to establish through a statistical model the impact of ICT on teaching and learning of mathematics in secondary schools. According to Gbamanja, (1989. p. 131), education is a process, which seeks to change the behavior of a learner. Overall, behaviorist view education as the process of changing the behavioral pattern of people. Behavior in this sense refers to the way we change the learner, his or her thinking, his or her feelings and his other overt actions (Hergenhahn and Olson 1997)

Thus education is the process by which society deliberately transmits its cultural heritage through schools, colleges, universities and other institution (Gbemanja 1989). In other to achieve the above- mentioned purpose in education, information and communication technology (ICT), one could argue is an essential ingredient that could help bring these gains and benefits to the learners. Realistically, several researchers admitted that ICT have an impact in learning and teaching of science. Globally, the use of information and communication technologies (ICTs) is fast gaining prominence and becoming one of the most important elements defining the basic competencies of student. In Nigeria, science teaching at that various level still retains the old conservative approach and if this situation would change, there is need for a diagnostic study that this research offers.

The need for this study arose on the following basis;ICT is often perceived as a catalyst for change, change in teaching style, change in learning approaches to mention but few. An increasingly rich experience of technologies at home is likely to lead to many pupils entering school with a variety of ICT skills. To prevent such pupils from becoming frustrated and disaffected, these skills will need to be recognized and developed in appropriate programmes of study. Against these backgrounds is this study which would be at the best interest of the students, parents, curriculum developers and the government particularly in Bauchi state.

2.5 Retention and Performance of Geometry

Kurumeh (2007) maintained that the inappropriate, inadequate, elitist and euro-centric teaching techniques and methods used by mathematics teachers is instrumental to learners inability to understand and retain the basic mathematical principles, computations or logical facts involved. And the underlying process that gave rise to the mathematical facts resulted to learning by rote memorization, which led to poor retention, low performance and lack or loss of interest in mathematics. According to Child in Iji (2010), man is endowed with limited capacity for memorization. Thus the ability to memorize difficult subjects by rote learning calls for exercising the minds and the muscles of the mind and brain. However, mathematics is not a subject that can be learnt by rote memorization but for one to remember and recall information demand passing through one's experience. This goes to mean that the task before a teacher is how to help learners improve on their ability to assimilate information towards effective recalling and retrieving when the need arises. Resourcefulness in mathematics teaching demands that the mathematics teacher should focus attention on methods of teaching that stimulates learner's zeal, interest and higher retention rate, taking into cognizance of individual differences of learners.

This then suggest that mathematics educators should be able to develop new teaching techniques/methods to take care of the individual abilities of learners in the class room. Mari (2002) maintained that teaching strategies is a variable that can easily be manipulated by teachers to increase students' retention rate and performance as well as reduce or eliminate sex-related differences in science and mathematics performance.

Paden and Dereshiwsky (2007) and Omenka (2010) as well attributed the low performance and retention rate in mathematics of students particularly among sexes to instructional modality adopted by teachers.

They, in their research, recommended blended instructional techniques towards enhancing better retention and achievement. In view of the above situation there is need to develop or adopt teaching methods which are capable of improving the reasoning and logical ability of the learners to enable them retains concepts. Against this background the effect of ICT approach to teaching of geometry in senior secondary II is examined, being an approach that is built on the students' background, his previous knowledge, the role his environment plays in terms of content and methods of teaching geometry in a practical way (Bolaji, 2005; Kurumeh and Opara, 2008)

Geometry as an aspect of mathematics deals with the study of different shapes which may be plane or solid. A plane shape is a 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. Geometry forms the building blocks of engineering and technical graphics. Moreover, the conic section of geometry which is purely locus is of great importance to astronomy, mechanics and technology (Achor, Imoko and Uloko, 2009). Many different scientific and technological fields require knowledge of geometry. Especially in the more advanced and specialized study fields the use and knowledge of Geometry is essential to excelling. Geometry helps you to bring together both sides of your brain. In the fields of television, movies and even little things like puzzles or books all are influenced by geometry. Geometry is a good training ground for students to make use of concrete materials and activities. Those same experiments now will become stepping stones later in life. It will prepare you to use many different types of materials and textures together in fluent harmony.

The core topics in geometry where the problems of teaching and learning occurs most in mathematics are such as plane and solid shapes, measurement of plans and solid shapes, polygons, Geometrical ratio, geometrical transformation, latitude and longitude etc are topics that are generally identified to be difficult by both students and teachers. Statistics have shown difficulty in teaching and learning of mathematics, geometry in particular, has resulted in mass failure in examinations. The mass failure in mathematics examinations is real and the trend of student's performance has been on the decline (for example, Salau, 1995; Betiku, 2001).

Retention of knowledge is an important area of research that has the potential to inform instructional practices and school learning goals. It is the ability to retain and later recall information or knowledge gained after learning (Bahrick, 2000; Bichi, 2001; Desiree, 2009). The impact of ICT on intermediate outcomes is said to be greater and more persuasive such as motivation engagement with and independence in learning. The perceptive of ICT can support creativity, including critical thinking skills and problem-solving abilities is developing although some of evidence appears to be different. Hence, in general, impact is best observed where tasks have a clear educational aims which designed to maximize the usage of ICT as much as purposeful by students (Condie and Munro, 2007).

2.6 Gender and Performance in Geometry

Tiedemann (2000) observed that in the first through third grades, girls tend to outperform boys in mathematics achievement. Hyde, Fennema and Lamon (1990), confirm that by high school the exact opposite is occurring. The boys are outperforming the girls. Hyde et al. (1990), suggested that this dramatic turn of events occurs because in high school less computation is needed, and girls are better at computation. However, Tiedemann (2000) stated that when teachers are consulted, they believe that the difference in achievement between boys and girls is prevalent because boys are more logical, and therefore, they have a built-in advantage over the girls because mathematics is logical. He stated that teachers believe that sometimes girls can compete with boys in high school mathematics, but this is only because some girls know how to try harder when the need arises.

Tiedemann (2000) conducted a 2-year longitudinal study of boys and girls in grades four, five, and six to determine if boys were mathematically superior to girls in the early grades. His study involved three teachers and 75 students. He concluded that there were no significant differences in mathematics achievement based on the gender of the students. However, Tiedemann's subjects were in the early grades, and the participants in the present study were in 10th grade geometry. Students in the present study would be evaluated to see if there is an interaction between the use of ICT, mathematics achievement and gender.

Jussim and Eccles (1992), conducted a 2-year longitudinal study of students in the sixth grade. The purpose of the study was to examine teachers' beliefs about the gender of the students and to determine their effects on student performance in mathematics. They determined that (a) the teachers as well as the students held different beliefs for the boys and girls in mathematics, (b) the teachers felt that the average achieving boys were more logical than the average achieving girls and (c) the teachers rated mathematics more difficult for the average achieving girls than for the boys on the same level. Finally, concerning the girls, (d) the teachers stated that their failures have less to do with a lack of effort and more to do with low ability (Jussim and Eccles, 1992). The boys in the Jussim and Eccles (1992) study outperformed the girls in mathematics; the present study was interested in determining if there is an interaction in the achievement scores of boys and girls and the use of ICT.

The present researcher believed that through the use of ICT, teacher bias would be minimal at best, and further, that ICT provides a platform that increases the motivation levels of all students. Jussim (1989) concluded that when it comes to girls that range from below average to average in mathematics achievement, they must try much harder than the below average to average boys to achieve the same results. The findings leaned in the direction that the boys were more talented and exerted more effort towards learning mathematics than the girls. Eccles et al. (1990), observed similar results in the way that parents look at their sons and daughters differently.

MacGregor and Thomas (2002) conducted a study to determine the effectiveness of a student directed approach of using ICT to complete a project based task compared to a teacher directed approach. There were 82 tenth grade students from four geometry classes that met daily for 50 minute sessions. The students were from an all-girls private parochial academy that is nationally recognized for its academic prowess. They assigned the same project to both groups to determine the learner outcomes that occurred as the students completed the project. The primary goal of the project was to design and find the cost of making a garden that would be built on the campus.

The results of the MacGregor and Thomas (2002) study revealed that in the short term the teacher directed group had higher learning outcomes. The teacher directed group was characterized by a greater sense of direction and was less frustrated than the group of girls working with the ICT software alone. However the self- directed group expressed a sense of pleasure and an increase in self-confidence with a sense of pride in their accomplishments. They expressed that one should be wary of applying these results across student populations because most parents that can afford to send their daughters to an all-girl, private parochial academy are rarely low SES challenged. Also, one must consider the levels of motivation those students at a top tier private academy have over students at a school where many of the students are struggling both financially and academically (2002).

Tiedemann and Steinmetz (1997) stated that girls were less logical thinkers than boys, and that the unexpected success that some girls experienced was due more to effort and less to ability. Through the use of dynamic geometry software, the present study discovered if gender biases could be observed through an interaction in the achievement scores of boys and girls. Rebhorn and Miles (1999) conducted a study to determine if high stakes testing is a barrier to middle-school gifted girls. They hypothesized that if girls scored lower than boys on standardized mathematics tests, then it would adversely affect their opportunity to be accepted into specialized mathematics programs that could eventually lead to networking opportunities, college admissions, and the ability to learn how to interact in higher level academic settings. They revealed that there is a 30 point difference (favoring the boys) in all of the mathematics scores of girls and boys on the Scholastic Achievement Test (SAT). They stated that boys are more likely to be accepted into gifted mathematics programs if the SAT math test is the lone determinant. They discovered that accelerated university-based programs that target gifted students have many more boys than girls participating.

Benbow and Stanley (1983) determined that of all the students that took the mathematics portion of the SAT and scored at or above 500 (out of a possible 800 total), about 67% were boys. They revealed a few advantages of participation in university programs for gifted middle-school boys: The boys ended up with an enhanced self-esteem, superiority due to working with the cream of the crop, improved preparation for the future, a desire to learn more, a feeling that school is a good thing, a desire to be better qualified to attend higher echelon colleges, and improved researching abilities.

According to Olszewski-Kubilius and Grant (1996), something special happens to the girls that attend these specialized programs as well. These girls are more likely to take Advanced Placement (AP) classes once they go to high school. The AP courses assist the girls in being able to make technical career choices, being exposed to college and career counseling, and being provided opportunities to be mentored by girls that are upperclassmen. They posited that when girls are given an opportunity to excel on higher levels they have more opportunities than girls that do not score high on mathematical tasks. The present study sought to determine if ICT has the potential to assist girls in increasing their mathematics achievement.

Rebhorn and Miles (1999) stated that boys have an unfair advantage over the girls on the SAT due to gender bias that is built in to the SAT examination. Although their study brought to light built-in gender biases in standardized tests, it did not include consideration of the students' SES in its discussion of results. Their study did not use dynamic geometry software to prepare their students for the SAT. The present study was based on the use of ICT to examine its effects on students' achievement as measured by their mathematics FCAT results. By using this dynamic geometry software both the boys and the girls had the same opportunities to learn and excel.

The questions of differences in mathematics scores due to gender were closely examined. Dix (1999) conducted a study on eighth grade girls and boys using ICT as a treatment for the experimental group and pencil and paper for the control group. She also administered a computer attitudinal survey. The results of her survey revealed a significant difference in the ways that girls and boys think about the use of computers. That study revealed that boys and girls thought positively about the use of computers.

However, an analysis of the survey results revealed that the boys thought more positively about the use of computers. Dix's study also showed that through the use of technology, girls can improve their thinking on mathematical tasks, thereby giving the girls more inspiration to perform just as well as the boys or possibly even outperform the boys in mathematics.

Altermatt and Kim (2004) stated that boys outperform girls in mathematics because the boys were exposed to hormones in the womb that lead to more analytical thinking in the brain and to increased spatial abilities. They also stated that some girls suffer from "low confidence and high uncertainty," and that these qualities are exposed during mathematical thinking. They expounded on another theory that states girls are more likely than boys to want to please others, whereas boys are more competitive, and this may account for the discrepancy between the mathematics test scores of boys and girls. The present study was interested in comparing the mathematics FCAT scores of boys and girls to determine if the use of ICT affected the mathematics scores of the girls enough to close the gender gap. Parents play a large role in the perceptions of their children's attitudes towards mathematics (Leedy, Lalonde, and Runk, 2003).

Leedy et al. (2003), stated that boys exude higher confidence levels in their mathematics abilities because boys view mathematics as a male dominated arena. The researchers suggested that girls have less confidence in their mathematical ability, and believe that their mothers expect less from them mathematically than do their fathers. Further, they stated that teachers have different perceptions of boys and girls mathematically, and that the teachers in their study showed preferential treatment towards the boys and paid less attention to the girls' mathematical abilities. These results were based on a survey that was given to all of the participants, including the parents. The purpose of this survey was to examine how the parents and students viewed mathematics. The girls, as well as their mothers, thought that the survey was insulting and biased against women because the questions were geared to show male dominance.

Martinot and De'sert (2007) examined a group of fourth and seventh graders to explore whether they were aware of gender stereotypes. According to the results of the study, seventh grade boys believed that the girls were academically superior in mathematics. The girls, on the other hand, held deep-seated beliefs that their mathematical abilities were lower than that of the boys'. That study opens a window into the minds of girls and boys and provides additional support for claims that boys think differently than girls. Bracey (1994) discovered that boys look at mathematical problems differently than girls do. Boys use a "top-down" approach in which they quickly identify what category a problem belongs to and make adjustments accordingly, whereas girls use a "bottom-up" method in which they look for patterns as they pull together information from the problem. Bracey theorized that girls are more likely than boys to spend time examining "irrelevant" information as they attempt to solve a problem. Bracey stated that boys quickly discard irrelevant information and stick to the rules and algorithms for solving problems.

Through the use of ICT students can instantly make and examine conjectures and determine quickly if certain properties are relevant or not. The use of ICT may be able to assist girls in solving the problem more effectively. Sprigler and Alsup (2003) conducted a study on 120 boys and 119 girls in grades one through five in a rural South Dakota community. They observed that students in elementary school do not demonstrate a gender gap in mathematics. They also stated that gender differences in mathematics begin to occur in the middle grades, and that when time constraints are removed from tests there, girls perform just as well or better than boys.

All of the studies reviewed here reported the same conclusions, that in the lower grades girls outperform boys in mathematics. As students move into the middle grades, boys are expected to take the lead in mathematical abilities over the girls. Beginning in middle school the boys do take a lead in mathematics achievement. The present study was interested in discovering if the use of ICT can assist girls in closing the mathematics achievement gap that has been documented in the higher grades.

2.7 Gender and ICT

Gender is a socially ascribed attribute, which differentiates feminine from masculine. A number of studies have verified the influence of gender on mathematics achievement of students. This had led to series of divergent views on the influence of gender on the mathematics achievement and interest of students. Many research findings in Nigeria have shown that boys perform better than the girls in mathematics generally despite the fact that they are put under the same classroom situation (Agwagah, 1993; Alio and Harbor-Peters, 2000; Ezeugo and Agwagah, 2000; Jahun and Momoh, 2001; Etukudo, 2002). To the contrary, Agwagah (1993) had reported that female students perform significantly better than their male counterparts. Etukudo (2002) shares similar view. Meanwhile other research findings have debunked the idea of sexual differentiation in ability. This school of thought said that there is no disparity in the performance of both boys and girls (Olagunju, 2001; Gbodi and Laleye, 2006). These conflicting views necessitate the present study with a view to lending support to the actual situation in Nigeria.

There is no gain saying that gender disparity exists in mathematics achievement, but Etukudo (2002) emphasized that this is in the face of weak methods. The search for a good instructional delivery process that could balance the gender inequality in mathematics cannot, therefore, be over-emphasized. There is therefore the need to find out if ICT (PowerPoint animated presentations) as instructional strategy is capable of eradicating this gender related differences in mathematics achievements among students. Thus, among the aims of this study are:

1. to ascertain whether there is gender disparity in the achievement of male and female students in geometry when taught using ICT (PowerPoint animated presentation).

2. to ascertain if there is gender disparity in the retention ability of male and female students in geometry when taught using ICT (PowerPoint animated presentation).

2.8 Overview of Related Studies and Computer Aided Instruction

This section provides a brief review of the literature on the status of ICT in the Nigerian education system. The efforts of some agencies involved in the drive are highlighted, while a review is also made on some empirical studies that have been carried out in this regard. The review indicates that Nigeria is gradually advancing towards full integration of ICT into her educational system, even though at a slow pace. Conferences, workshops, and seminars are being held across the country on the integration of the computer into the Nigerian education. The science Teachers Association of Nigeria's (STAN) annual conference held in Abuja in August 2003 had many stakeholders in attendance (Adeyegbe *et al.*, 2003). There was also a team of experts from the University of Botswana that conducted training for attendants, on the use of ICT in education.

The papers presented reviewed the status of ICT in Nigeria as at 2003, and they provided suggestions and recommendations that could enhance ICT integration into the Nigerian education system. Particular emphasis was on the use of ICT in science and mathematics education since the theme of the conference was 'Information and Communication Technology and Science, Mathematics and Technology Education'. Adeyegbe, Oke and Tijani (2003) conducted a research on the feasibility of teaching and assessing STM with ICT in Nigeria. They sought to find out the level of availability and capacity development of ICT in teaching and assessing STM in Nigeria, and when exactly should Nigeria adopt ICT in teaching and learning STM.

A questionnaire was administered to collect data from six sampled secondary schools in Lagos state (two federal government colleges, and four public schools). The respondents comprised of 246 SS3 students (165 males and 81 females), and 46 STM teachers (28 males and 18 females). Analysis of data collected was through the use of frequency counts of the responses to the items on the questionnaire, which was reduced to percentages for each category of respondents. The result indicated a very low availability of ICT materials and equipment in the sampled schools although eighty percent (80%) of the respondents (both teachers and students) indicated their willingness to be trained for ICT usage.

This corroborated the low level of capacity development for computer use in teaching and assessing STM subjects. From the free comments of the respondents, it was apparent that there was an eagerness to understand the usage of the computer for teaching and assessing STM subjects. The researchers expressed a high hope for the adoption and integration of the computer in the teaching and assessment of STM in Nigeria. Among the various recommendations made were that STM teachers should be trained on the use of ICT gadgets and that the present STM curriculum should be overhauled to accommodate the use of the computer in teaching and assessing STM subjects. These are pointers that could be of great impact in the teaching and learning of mathematics, moreover the only way to justify any investment either by government or public private is good performance in subjects of endeavor in which mathematics is paramount.

Computer Aided Instruction in other Countries

According to Means *et al*. (2009), student motivation is enhanced through *online* collaborative research that includes online communication with peers and experts in other states and countries, evaluation of evidence and sharing of information and the use of standards-based curricula that are integrated with scientific visualization tools. Project GLOBE engaged K-12 students from schools in 34 countries in gathering data about their local environments. Students in the GLOBE classrooms demonstrated higher knowledge and skill levels on assessment of environmental science methods and interpretation of data than did their peers who did not participate in the program.

A systematic review by Goldberg et al. (2003), found that *"*on average, students who use computers when learning to write are not only more engaged and motivated in their writing, but they produce written work that is of greater length and higher quality.*"* (p.2).The effect sizes were however, found to be moderate (0.50 for quantity and 0.41 for quality) and that this kind of impact would move a class using word-processing, from 50th up to 36th in a league table of 100 classes in terms of the quality of their writing. It further suggested on the basis of a meta-analyses conducted by Boston College on Writing with Word Processors across the curriculum, which students using these electronic tools wrote significantly more, received earlier interventions by teachers, and wrote higher quality work than students in comparison group.

In the area of reading, several studies have shown that students who use *word processors*, versus those who use *pen and paper,* are more engaged and *motivated* in their writing, they write more, they receive earlier scaffolding and intervention by teachers, and they produce higher-quality work. Pittard *et al*. (2003), noted that evidence from large scale studies, most notably *impaCT2* (Harrison *et al*., 2002), showed that the use of ICT can motivate pupils and result in a positive effect on attainment amongst those pupils who make relatively high use of ICT in their subject learning. Strand 1 of the *impaCT2* investigation focused specifically on pupil learning and attainment and found positive associations between ICT use and achievement on some key stage (KS) tests, although the strength of the associations observed varied with stage and subject area. Statistically significant positive associations were found between ICT use and higher levels of attainment in; National Tests in English (KS2), National Tests in Science (KS3), GCSE Science (KS4), and GCSE design and technology (KS4). Positive associations were found between ICT use and National Test results in Mathematics (KS2) and in relation to GCSE outcomes in GCSE modern foreign languages and geography (both KS4), although they did not reach statistical significance. However, it was also noted that no association between superior performance and low levels of ICT use was observed. Factors such as expertise of the teaching staff, access to subject specific resources at each key stage and quality of the materials were identified as influential.

Passey *et al*. (2004), in a study to establish systematically the impact of ICT use in school on pupil motivation, found that the perceptions of teachers and pupils towards using ICT in school had an overall positive motivational impact on the pupils studied, based on case studies carried out in 17 schools, including interviews with 121 head teachers, teachers and classroom learning assistants and with 126 pupils, 33 lessons observed and 1,206 pupil questionnaires administered, besides interview with 24 social workers, youth workers, health workers, careers officers and police officers concerned with school liaison and youth offenders. The most significant research study on the motivational effect of ICT on pupils Passey *et al*. (2004), aiming to identify and, where possible, to quantify impact and to relate it to aspects such as learning outcomes, behaviour, school attendance, truancy, antisocial behaviour and uses of digital content, found that ICT helped to draw pupils into more positive models of motivation and could offer a means by which pupils could envisage success.

All of the secondary school teachers involved felt that ICT had a positive impact on pupil interest in and attitudes to school work. Pupils took greater pride in their work and it was more likely that tasks were completed and on time. The study drew on a range of theoretical stances, problematising the concept of motivation and identifying a number of different dimensions. It defined eight measures that could be used to identify and quantify these – learning goals, academic efficacy, identified regulation, intrinsic motivation, performance approach goal, performance avoidance goal, external regulation and motivation. Each of these is based on usually implicit reasons pupils might have for engaging with tasks in the context of school. For the first four, high levels of measurement produce a positive learning profile while for the last four, low levels are desirable.

The measures formed the basis of pupil questionnaires and motivational profiles constructed from the responses. The study also found that, when working with ICT pupils, learning was characterized by high levels of motivation towards achieving personal learning goals – a desirable outcome – but also high levels of motivation towards gaining positive feedback on individual competence (performance approach goals) -which was less desirable.

Davies *et* al. (2005), in reviewing the research evidence on the impact of ICT in the 14 to 19 age range, found that motivational variables do not in themselves lead directly to improvement in achievement; rather the effects of increased motivation are mediated by other variables that are linked to the development of learner autonomy and higher order cognitive skills. The development of meta-cognitive skills and self-regulation, it is argued, leads to increasingly effective learning strategies amongst pupils, greater engagement with learning activities, and in turn attainment. Valentine *et al*. (2005) found that parents and pupils believed that ICT improved motivation and confidence, made school work more enjoyable and improved achievement. They reported a statistically small improvement in attainment in Mathematics and English linked to the home use of ICT for educational purposes at particular key stages, and concluded that home use brings advantages in terms of new sources of information, enhanced presentation and raised self-esteem which, in turn, affects attainment.

Chem *et al. (*2006), in Greenwood and Davis (2011), investigating use of ICT in music classrooms, with focus in secondary school music curriculum in the UK, revealed significant improvement in reading music (staff) notation and rhythm skills. The study focused on two aspects highlighted in the National Curriculum for England for Music (1999) which suggested that basic music notation and keyboard skills form part of pupil's musical learning experience, and that such practical skills support classroom musical activities like performing, listening and composing. The study was carried out in a British Secondary School using a commercial CD entitled "*Teach me Piano Deluxe"*, designed to teach music practical skills.

Much of the research into the effective use of graphic calculators in enhancing student achievement appears to show positive results. In a study by Alexander (1993), college algebra students who used software designed "to aid in the instruction of functions using concrete visualization "plus a graphing calculator significantly outperformed students receiving conventional instruction in their "understanding of the concept of functions…. and in mathematical modeling". The results in this study suggest the power of the computer to provide concrete visual support for the learning of abstract concepts.

McFarlane *et al*. (1995), introduced line graphs to eight-year old children, using data logging. Children, who had been exposed to data logging showed an increased ability to read, interpret and sketch line graphs when compared to children using traditional apparatus. The results suggested that the manual plotting of points as a first introduction to graphs appeared to interfere with understanding. Pengalese and Arnold (1996) urged researchers not to treat the graphic calculator in isolation from the context in which it is being used – the particular learning environment.

Tharp, Fitz Simmons and Brown Ayres (1997), in a four month study of 261 mathematics and science teachers, found that while participants' views changed significantly in favour of viewing the graphics calculator *"as a 'thinking tool' to enhance conceptual understanding and expand exploration",* there was a difference between the teachers classified as holding a *rule-based* view of mathematics learning and *non-rule based* teachers. In particular, *rule-based* teachers, quickly abandoned inquiry approaches, were more likely to feel that the calculators were a hindrance to learning and were more concerned about students' emotional reactions than indications of conceptual understanding.

Barton (1997) in a comparative study on 12-14 year old students to investigate if there are any advantages to pupils using computer generated graphs as opposed to plotting them manually, found that manual plotting was a problem for all, particularly the weaker students; it not only caused a time penalty, but misunderstandings too about the relationships between the variables being plotted, reinforced by difficulties the students had in drawing the best-fit lines. On the other hand, the *computer-assisted graphing* approach was particularly effective for the younger, weaker students, the production of real-time graphs stimulated the students to provide explanations, make predictions and spontaneously make links to previously acquired knowledge.

Hennessy et *al*. (2001), in their PIGMI (Portable Information Technologies for supporting Graphical Mathematics Investigations) *Project* investigating the role of portable technologies in facilitating development of student's graphing skills and concepts, examined the impact of a recent shift towards calculating and computing tools as increasingly accessible, every day technologies on the nature of learning in a traditionally difficult curriculum area. It focused on the use of *graphic calculators* by undergraduates taking an innovative new mathematics course at the Open University. A questionnaire survey both of students and tutors was employed to investigate perceptions of the graphic calculator and the features which facilitated graphing and linking between representations. Key features included visualization of functions, immediate feedback and rapid graph plotting.

A follow-up observational case study of a pair of students illustrated how the calculator can shape mathematical activity, serving as a catalytic to facilitating and checking roles. The features of technology-based activities which can structure and support collaborative problem solving were also examined. In sum, the graphic calculator technology acted as a critical mediator both in the students' collaboration and in their problem solving. The pedagogic implications of using portables are considered, including the tension between using and over-using portables to support mathematical activity.

Zollman *et al*. (1989), in a study of reading and mathematics achievement of Grades 2-6 students , experimental groups using *Education Systems Corporation (ESC) software* in computer laboratories twice per week during a period of one school year, and with access to the computer laboratories, demonstrated significant increases in achievement both in reading and mathematics. Wood, exploring the effects on mathematics achievement of two different types of software: *a tutorial program and a* *tool program* on high school students studying algebra and using the tutorial, demonstrated higher achievement in computational skills. The students using e tool program evidenced higher achievement in their understanding of algebra concepts. The study suggested that the best choice of software type may depend on the instructional goal. Since success in mathematics requires both computational and conceptual skills, students are likely to benefit from both types of software (Freeman, *et al.*,2014).

Gardner, Simmons and Simpson (1992) found evidence of the benefits of hands-on meteorology activities combined with *content-specific tool software.* Three groups of third graders were compared: one group receiving hands-on activities with software; one receiving hands-on activities without software; and one receiving traditional classroom instruction. The hands-on activities with software group significantly out-performed the hands-on activities only group on a test of meteorology knowledge. Both of these groups scored significantly higher than the students receiving traditional instruction did. Lazarowitz and Huppert (1993) had similar results with high school biology students. One group received classroom–laboratory instruction that included use of a software program that combined simulated experiments and laboratory analysis tools. The other group received class room–laboratory instruction only. The group using the software demonstrated significantly higher achievement in content knowledge and science process, skills of graph communication, data interpretation and controlling variables.

A study by Carter (1994) suggested that supplementing classroom instruction with *tutorial and practice software* had a positive impact on mathematics and reading achievement for low performing ninth graders. A group of students receiving computer-based instruction for one 50-minute period per week both in their mathematics and English classes for most part of one school year and for the remaining time, took part in regular classroom instruction, demonstrated significantly greater gains both in mathematics and reading skills than another group of low-performing students who received traditional instruction without access to computers. Both groups had the same amount of total instructional time.

Researchers from Leicester University (Underwood, Cavendish, Dowling, Fogelman and Lawson, 1996) found that8-13 age group students using *mathematics software* in an Integrated Learning System (ILS) at schools throughout the United Kingdom showed significant learning gains, compared to students not using the software. Those in primary schools performed significantly better in the areas of addition, subtraction, multiplication and extensions while those at the secondary level showed significant gains in the areas of operations and diagrams. Stone (1996), comparing second grade students who had used several mathematics and reading software programs since kindergarten with students in a nearby school who did not use the software demonstrated that the students who had used the software scored significantly higher in mathematics problem-solving on a standardized test than those who did not use this software. Both schools followed the same Board of Education approved course of study.

Elliott and Hall (1997), found that the use of computer-based mathematics activities enhanced mathematical achievement among at risk four year old children placed into one of the three groups, two of which used *computer-based mathematics software*. Children in the third group participated in a range of typical discovery-oriented preschool mathematics activities off-computer, together with computer activities in other areas. Students in both groups that used computer-based math activities had significantly higher post-test scores on the Test of Early Mathematics Ability (TEMA-2).

Two unpublished studies by researchers at the Stevens Institute of Technology (Jurkat, Skov, Friedman, Pinkham and McGinley) demonstrated positive effects of commercially available high school *mathematics software on retention* (that is, performance on a delayed post-test). In one study, each student received instruction *for two geometry topics,* one with supplemental software and one without. One group used software for the first topic and the other group used software for the second topic. For retention, student performance was *significantly better* when instruction included software. In the other study, two groups of students were compared. One received instruction that included supplemental software and the other group did not use software. Once again, the group using software demonstrated significantly better retention(70 per cent better) than the group that did not use the software.

Wheeler *et al*. (1999), exposed ninth graders enrolled in algebra classes with traditional instruction to one of three conditions: (1) a control group; (2) a Placebo condition, where students were given a computerized word problem environment without active tutoring; and(3) an experimental group that received a computerized word problem environment with native tutoring, found that students who received *computerized tutoring system performed* better both on abstract and concrete reasoning word problem tasks than their age- mates in the other two conditions. However, they did not do better than students given human tutoring as a supplement to traditional instruction. In addition, although the *tutoring system* was designed to increase the ability to solve problems of a more abstract and theoretical nature, the students actually showed more improvement on concrete test questions than on abstract ones. Because the students were not assigned to conditions randomly, may be the results are attributable to the preexisting differences between the control and experimental groups; as the experimental group scored significantly higher on test problems even before the manipulation. Notwithstanding its limitations, the study provides limited support for the argument that the use of *computer tutorial programs* has the potential to help students with problem solving skills.

Rogers and Newton (2001), exploring the potentials of software for supporting investigative work in practical science with 13-14year old students, suggested that the *software* proved successful in promoting students' abilities to collect and manipulate data. Huppert *et al.* (2002) evaluated a software programme in Israel for its potential to enhance tenth-grade biology students' understanding of the life processes of microorganisms. Control students studied the same learning material in the classroom and the laboratory. It found that the *Growth Curve of Micro-Organisms* simulation programme makes it possible to perform 'experiments' in short time and to check the Influence of various factors such as the initial number of organisms in a Population, the temperature range and the nutrient concentration on the Growth Curve. It also gave opportunities to evolution of facial expressions and was used to teach the concepts of artificial selection, genotypes and mutations.

General tools for mathematics education include, for example, dynamic geometry software, computer algebra systems, spreadsheets, and dynamic mathematics software. Fuglestad (2005) defines such toolsas open and flexible software, not made for specific topic or limited to teach specific tasks [This kind of] computer software [….] makes it possible for the user to plan and decide what to do. Such tools can be used for a wide variety of problems and can provide learning situations to explore and experiment with mathematical connections, and provide new ways of approaching the task**.** Although "general tools allow students and teachers much more freedom to shape and modify how to use them" (Barzel, 2007, p.80), the introduction of a general tool for mathematics education requires more time and effort both from teachers and students than simply using the virtual manipulative. Computer algebra systems, dynamic geometry software, and spread sheets are the main types of educational software currently used for mathematics teaching and learning (Fulestad, 2005; Drijvers and Trouche, 2007).

Since the late 1980s, researchers worldwide have consistently reported positive learning gains from classrooms that integrated CAS appropriately. Keller and Russell (1997),in a large study involving hundreds of college students, showed that when teachers used *CAS* technology with an appropriate instructional emphasis (i.e., on making sense of mathematics in group discussions), students learned to reason about symbolic expressions. The students taught *with CAS* were more successful than students *without CAS* at three levels*: basic computation, more advanced computation and complex symbolic problems*. Similar findings were reported for upper secondary school students (aged 16-19) in Finland who were taught the *concept of derivative* with and without *CAS* (Repo, 1994). Research has also examined student motivation. When used effectively, CAS can make mathematics more interesting and meaningful to students.

Velchos and Kehagias (2000), in a study with Greek business students showed that students using *CAS* were more interested, participated actively and spent more time preparing for class than their *non-* using *CAS* counterparts. Schmidt and Moldenhauer (2002) in Schmidt *et al.* (2009) in a 3-year study of *CAS* with grade 11-12 students in Germany found a moderate enthusiasm for mathematics and overall positive attitude of *CAS.* Kramarski and Hirsch (2003), investigating the differential effects of Computer Algebra Systems (CAS) and self-regulated learning (SRL) on algebraic thinking and self-regulated skills, comparing CAS Learning with SRL (CAS + SRL), and CAS Learning without SRL, found that (CAS+SRL) students used more easily and correctly generalized letters (variables) and algebraic manipulations. Empirical results from the experimental and caste study designs revealed that (CAS+SRL) students outperformed (CAS) students on algebraic thinking and that (CAS+SRL) students regulated their learning more effectively.

"Dynamic Geometry Software (DGS)" […..] is used as a generic term to describe a certain type of software which is predominantly used for the construction and analysis of tasks and problems in elementary geometry (StraBer, 2002).Pure DGS is operated mainly with the mouse by activating different geometric tools and applying them to the drawing paid or already existing objects. An examples of DGS is *Cabri Geometry* (Cabrilog SAS, 2007). In general, DGS provides three main features that usually cannot be found in CAS or spreadsheets: drag mode, customizable tools, and trace or locus of objects (Graumann *et al*., 1996, p.197), DGS usually provides the following basic mathematical objects: points, segments, lines, circles, vectors and conic sections.

Dixon (1996), found that students who used the GSP (*Geometer's sketchpad* software) had higher significant achievement scores on a test containing the concepts of *reflection and rotation.* Growman (1996), studying the use of GSP in a Geometry Course for Secondary Education Mathematics Majors and offering three examples of how sketchpad is used, showed that students wanted to get their own copies of the GSP software. The use of GSP showed *more positive reaction* both from the students and the instructors in testing *conjectures and constructions.* Lester (1996), investigating the effects of the GSP software on achievement of geometric knowledge of high school geometry students, indicated that the mean of posttest scores for the dependent variable (geometric conjectures) of the experimental group was significantly higher than that of the control group and also that the GSP provided intelligent capabilities for improving learning and teaching.

White and Norwich (1997), presenting nine exercises on using different technological tools – GSP one of them – in explaining *Calculus* Concepts, found that the GSP can be used in teaching some of Calculus Concepts such as: vertices of a triangle, midpoint, equation of a line, slope of a line, and the trigonometric identities of sine, cosine, and tangent functions. Yousef (1997), investigating the effect of using the *GSP* on high school students' attitudes towards geometry, indicated that the scores of the pre-test and post-test of the students in the experimental group were significantly different and that *there were significant differences* also between the control and experimental groups' gain scores from the pre-test to the post-test.

Gerretson (1998), comparing the geometry performance of two groups of pre-service elementary teachers enrolled in a mathematics methods course, both groups completed hands- on, experiential activities designed to help them develop a deeper understanding of the concept of similar geometric figures. The control group used manipulative and traditional tools such as a protractor and ruler, together with a mechanical device for drawing similar figures. The experimental group used *Geometer's sketchpad* software, showed that students using the Software performed significantly better on a posttest measuring understanding of the concept of similarity and that the use of the *GSP* in teaching and learning mathematics is a useful and attractive program that can create a healthy atmosphere in the educational process.

Funkhouser in a longitudinal study (1990) on the effects of integrating the so called *"Problem-solving software"* into mathematics instruction on 2nd and 3rd year high school students, showed that not only did the students develop more positive attitudes about themselves as learners of mathematics and mathematics as a discipline but they also demonstrated significant gains in problem-solving ability and mathematical content on standardized tests of mathematics. In a similar study, of the influence of *problem- solving computer software* on the attitude of 40high school mathematics students toward mathematics, enrolled either in geometry or second year algebra course in a public high school, Funkhouser (1993), showed that "Students who use *problem solving software* tend to develop a more positive view of their own mathematical abilities and a more positive disposition toward mathematics as a subject" A rigorous schedule of computer-based and non-computer-based student's activities was developed and the students were given the National Assessment of Education Progress (NAEP), and skills-based test of problem- solving ability developed by Mayer and Weinstein (1986).

Liu (1993) found that *hypermedia* software designed to permit exploration of the semantic networks can help international college and graduate students (non-native English speakers) in English Vocabulary development. A semantic network is the web of interrelated concepts that represents one's depth of understanding of any given concept. For example, a semantic network for the concept, *Lawyer* could include *trial, judge, defendant, and jury,* among others. Students who used the software demonstrated *significant gains* in vocabulary knowledge.

Brantmayer (1994), comparing the effectiveness of *hypermedia* to traditional lecture for graduate students studying safety and industrial hygiene, in retention to the topic of instruction noise and hearing conservation, found that the students who used the hypermedia program demonstrated significantly superior achievement on a test of hearing conservation concepts and principles. Dede (1994) too found that *hypermedia* tools offer new methods for structured discovery, address varied learning styles, motivate and empower students and allow educators to present information as a web of interconnections rather than a stream of facts.

Montazemi and Wang (1995), studying the impact of a *hypermedia tutoring program* that had been implemented to help students in a management information systems course preparing for weekly lab tests through questions and feedback, showed that students who spent more time with the program generally did better on the lab tests and in the final examination. Comparison of final examination scores with scores for the previous year showed a significant gain from the 71.43 per cent previous year to 81.81 per cent using the tutoring system. Liao (1999), in a meta-analysis of 46 studies performed to synthesize existing research comparing the effects of *hypermedia verse non-hypermedia instruction* (.for example, CAI, text, traditional, videotape instruction) on students' achievement, found that the effects of using *hypermedia* in instruction are positive over *non-hypermedia instruction* as a whole and that they also provide to classroom teachers an accumulated research-based evidence for using technology in instruction.

Forty-six studies located from three sources, their quantitative data transformed into Effect Size (ES), and their overall grand mean of the study-weighted ES for all 46 studies 0.41 too suggested that hypermedia instruction is more effective when there is no instruction for the comparison group or when the comparison group uses videotape instruction. However, CAI and text instructions were found to be slightly more effective than *hypermedia* instruction. As a whole, the results of this analysis suggest that the effects of hypermedia instruction on students' achievement are mixed, depending on what type of instruction it compares to. In addition, four of the seventeen variables selected for this study (i.e., instrumentation, type of research design, type of delivery system, and comparison group) had a statistically significant impact on the mean ES.

In general, CAI in the content areas offers small yet significant advantages to learning with computers over learning in more traditional ways. Chang (2003), building on previous studies, compared the achievement of tenth grade Taiwanese students who experienced teacher directed CAI (TDCAI) with those who undertook student-directed CAI (SCCAI). Both groups used the multimedia CAI software, which was designed to allow users to navigate the various learning sections in a non-linear fashion. The TDCAI approach emphasized direct guidance from the teacher, while the SCCAI stressed student self-paced learning.

Becta (2004), comparing the academic achievement of elementary students who received CAI as a supplement to the traditional program versus students who received traditional instruction only, showed better achievement among the CAI students. Cepni, Tos and Kose, (2006) investigating the effects of a computer-assisted Instruction material (CAIM) related to “Photosynthesis” topic on students’ cognitive development, misconceptions and attitudes, found that using AIM and CAIM in teaching photosynthesis topic was very effective for students to reach comprehension and application levels to cognitive domains.

The study conducted in 2002-2003 academic year was carried out in two different classes taught by the same teacher, in which there were fifty-two 11th grade high school students in Central City of Trabzon in Turkey. An experimental research design including the photosynthesis achievement test (PAT), the photosynthesis concept test (PCT) and Science Attitude Scale (SAS) was applied at the beginning and at the end of the research as pre-test and post-test. After the treatment, general achievement in PAT increased by 10% in favour of the experimental group at ($P<0.05$) significant level. Although the treatment, general achievement in PAT increased in cognitive development at Knowledge Level was 14.8% in the EG and 18.2% in the control group (CG), the development at comprehension and application levels were 19.8-18.5 in the Experimental Group and 1.75-0.86 in the control group, respectively.

In a broad sense, the use of computer games in educational settings seems to have a positive effect on academic achievement (reading comprehension, algebra and decoding); on attitudes toward learning; and on self-concept in comparison to traditional instruction. Games offer immediate feedback, increase active learner participation, reinforce knowledge, and influence attitudinal changes. Marty (1985) investigating the effect of games in the students' attitude towards and achievement in mathematics, revealed the following findings: (1) a significant difference at the .08 level, in change of class means on mathematical achievement favoring use of the computer game, (2) very little difference ($p = 0.38$) in the change of class means on attitudes towards mathematics, and (3) a significant difference at the .005 level, in change of class means on graphing ability favoring the use of computer game. The computer games Algebra Arcade was used with experimental class in lieu of the in-class assignment during the 15-20 minutes at the end of mathematics classes.

Kafai (1996) found that learning about technology and programming supports other type of learning. When students find the games meaningful to their lives, learning and learning about learning takes place. The idea of children making software for fun and learning is definitely not limited to school activities, it has a place at home and in the virtual playground. This activity leads children into thinking and learning in mathematical terms. Children also learn to express themselves in the technological domain by engaging in programming activities, like designing games for younger students to learn mathematics, Programming games are a medium for personal and creative expression.

Educational gaming favours the development of complex thinking skills and problem-solving, planning and self-regulated learning (Rosas et.al.2003).The power behind games is in the concentration of attention of the user to an environment that continuously reinforces knowledge, scaffolds learning, provides leveled, appropriate challenges, and provides content to the learning of content. Bull *et al*. (2003) describe the innovative use of blogs for students' journals, which can be shared with and commented on by other students, linked to outside sites and include photos and texts which can deepen or illustrate the ideas presented. Green and Hannon (2007) indicate that "with the advent of blogging and tools such as wikipedia, young people are just as likely to seek feedback from their peers and strangers as they are from teachers and parents. Solomon and Schrum (2007) described ways in which blogs, Podcasts, Wikis and Photo-sharing can be used in K-12 classrooms, with the objective of providing difficult and challenging activities to entice and engage students.

During the last thirty years, mathematics as an activity has become more experimental and more visual. In line with this development, the computer is a unique tool that has the potential of enhancing both visual and experimental features. The visual medium is widely used as instructional resource as children can learn from viewing and interacting with video and television, viewing video once thought to be a passive process. Video can add rich context to students' learning experience without increasing load on working memory, translating into increase in complex and higher-order thinking.

A study by Ziegler (1990), examining the effectiveness of three different methods of introducing university students to the academic library: *interactive video with learner control;* linear video; and traditional guided tours, found that students who had used the learner-controlled interactive video scored *significantly higher* than other students on measures of recall learning and self-perceived effectiveness at using the library.

Woodruff and Heeler (1990), working on a unique application of interactive *videodisc technology* to administer aural tests to university students taking a music appreciation course, found that the students who took the aural tests received significantly higher grades on unit tests than other students. Two groups were given study guides that identified aural objectives and specified the location of the musical examples for study … (One group) was required to take aural tests over each unit in a supervised computer laboratory… The (other) group did not take (the tests).The testing followed a competency-based method developed by *Keller (1968)*, which has proved successful in science education (Kulik, Kulik and Carmichael, 1974).

Vitale and Romance (1992), examining the effectiveness of videodisc Instruction plus supplementary activities focusing on core science concepts with female elementary education majors found that the students who used the videodisc and participated in the supplementary activities demonstrated significantly higher achievement on a test of application of science concepts. One group of students received conventional science methods instruction. The other group followed the same syllabus but also received videodisc-based lessons, completed corresponding workbook activities and prepared and presented model science lessons. Kitz and Thorpe (1992), comparing the effectiveness of *videodisc-based algebra instruction* to conventional instruction using a textbook with learning disabled adults preparing for college revealed that students using the videodisc significantly outscored the students using the textbook on two different tests of algebra achievement.

Johnson (1993) comparing the effects of three instructional approaches for teaching college-level lessons in human resource development; that is, conventional lecture-demonstration; interactive video with students handling the computer controls; and interactive video with the instructor handling the computer controls found no significant achievement differences between students who directly controlled the computer and those who did not, though both videodisc approaches resulted in *significantly higher* levels of student achievement than conventional instruction in a test of initial learning and a delayed test to measure retention.

Bitter and Hatfield (1993), comparing the effects of two methods for teaching about the use of geoboards to elementary education majors, as part of mathematics methods courses revealed that while both groups showed achievement gains in knowledge of geoboards as an educational tool, students receiving *videodisc-based* instruction demonstrated *significantly higher* gains. Both approaches began with instructor-led lessons. For one group of students, this was followed by *videodisc-based instruction* and for the other group, the follow-up consisted of cooperative, hands-on experiences with geoboards and discussion of the application of geoboards to classroom teaching.

Viesulas (1994), comparing the impact of demonstrations of standard chemistry experiments via video and via live lecture presentation, showed that students who watched the *video demonstrations* received *significantly higher* grades on their lab reports as well as on the mid-term and final examinations and that they also completed experiments in less time, with fewer equipment breakages. Video offers the advantages of allowing each student a closer view of the presentation, permitting replay of any segment as needed. Cavanaugh (2001),in his synthesis of 19 experimental and quasi-experimental studies of the effectiveness of interactive distance education using video conferencing and telecommunications for K-12 academic achievement, found a small positive effect in favour of distance education and more positive effect sizes for interactive distance education programs that combine an individualized approach the traditional classroom instruction.

Boster, Meyer, Roberto and Inge (2002), examining the integration of standards-based *video clips* into lessons developed by classroom teachers found increase in student achievement in a study of more than 1,400 elementary and middle school students in three Virginia school districts, showing an average increase in learning by students exposed to the video clip application compared to students who received traditional instruction alone. Lehrer (1993), in a study of eighth graders using a *hypertext/ multimedia* tool to design their own lessons about the American civil war, revealed that the scores of students using the *multimedia tool* did not differ from the scores of the control group on a test given at the completion of the lesson. However, when tested one year later by an independent interviewer, the *multimedia group* displayed elaborate concepts and ideas that they had extended to other areas of history. In contrast, the control group of students remembered almost nothing about the historical content of the civil war lesson. The results reveal that multimedia tends to have long term effects on understanding and retention.

A study of the use of multimedia in the mathematics classroom, conducted by Phillips and Pead (1993) found no such evidence and concluded that learning through the use of multimedia appeared to be a natural continuation of the evolution of ideas for teaching with computers that took place in the 1980's. While the study extended over 2 years and a free choice of software titles was used by teachers in 7 schools spread throughout England, only a small sample of teachers (14) was used, the researchers admitting that while the software materials used were diverse, they could not be said to represent all multimedia materials used in mathematics teaching. Therefore, they felt that some caution is needed in drawing the conclusions.

Bell and Bell (2003), identified over 200 published texts dealing with the use of ICT in science education from 1994 to 2002. From their search they concluded that teacher educators are unfamiliar with the literature that has been published because it is situated in journals that are not familiar to most science educators. If science teacher educators are unaware of the findings of research into ICT in science education and hence of the affordances of various types of ICT for learning science, there is little hope that many science teachers will be adequately knowledgeable about the value of ICT in their teaching.

Keys and Watters (2006), in a study to determine if the beliefs of elementary pre-service teachers had been influenced by the provision of an interactive CD ROM of modeled case studies of teaching science through a grounded theory approach using constant comparative analysis, revealed that the modeled practices by themselves made little impact on the pre-service teachers' beliefs and practices. The twenty-four pre-service teachers in the study continued to use traditional teaching approaches in their lessons, at the same time, they espoused the concepts of constructivism. Therefore, as an outcome of this study, it provides a transformative learning model that uses multimedia and ICT as a strategy in bringing about conceptual change in pre-service teachers' beliefs which has application and implications for professional development for in-service teachers, as well as.

Text-to-speech feedback in a *word-processor* or interactive story book can improve early reading (Olson and Wise, 1992; Olson, 2007). Voice input and text feedback (Miles *et al*., 1998) can also improve pupils' reading and writing. These studies also indicate the importance of matching the tasks on a computer to pupils' current attainment. Moseley *et al*. (1999) in their collaborative research project working with teachers to help them make more effective choices about when, when not and how to use ICT in their teaching of literacy and numeracy, found that software enabled teachers to show ideas dynamically – for example, when showing suffixes joining with root words. Pupils were *motivated* to read more and in doing so, extending their vocabulary using ICT texts such as word processors with speech facilities.

While the project demonstrated that ICT can be part of raising attainment dramatically, the researchers stressed that these gains cannot be attributed to the use of ICT alone and must be taken in the wider context of learning and teaching. However, students writing development was accelerated and enhanced by *access to word processing* and there was an average improvement in literacy of 5.1, month by month. (U.K.).

Bresse *et al*. (1996), investigating the effects of unlimited *access to word processors* on students writing over a period of 20 months, found that students using word processors showed significant improvement over those using pen and paper. Each of the seven 22 year students was given a laptop to use for all their writings in English Lessons and the samples of their narrative writings were compared with the samples from a parallel class who only used hand writing methods.

Several studies found evidence for the benefits of animated graphics. Calvert, Watson, Brinkley and Penny (1990) experimented with different versions of a graphic "micro world" designed for young children's language development. ...a computer screen depicted a park scene that had a green grassy area, a blue lake, able sky, a black train track and a brown road. Twenty-four... objects...could appear by...typing...the word for the...object. Szabo and Pochkay (1996) found that university students in a mathematics education class learned better from *animated illustrations* than from *static graphics or text* only description. On the post-test, which included a hands-on *triangle construction* problem and multiple choice questions, students who read text and viewed *animated graphics* showing how to construct a triangle using a compass *performed* *better* than students who read a text explanation only or students who read a text explanation accompanied by static graphic illustrations.

Smith (1996) reported that developmental mathematics students at a community college learned significantly more from an-hour *animated software* tutorial on *matrix Algebra* than from a *static one*. Animation was used mostly to highlight symbols, objects, and "Morphing of addition elements and multiplication factors into sums and products." Students could stop or repeat animation or alter the variables from a menu. A third (control) group read for an hour from a commercial algebra text. Smith found that both the static-CAI and the animated-CAI students performed *significantly better* than the text group on the immediate post-test. Animation seems to have had a *positive impact* on content retention for students in this study.

The three Chang studies, using multimedia computer facilities, including guided inquiry, animated weather-satellite images, virtual field trips and internet usage sought to evaluate different pedagogical approaches. Chang (2000), the author investigated the comparative efficiency of computer-assisted instruction (CAI) and traditional teaching methods in Earth Science classes in Taiwan. The focus of learning was on knowledge (the recall or recognition of ideas or concepts), comprehension, and the students' ability to apply acquired knowledge to a new situation. Guided inquiry provided by a computer programme allowed tenth-grade students to work individually with a range of provided resources, video, animated weather maps, books, and so on in a virtual research office to prepare a research report on debris flow hazards following a typhoon.

Chang (2001) formalized a problem-solving computer-assisted tutorial, involving *lecture-internet-discussion* teaching, with a focus of learning on the recall or recognition of ideas or concepts, comprehension and the students' ability to apply acquired knowledge to a new situation. The software, included relevant data, a virtual field trip and animated weather maps provided guidance for interactive investigation. Students in the comparison group were given clear and detailed instruction and explanations by the teacher on the same topic and used the internet to control for *'Computer-novelty effects'.*

Othman et.al. (2005) conducting a study to examine the effects of computer-animated instruction (CAnI) on a group of students' conceptual change progress by teaching complex, *abstract and dynamic (CAD)* concepts of electro-chemistryat a matriculation centre in Malaysia showed that the CAnI approach was found to have a positive effect on their overall performance in electro-chemistry and also on the students' conceptual change progress and an effective alternative instructional method in the understanding of CAD concepts. The study used an experimental pre-test and post-test control group design and open-ended questionnaires to collect data and responses from the CAnI and the CLI groups respectively. 120 subjects, comprising 60 high and 60 low achiever students were randomly chosen from the total research populations of 250 students and subjects were randomly assigned to a CAnI or a CLI group. Data collected from the post-test were analysed to examine the statistical significance of differences amongst the CAnI and the CLI groups. The website is integral to both the courses as participants build their own functional web pages on the server. The website also is integral to building continuing support of the mathematics teachers after the courses. The website is user-friendly, featuring simple but elegant navigation. This helps to promote understanding of the concepts as well as the skills needed to optimize use of the Internet as a teaching-learning tool.

2.9 Implications of Literature Reviewed on the Present Study

The above discussions and literature considered have implications on the present study as well as the teaching and learning of mathematics in senior secondary schools in

Bauchi, north-eastern state of Nigeria. This is because most of the studies claimed consistence trend for pupils and students in schools with better ICT resources to achieve better grades for English, Mathematics and Sciences. This study perhaps could have a correlation with their findings. An impact Study (Cox, 1993) including a large scale investigation into the effects of ICT on children's achievements, found that effective use of IT required substantial demands in terms of [teachers'] knowledge and understanding of, and familiarization with a variety of software in order to integrate the activity, in philosophical and pedagogical terms, with a larger scheme of work. The research methods related to three components: an assessment of pupils' achievements through MAT which is considered valid for this work.

Becta (2000) investigated the relationship between ICT resources and pupil attainment in primary and secondary school and found a consistent trend for pupils in schools with better ICT resources to achieve better grades for English, Mathematics and Science. More than half of the schools with very good ICT resources were achieving above the national standards in science, compared with less than a third of schools with 'poor' ICT resources. There were similar results for English and Mathematics. Schools with very good ICT resources were found in a similar range of social contexts as schools with poor ICT resources. The present study intends to find the dividing line.

Goodison (2002) investigated the UK primary school children's awareness of the linkage between ICT and the way they learn within the context of a school that has been particularly successful in integrating ICT into the curriculum. Pupils were interviewed by their teacher and extracts from the dialogue, identified examples of good practices. Results of the study illustrate that ICT can make contributions to the promotion of independent learning which the current study investigates at higher schools.

Allan *et al*. (2003), reporting the findings of an analysis on models of change in 18 schools striving to integrate the use of ICT in teaching and learning across the school curriculum, showed that the strategy adopted by a school in instituting such a change and resulting variation of pedagogical practices using ICT is strongly dependent on the school leaders' vision and understanding of the role and impact of ICT in the curriculum, their goals and objectives for ICT integration, as well as the history, culture and background of the school and its general vision and mission. Could this not be a narrow bridge for a truck carrying tones of concretes, this study investigates.

Osborne and Hennessy (2003), reviewing the current state of science education, the impact of ICT use on the curriculum, pedagogy and learning and the implications for future practice, considered how ICT can be employed flexibly to support different curricular goals and forms of pedagogy. They revealed that there are diverse ways of linking ICT use to existing classroom teaching, including supporting or replacing it, suggesting further that transformative use of ICT in science is found only in isolated pockets as technology is not yet embedded in the culture and practice of many science teachers. They hinted that the content oriented National Science Curriculum hindered the development of classroom use of ICT, but as the science curriculum moves towards a greater emphasis on scientific reasoning and analytical skills, there would be more opportunities for ICT to play a key role in Science Education. The uniqueness of the current study lies in the fact that ICT is penetrating into the culture and practice of many teachers hence the need to transform this to effective teaching and learning strategy.

Hennessy *et al*. (2001) investigated teachers' and students' changing roles and strategies in the context of using various forms of computer-based *information and communication technology* to support subject teaching and learning at secondary level. One hundred and fifteen teacher researchers participated in a collaborative programme of small-scale, classroom-based projects involving development, evaluation and refinement of new pedagogic approaches, strategies and activities in six curriculum areas. An analysis was conducted across the case study data derived from lesson observations; follow up teacher interviews and teachers' written research reports. While interactions with individual students and small groups were increased and reportedly successful, mediating interactions between students and technology through whole-class interactive teaching, modeling and discussion appeared to be under-developed. The in flush of ICT in the society in recent times could have affected their position among others as this study investigates uniquely.

Baurer and Kenton (2005), in their qualitative study about technology integration in the schools to examine the classroom practice of 30 *"Tech-Savvy"* teachers who used computer technology in their instruction, found that though the teachers were highly educated and skilled with technology, were innovative and adept at over-coming obstacles, yet they did not integrate technology on a consistent basis both as a teaching and learning tool, perhaps for two major reasons, that is, the students did not have enough time at computers and teachers needed extra-planning time for technology lessons, besides concerns like outdated hardware, lack of appropriate software, technical difficulties and students' skill levels. This would be considered in this study as we enumerate challenges for effective impact.

Chong*et* al. (*2005*), in a survey to study the barriers preventing the integration and adoption of information and communication technology (ICT) in teaching mathematics, identified six major barriers, that is lack of time in the school schedule for projects involving ICT; insufficient teacher training opportunities for ICT projects; inadequate technical support for these projects, lack of knowledge about ways to integrate ICT to enhance the curriculum; difficulty in integrating and using different

ICT tools in a single lesson; and unavailability of resources at home for the students to access the necessary educational materials. To overcome some of these barriers, it proposed an e-portal for teaching mathematics. The e-portal consists of two modules: a resource repository and a lesson planner. The resource repository is a collection of mathematical tools, a question bank and other resources in digital form that can be used for teaching and learning mathematics. The lesson planner is a user-friendly tool that can integrate resources from the repository for lesson plan. If any, this study intends to investigate the effects of ICT especially PowerPoint animated presentation as instructional material before recommending e-portal approach in the teaching and learning of mathematics.

Ololube (2006), set out to identify and evaluate how the relevant strategies, professional and non-professional ICT instructional material utilization competencies play in stimulating students' academic achievement during and after instruction, revealed that there are significant differences in effectiveness between professionally trained teachers and untrained teachers in their ICT instructional material utilization competencies. To achieve the purpose of this study, several sets of statistical analysis were conducted using SPSS version 11.5 of a computer programme: Mean and Standard Deviation, ANOVA, t-test of significance and cross tabulation (N=300). This was done on teachers, however it is timely now to determine the effects of ICT on students' geometry performance.

Higgins and Moseley (2001), in a study of teachers' attitude towards ICT and an investigation into the correlation with pupil attainment constructs relating to teaching and learning elicited from 75 primary school teachers, revealed that professional development needs to take into account teachers' thinking about teaching and learning generally, and also the year group taught. Self-ratings on constructs related to ICT and learning were compared with pupil outcome data, questionnaire information about classroom practice, and teachers' self-reported levels of ICT skill. Consistent patterns of thinking emerged, as did clear differences in how these predicted pupil progress by the year-group taught. There were also links between the way teachers reported that they used computers and the relative pupil progress data from the performance indicators in Primary School Project (PSP) at Durham University, but only when examined by year group: amongst reception teachers, skepticism as to the value of ICT was a positive indicator of pupil's progress, whereas for year 2 and 4 teachers, favouring the use of ICT was associated with pupils' progress. What would be the effect of ICT method on the year group thought is among the focus of this research work.

Experimental results regarding access to computers without additional instruction, provided by Gardner *et al*. (1993), who supplied 235 students with a *personal Laptop* for an entire school year and matched them to a control group that did not receive computers, found no significant differences between the two groups, suggesting that mere access to computer technologies without concurrent changes to instruction is not sufficient to effect achievement. Instruction was same for both the groups, and their performance in English, mathematics, and science was measured after the year. However, this study uses ICT (PowerPoint package) as instruction material in the hand of competent teachers.

ICT might be more the less quite powerful in presenting or representing information in different ways and through different forms *(text and pictures or tables and graphs)* or by enabling changes to be shown dynamically such as in mathematical *modeling* or by helping *visualization* of complex processes in science. Information can be manipulated easily on a computer so that a pupil can make changes and evaluate the effect of those changes. This can be where the information is of the same type such as text in *word- processing (*Snyder, 1993; Breese *et al*., 1996) or number of *spread sheets* (Mann and Tall, 1992). It may be important, however, not to teach skills in isolation. Multimedia presentation in the form of talking books has been shown to improve beginning readers' phonological awareness but without improving their word recognition (Chera and Wood, 2003). An interpretation of this might be that children get better at playing the computer *'game'* (as they set it) but that the improved skills are not readily used away from the computer.

Historically, research results on the use of *calculators* in mathematics have been mixed. However, after the graphing calculator was introduced in the 1980s, results were increasingly more positive. In the United States, the National Council for Teachers of Mathematics credited the graphing calculator for "the emergence of a new classroom dynamics in which teachers and students become natural partners in developing mathematics ideas and solving mathematical problems,"especially in algebra and higher mathematics (Interactive Educational Systems Design (IESD) Inc. , (2003). In general, literature suggests that the use of calculators improved learning in three areas: understanding of graphical concepts; the ability to make meaningful connections between functions and their graphs, and enhanced spatial skills (Penglase and Arnold (1996).

Pennington (1998) in Kastberg and Leatham (2005) investigating the value of providing access to calculators and of providing instruction on how to use calculators (in addition to access) for increasing middle school students' mathematics test scores, found that seventh and eighth-grade students using calculators outperformed students without calculators on a test of basic mathematics skills, whether or not the students were instructed in how to use the calculators. Wetzel (2001), investigating the factors that influenced five middle school science teachers as they implemented and integrated

Calculator-Based Laboratory *(CBL)* probe ware in the curriculum, found that 80 per cent of participating teachers successfully integrated CBL probe ware into their teaching.

The study involved empirical research both with qualitative and quantitative data, through interviews, questionnaires, anecdotal records and observations of teachers, presenting a holistic view of the influences on the level of teachers' technical proficiency with CBL probe ware, level of actual use during integration into the curriculum, changes in pedagogy, changes in organizational culture, and curriculum transformation related to CBL probe ware. The study also identified the contextual barriers of integration, including training in the use of technology and pedagogical support. This is one of the reasons that the current research would take into consideration the Technology Pedagogical Content knowledge (TPACK) as a holistic requirement in the teaching and learning of mathematics.

Bett's (2003), assessing the extent to which ICT contributes to quality in learning in science at key stage 3, found that ICT can enhance the quality of learning where its use is tailored to lesson objectives and the needs of pupils. Considering the meaning of quality in the context of science education, it also identified some of the indicators of quality and drawing on data from tests, interviews and observations, examined how ICT affected pupils' understanding, their motivation and use of learning strategies as well as their mental engagement and the context for their learning. The study would like to compare the claim above.

According to Means *et al*. (2009), student motivation is enhanced through *online* collaborative research that includes online communication with peers and experts in other states and countries, evaluation of evidence and sharing of information and the use of standards-based curricula that are integrated with scientific visualization tools.

Project GLOBE engaged K-12 students from schools in 34 countries in gathering data about their local environments. Students in the GLOBE classrooms demonstrated higher knowledge and skill levels on assessment of environmental science methods and interpretation of data than did their peers who did not participate in the program. A general opinion that mathematical and scientific knowledge is universal may equally be the investigation of this study as the above study claimed.

The most significant research study on the motivational effect of ICT on pupils Passey *et al*. (2004), aiming to identify and, where possible, to quantify impact and to relate it to aspects such as learning outcomes, behaviour, school attendance, truancy, antisocial behaviour and uses of digital content, found that ICT helped to draw pupils into more positive models of motivation and could offer a means by which pupils could envisage success. All of the secondary school teachers involved felt that ICT had a positive impact on pupil interest in and attitudes to school work. Pupils took greater pride in their work and it was more likely that tasks were completed and on time.

The study drew on a range of theoretical stances, problematizing the concept of motivation and identifying a number of different dimensions. It defined eight measures that could be used to identify and quantify these – learning goals, academic efficacy, identified regulation, intrinsic motivation, performance approach goal, performance avoidance goal, external regulation and motivation. Each of these is based on usually implicit reasons pupils might have for engaging with tasks in the context of school. For the first four, high levels of measurement produce a positive learning profile while for the last four, low levels are desirable. The measures formed the basis of pupil questionnaires and motivational profiles constructed from the responses. The study also found that, when working with ICT pupils, learning was characterized by high levels of motivation towards achieving personal learning goals – a desirable outcome – but also high levels of motivation towards gaining positive feedback on individual competence (performance approach goals) -which was less desirable. While environmental ecstasy might be an experience, would there be individual performance in terms of the GPT to measure the effect of the ICT method, this study is out to investigate.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The study aimed at investigating the effects of the use of Information and Communication Technology (ICT) on the students' academic performance and retention in geometry at senior secondary school level. The methodology is presented under the following sub-headings;

3.2 Research Design

3.3 Population of the Study

3.4 Sample and Sampling Procedures

3.5 Instrumentation

3.6Validation of the Instrument

3.7 Pilot Testing

3.8Reliability of the Instrument

3.9Item Analysis

3.10 Administration of Treatment

3.11 Data Collection Procedure

3.12 Data Analysis

3.2 Research Design

This study was quasi-experimental in nature. It was non- equivalent pretest, posttest, post-posttest control group in design. This design was adopted because it is not possible to undertake true experiment in social sciences. There was no randomization of subject since this might disrupts school organization, hence, intact classes of SS II students were randomly assigned to experimental and control groups respectively. The experimental group was taught through ICT used teaching method and the control group through lecture method. The intact groups were tested for homogeneity in terms of academic performance, gender and retention. The research design is illustrated in Figure 3.1.

$$\mathbf{E_G} \longrightarrow \mathbf{O_1} \longrightarrow \mathbf{X_1} \longrightarrow \mathbf{O_2} \longrightarrow \mathbf{O_3}$$

$$\mathbf{C_G} \longrightarrow \mathbf{O_1} \longrightarrow \mathbf{X_0} \longrightarrow \mathbf{O_2} \longrightarrow \mathbf{O_3}$$

Figure 3.1 Research Design Illustration

$\mathbf{E_G}$ = Experimental Group; $\mathbf{C_G}$ = Control Group; $\mathbf{X_1}$ = Treatment (ICT); $\mathbf{X_0}$ = Lecture Method; $\mathbf{O_1}$ = Pretest; $\mathbf{O_2}$ = Posttest; $\mathbf{O_3}$ = Post post test.

3.3 Population of the Study

The targeted population of this study comprised of all state owned Senior Secondary Schools in Bauchi State, metropolis. The total population of eight thousand two hundred (8,200) SS II students comprising four thousand six hundred and forty-five (4,645) males and three thousand five hundred and fifty-five (3,555) females. Nineteen (19) out of these twenty-four (24) schools were coeducational with six thousand one hundred and eighty-nine (6,189) students and only three schools did not separate their classes gender wise which make a total of one thousand seven hundred and forty-three (1743) students. The schools with ICT capacity were thirteen (13) with the total of six hundred and eight (608) computers. The details of the population is presented in Table 3.1.

Table 3.1: Population of the Study

S/N	Sch.	Location	Male SSII	Female SSII	Total	ICT Capacity
1	Comm. Day Sec. Sch.	Durum	73	86	159	NIL
2	Comm. Day Sec. Sch T/Gambo	Tirwun	103	75	178	NIL
3	Govt. Day Sec. Sch.	Army Barrack	489	498	987	12
4	Govt. Day Sec. Sch.	Bakari Dukun	124	135	259	NIL
5	Govt. Day Sec. Sch.	M/Liman Katagun	69	24	93	NIL
6	Govt. Day Sec. Sch.	Miri	105	28	133	NIL
7	Govt. Day Sec. Sch.	Tudun Salmanu	140	100	240	NIL
8	General Hassan Usman Katsina Unity Col.	Yelwan Tudu	614	0	614	33
9	Govt. Girls Col.	Ran Road	0	389	389	133
10	Govt. Girls Science Sch.	Liman Katagun	0	541	541	112
11	Govt. Day Sec. Sch.	Luda	68	12	80	12
12	Govt. Day Sec. Sch.	Gwallameji	137	154	291	NIL
13	Govt. Comp. Day Sec. Sch.	Balewa Estate	225	114	339	33
14	Govt. Day Sec. Sch.	Bayara	220	245	465	112
15	Govt. Day Sec. Sch.	Games Village	640	310	950	NIL
16	Govt. Day Sec. Sch.	Lanzai	0	0	0	NIL
17	Govt. Day Technical Col.	K/Wambai	341	79	420	50
18	Govt. Day Sec. Sch.	Kofar Wambai	350	158	508	33
19	Govt. Day Sec. Sch.	Kofar Idi	832	494	1326	33
20	Govt. Comp. Day Sch.	Bauchi	0	0	0	NIL
21	Govt. Day Senior Sec. Sch.	Jahun	0	0	0	NIL
22	Jibrin Aminu Model Sec. Sch.	GRA/Dogoyaro	75	52	127	33
23	Married Women Sec. Sch.	Jahun	0	47	47	NIL
24	Special Education Centre	Yelwan Tudu	40	14	54	12
Total			**4645**	**3555**	**8200**	**608**

Source: Ministry of Education (MOE), Bauchi, Bauchi State (2015).

3.4 Sample and Sampling Procedures

Stratified samplingwas adopted in this study which is a commonly used probability method that is superior to random sampling because it reduces sampling error. The researcher first identifies the relevant stratums and their actual representation in the population. Random sampling is then used to select a *sufficient*intact class from each stratum. *Sufficient* refers to a sample size large enough for us to be reasonably confident that the stratum represents the population.

In this study, 19 out of 24 schools were coeducational out of which only 3 did not separate their classes by gender (Those 3 comprise of 1743 students) and 2 of them were randomly selected so as to equally investigate the gender effect of the ICT. Each of the selected schools has four intact SS II classes and a sample of two intact classes of senior secondary school II students was drawn randomly by ballot, one from each coeducational schools within Bauchi metropolis notwithstanding the availability of computer laboratories since the researcher prepared for the required equipment. The details of the two selected schools used as the experimental and control groups is presented in Table 3.2.

Table 3.2: Sample for the Study

S/N	Groups	Boys	Girls	Total
1	Experimental	46	28	74
2	Control	32	22	54
Total		**78**	**50**	**128**

The sample could have been considered small for the result of the study to be generalized, but an experimental study is normally much more suitable on a small sample as substantiated by several investigations conducted through experimental design. Krulger (1999) and Angrist & Lavy (2004) among others provided evidence in favour of positive and significant effect of small sample classes in experimental studies. Similarly, Arias and Walker (2004) in an experiment conducted to test the relationship between class size and students' academic performance, controlled variation in instruction, lecture material, and topic coverage using the same instructors. Their results were quite statistically significant showing that small class size had a positive impact on student performance.

3.5 Instrumentation.

The instruments used for the study are:

1. The Intelligent or Ability Status Test on geometry known as Pretest
2. The Geometry Performance Test referred to as Post test
3. Retention Test known as Post post test

3.5.1 Ability-level Test

The stage involved pre-testing of all the students of both groups (after an earlier familiarization tours with the students) on their ability level or intelligence and academic performance in geometry. This was done to determine the status or the ability level of the students on their understanding of the concept of geometry through the use of Geometry Performance Test (GPT).

3.5.2 Geometry Performance Test

The posttest stage involved the experimental treatment, which consisted of five subunits of senior secondary geometric mathematics, that is; cuboids, cylinder, cone, sphere and hemisphere taught through ICT-based teaching and through traditional teaching to control group for six (6) weeks. On the conduct of the experiment, the instructional treatment was given to the experimental group, whereas the control group was taught by the lecture method. The same content was taught to both groups and the researcher taught both the control and the experimental groups on areas, volumes and other parameters of the selected solid shapes popularly known as mensuration.

Immediately after the instructional treatment was over, the researcher tested the subjects of experimental group and control group on the dependent variable (academic performance in geometry).Time allowed for the GPT was one hour thirty minutes which was an extension of time spent during pilot testing with additional ten minutes. The answer sheets scored with the help of scoring key. The scores indicated the previous knowledge possessed by the students and their performance in geometry.

3.5.3 Retention Test

This stage dealt with post-post testing of the control and experimental group after two weeks of the post testing using the Geometry Performance Test reshuffled to determine the effect of the treatment on the students' retention ability in geometry.

3.6 Validation of the Instrument

The Researcher prepared a thorough study on, lateral and surface areas and as well volumes of solid to validate the topics that was taught to both groups by making the chart of specification, and by considering the technique of paper setting for different understandings, for example 15% for difficulty, 70% for average, and 15% for easy levels. This instrument was validated by three independent experts (three Professors, two in Mathematics education and one in educational measurement and evaluation).Although the items of the instruments above were in three categories, they were all objective questions and carrying equal mark each. Based on the suggestions of these experts, the necessary corrections were made especially similar questions 74 and 77 of initial Appendix C removed, questions 4 and 55 reframed to avoid confusing language, avoidance of 'none of the above' as option, more operational questions created and properly formatted.

3.7 Pilot Testing

Pilot study was conducted in order to ascertain feasibility of conducting the present study. Content and face validating were taken care of and provided ground for the real study. The reliability coefficient of 0.86 was found significant. The findings enabled the researcher to fine tune the instrument and adjust the set time of the test with extra 10 minutes. He equally made provision for power generator to bridge the gaps experienced during the study. International Secondary School of the Abubakar Tafawa Balewa University Bauchi's SS II students were used for the pilot study. The pilot study involves a group that has the same characteristics with the research sample, but not necessarily involved in the main study (Angrist and Lavy, 2004).

3.8 Reliability of the Instrument

The Geometry Performance Test (GPT) composed of 76 items in various difficulty levels from five areas of senior secondary school geometry was used and had reliability coefficient of 0.86 using split-half (odd-even) method. In this method the score obtained from each individual was divided into two groups by pooling the odd number items and even number items, ranking them and obtained the sum of the squares of the deviation of the ranks. Spearman-Brown prophecy method was applied to find out the coefficient of reliability from the comparable values of the post-test at 0.5% levels of significance (see Appendix E).

3.9 Items analysis

The Geometry Performance Test (GPT) composed of 76 items in various difficulty levels from five areas of secondary school geometry was used. The Researcher prepared a thorough study on, lateral and surface areas and as well volumes of solid to validate the topics that was taught to both groups by making the chart of specification, and by considering the technique of paper setting for different understandings, for example 15% for difficulty, 70% for average, and 15% for easy levels.The following formula isused to finddifficulty level.

D. L= R_u+R_l/N_u+N_l or $\frac{Ru+Rl}{Nu+Nl}$Where,

R_u= the number students in the upper group who responded correctly

R_l= the number students in the lower group who responded correctly

N_u = Number of students in the upper group

N_l = Number of students in the lower group

The Geometry Performance Test (GPT) composed of 76 items drawn from WAEC, NECO, JAMB and other relevant past questions. These were validated by three experts (professors in the Faculty of Education) and subsequently pilot tested with reliability coefficient of 0.86. A total of 80 objective type items validated to 76 items were constructed from five units of mathematics (geometry)syllabus depicting the SS II curriculum by Nigerian Education and Research Development Council (NERDC) reflecting the objectives of the programme in conformity with the Blue-print of the table of specification. In order to facilitate objectivity in scoring, the **76** validated items that constituted the Geometry Performance Test, scoring keys were prepared separately for Multiple Choice Questions, Fillin the Blanks and True and False Questions. The details of items specification is presented in Table 3.3.

3.10 Administration of Treatment

The study involved three operational stages as identification stage, treatment stage and post-testing stage. The first stage involved pre-testing of all the students of both groups on intelligence and academic performance in geometry. The second stage involved the experimental treatment, which consisted of five subunits of senior secondary geometric mathematics, that is; cuboids, cylinder, cone, sphere and hemisphere taught through ICT-based teaching and through traditional teaching to control group for six (6) weeks. The third stage dealt with post testing and post-post testing of the control and experimental group using the Geometry Performance Test to determine the effect of the treatment on the students' academic performance and retention ability in geometry.

On the conduct of the experiment, the instructional treatment was given to the experimental group, whereas the control group was taught by the lecture method. The same content was taught to both groups and the researcher taught both the control and the experimental groups on areas, volumes and other parameters of the selected solid shapes popularly known as mensuration. Time allowed for the GPT was one hour thirty minutes which was an extension of time spent during pilot testing with additional ten minutes. The material used for the control group was a comprehensive lesson plans from the senior secondary school mathematics curriculum and that of the experimental group involved ICT facilities like LCD projectors, slide screens, laptops computer and with the help of MS Animation Clips the researcher presented content specification prepared on PowerPoint application slides. The sequence of the steps is detailed in APPENDIX A and the Figure 3.2 showed the flowchart of the steps of the treatment presentation.

Topics	**Knowledge =10%**	**Comprehension =21%**	**Application =44%**	**Analysis =10%**	**Synthesis =8%**	**Evaluation =7%**	**100 %**
Cuboids	2	4	8	2	2	2	**20**
Cube	1	3	5	1	1	1	**12**
RightCircular and Cylinder	1	3	7	1	1	1	**15**
RightCircularCone and Frustum	1	2	3	1	1	1	**9**
Spheres and Hemispheres	2	4	9	2	2	1	**20**
Total	**8**	**16**	**33**	**8**	**6**	**5**	**76**

Table3.3: Specification for Geometric Performance Test

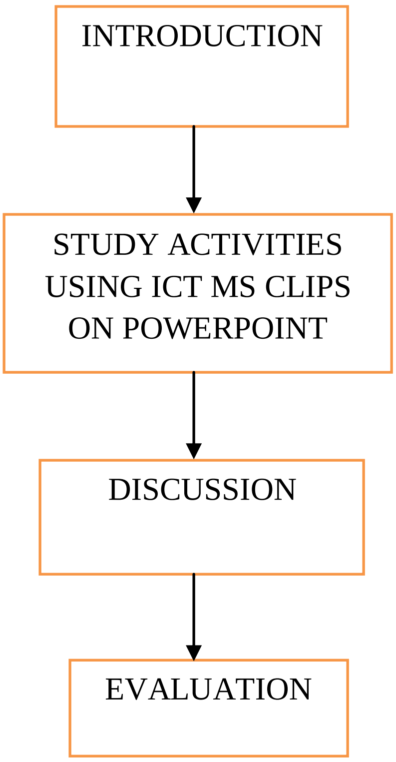

Figure 3.2: Flowchart ICT Model.

Source: (Lewis, 2002; Price and Nelson, 2003).

3.11 Data Collection Procedure

The researcher sought permission from the Bauchi state Ministry of Education to conduct this research, and the approval was given.The researcher taught both the control and the experimental groups on areas, (curved, lateral surface, total surface area) volumes and other parameters of the solid shapes popularly known as mensuration and the treatment of the Geometry Performance Test (GPT) was administered to both experimental and control groups for six (6) weeks and allthe tests conducted at two weeks interval, all in all within the period of eight (8) weeks. The tests scores obtained from pretest, post-test and post-post-test were recorded accordingly and formed the data tabulated for analysis (See APPENDIX D).

3.12Procedure for Data Analysis

To achieve the objectives of the study, the data collected were statistically analyzed using the following techniques: t-tests and two-way analysis of variance (Two-way ANOVA).This statistic handles two or more variables, factors, satisfying the necessary assumptions, affect the dependent variable. Each factor will have two or more levels within it, and the degrees of freedom for each factor is one less than the number of levels. (hence the name two-way ANOVA) This statistic was used to measure the effect of gender on the mean retention and academic performance in geometry of those taught using ICT and those taught using lecture method.

The two types of t-test are the t-test for independent samples and t-test for non-independent samples. Independent samples are samples, which are randomly formed. The members of one group were not related to members of the other than that they were selected from the same population. In a nutshell, the t-test of independent samples was used to determine whether there was probably a significant difference between the means of the independent samples. The following statistics instruments were meant to test their respective hypotheses;

Hypothesis One: There is no significant differences in the mean of students' academic performance scores in geometry taught using ICT and those taught using lecture method.

Statistics: Independent t-test statistics were used to calculate the differences in the mean of students' academic performance scores in geometry taught using ICT and those taught using lecture method.

Hypothesis Two: There is no significant differences in the mean retention ability in geometry taught using ICT and those taught using lecture method.

Statistics: Independent t-test statistics were used to calculate the differences in the mean retention ability of students in geometry taught using ICT and those taught using lecture method.

Hypothesis Three: There is no significant effect of gender on the mean academic performance in geometry of those taught using ICT and those taught using lecture method.

Statistics: Two-way analysis of variance (Two-way ANOVA) was the statistics employed to measure the effect of gender on the mean academic performance in geometry of those taught using ICT and those taught using lecture method. There are two independent variables involved which are called factors in a two-way ANOVA. The idea was that these two variables, factors, satisfying the necessary assumptions, affected the dependent variable. Each factor has two levels within it, and the degrees of freedom for each factor was one less than the number of levels,(hence the name two-way

ANOVA) which was to measure the test within and between the groups (the interaction between sex and group).

Hypothesis four: There is no significant effect of gender on the mean retention ability of students in geometry of those taught using ICT and those taught using lecture method.

Statistics: Two-way analysis of Variance (Two-way ANOVA) was the statistics employed to measure the effect of gender on the mean retention ability of students in geometry of those taught using ICT and those taught using lecture method. There were two independent variables involved which are called factors in a two-way ANOVA. The idea is that these two variables, factors, satisfying the necessary assumptions, affect the dependent variable. Each factor has two levels within it, and the degrees of freedom for each factor was one less than the number of levels,(hence the name two-way ANOVA) which was to measure the test within and between the groups (the interaction between sex and group).

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSIONS

4.1 Introduction

In this chapter, the results obtained from the analysis of the data collected and the discussions of the results are presented. The data collected was analyzed using standard statistical package. The chapter is presented in the following sub-headings.

4.2. Presentation and Analysis of Data

4.3. Summary of Major Findings

4.4. Discussions

4.2 Presentation and Analysis of Data

The major objective of the study was to test the effectiveness of the ICT-used teaching method on the academic performance in geometry of secondary school students. The presentation of data, analysis and interpretations are organized around the research questions and hypotheses of the study. The treatment of the Geometry Performance Test (GPT) for the 128 sampled students was administered to both experimental and control groups within the period of eight (8) weeks. The test scores collected from pretest, post-test and post-post-test were recorded accordingly and formed the data tabulated for the following analysis using relevant statistical techniques. The raw data for the study is presented as APPENDIXD**.** The variables studied in this research are; students' performance, student's retention ability and the gender differential effect of the ICT teaching method. There are two independent variables involved which are called factors in a two-way ANOVA. The idea is that these two variables, factors, satisfying the necessary assumptions, affect the dependent variable. The descriptive statistics on each of the research questions are as follow:

4.2.1: ICT performance in geometry between Experimental group and Control group.

Table 4.1: **Descriptive Statistics on the Mean of Students' Academic Performance Scores in Geometry Taught Using ICT and Lecture Method.**

Groups	N	Mean	Std.dev	Std. Err	Mean Difference
Experimental	74	46.20	3.69	0.43	9.35
Control	54	36.85	7.17	0.98	

The results in Table 4.1 showed that the students exposed to lecture and experimental methods had their calculated academic mean performance as 36.85 and 46.20 respectively, indicating a mean difference of 9.35. The significance of this difference were shown at the test of the hypothesis.

4.2. Retention level on the ICT PowerPoint animation method and lecture method.

Table 4.2: **Descriptive Statistics on the Mean Retention Ability of Students in Geometry Taught Using ICT and Those Taught Using Lecture Method.**

Variable	Groups	N	Mean	Std.dev	Std. Err	Mean Difference
Retention Ability	Experimental	74	40.89	9.14	1.06	4.89
	Control	54	36.00	7.32	1.00	

The results in Table 4.2 showed the students exposed to lecture and experimental methods and their calculated mean retention ability were 36.00 and 40.89 respectively, indicating a mean difference of 4.89. Although this showed a higher value, the decision and significance of the difference could only be determined by the test of the hypothesis.

4.2.3: Gender on ICT PowerPoint method and Lecture method

Table 4.3: **Descriptive Statistics on Gender on the Mean and SD of Academic Performance in Geometry of Those Taught Using ICT and Those Taught Using Lecture Method.**

Sex	Group	N	Mean	Std. Deviation	**Mean Difference**
	Experimental	28	44.16	4.10	
Male	Control	22	36.39	8.56	7.77
	Total	50	40.74	7.47	
	Experimental	46	47.45	2.81	
Female	Control	32	37.17	6.16	10.28
	Total	78	43.23	6.76	
	Experimental	74	46.20	3.69	
Total	Control	54	36.85	7.17	9.35
	Total	128	42.26	7.13	

The results in Table 4.3 showed the male and female students exposed to lecture and experimental methods in the academic performance in geometry. The mean calculated for the control group is 36.39 and that of the experimental is 44.16 (with mean difference 7.77), likewise the standard deviation of the experimental group, 4.10 is lower than that of the control group 8.56 which showed that the mean performance of the male in the experimental is higher than that of the control group. Similarly, the mean calculated for the control group of female is 37.17 and that of the experimental is 47.45(with mean difference 10.28) and the standard deviation of the experimental group 2.81 is lower than that of the control group 6.16 which showed that the mean performance of the female in the experimental is higher than that of the control group. The test of significance is determined by the result of the hypothesis.

4.2.4: Gender in retention ability using ICT method and Lecture method

Table 4.4: **Descriptive Statistics on Gender on the Mean and SD of Students' Retention Ability in Geometry of Those Taught Using ICT and Those Taught Using Lecture Method.**

Sex	Group	N	Mean	Std. Deviation	**Mean Difference**
Male	Experimental	28	42.82	7.55	9.96
	Control	22	32.86	7.85	
	Total	50	38.44	9.09	
Female	Experimental	46	39.72	9.88	1.56
	Control	32	38.16	6.18	
	Total	78	39.08	8.55	
Total	Experimental	74	40.89	9.14	4.89
	Control	54	36.00	7.32	
	Total	128	38.83	8.73	

The results in Table 4.4 revealed the mean retention ability of male and female students exposed to lecture and those exposed to experimental methods. It showed that among the males, their retention abilities were 32.86 and 42.82 by lecture and experimental groups respectively (with mean difference of 9.96). Among the females, their mean retention abilities were 38.16 and 39.72 (with mean difference of 1.56) by lecture and experimental method respectively. The determination of the significance of difference was shown by the test of hypothesis.

4.2.5Test of Hypotheses

In order to find out the relative effectiveness of ICT-used method and Traditional method of teaching, the scores of students on criterion measures were obtained before commencement of the experiment and after the treatment. Post post-test scores were also obtained to determine retention ability of the students. The hypotheses were tested as follows;

Hypothesis One: There is no significant differences in the mean of students' academic performance scores in geometry taught using ICT and those taught using lecture method.

Table4.5: **Independent t-test Statistic Differences in the Mean of Students' Academic Performance Scores in Geometry Taught Using ICT and Lecture Method.**

Groups	N	Mean	Std.dev	Std. Err	Df	t calculated	t-critical	Sig (p)
Experimental	74	46.20	3.69	0.44		9.62	1.96	
					126			0.001 *
Control	54	36.85	7.17	0.98				

Calculated p < 0.05, Calculated t > 1.96, **** = Significant at p ≤ 0.05***

The Table 4.5 showed the results of the independent t-test statistic showed that significant differences exist in the mean of students' academic performance scores in geometry taught using ICT and those taught using lecture method. The reason being that the calculated p value of 0.001was lower than the 0.05 alpha level of significance. Their calculated mean academic performance were 36.85 and 46.20 by students taught geometry using lecture method and those taught geometry using the ICT method respectively, indicating a mean difference of 9.35. This showed that students taught geometry using the ICT has significantly higher academic performance than those taught using lecture method. Consequently, the null hypothesis which state that there is no significant differences in the mean of students' academic performance scores in geometry taught using ICT and those taught using lecture method, was hereby rejected.

Hypothesis Two: There is no significant difference in the mean retention ability in geometry taught using ICT and those taught using lecture method.

Table 4.6: **Independent t-test Statistic Differences in the Mean Retention Ability of Students in Geometry.**

Variable	Groups	N	Mean	Std. dev	Std. Err	Df	t-cal.	t-critical	Sig (p)
Retention Ability	Experimental	74	40.89	9.14	1.06	126	3.25	1.96	0.001*
	Control	54	36.00	7.32	1.00				

Calculated $p < 0.05$, Calculated $t > 1.96$, * = Significant at $p \leq 0.05$

The results in Table 4.6 of the independent t-test statistic showed that significant differences exist in the mean of students' retention ability of students taught with using ICT and those taught using lecture method. The reason being that the calculated p value of 0.001 is lower than the 0.05 alpha level of significance. Their calculated mean retention ability were 36.00 and 40.89 by students taught geometry using lecture method and those taught geometry using the ICT respectively, indicating a mean difference of 4.89. This shows that students taught geometry using the ICT has significantly higher retention ability than those taught using lecture method. Consequently, the null hypothesis which stated that there is no significant differences in the mean retention ability of students in geometry taught using ICT and those taught using lecture method, was hereby rejected.

Hypothesis Three: There is no significant effect of gender on the mean academic performance in geometry of those taught using ICT and those taught using lecture method.

Table4.7:**Two-way ANOVA Statistics on Effect of Gender on the Mean Academic Performance in Geometry Using ICT and Lecture Method**

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig. (p)**
Corrected Model	2925.58[a]	3	975.19	34.34	0.001*
Intercept	203337.52	1	203337.52	7159.14	0.001*
Sex	123.50	1	1232.50	1.35	0.07**
Group	2428.00	1	2428.00	85.49	0.001*
Sex*Group	46.57	1	46.57	1.64	0.20**
Error	3521.91	124	28.40		
Total	235020.00	128			
Corrected Total	6447.49	127			

a. R Squared = .45 (Adjusted R Squared = .44) * = Significant ***at $p \leq 0.05$* ** = Not *Significant at $p \leq 0.05$***

The result in Table 4.7 showed that no significant difference existed between treatment and gender in relation to the students' academic performance. The reasons being that the calculated P value for sex versus group p value was 0.20 was found to be higher than the 0.05 alpha However, on treatment basis significant difference was established among the groups since calculated p value of 0.001 was found to be lower than the 0.05 alpha. But on the basis of gender, there was no significant differences since the calculated p value of 0.07 was found to be higher than the 0.05 alpha level Consequently, the null hypothesis which state that sex and group do not have significant interactive effect on students' academic performance, was accepted and retained.

Hypothesis four: There is no significant effect of gender on the mean retention ability of students in geometry of those taught using ICT and those taught using lecture method.

Table 4.8: **Two-way ANOVA Statistics on Effect of Gender on the Mean Retention Ability of Students in Geometry Using ICT and Lecture Method.**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig. (p)
Corrected Model	1279.98[a]	3	426.66	6.29	0.001*
Intercept	175765.02	1	175765.02	2592.08	0.001*
Sex	35.70	1	35.70	0.53	0.47**
Group	989.03	1	989.03	14.59	0.001*
Sex*Group	525.53	1	525.53	7.75	0.01*
Error	8408.24	124	67.81		
Total	202664.00	128			
Corrected Total	9688.22	127			

a. R Squared = .13 (Adjusted R Squared = .11) * = ***Significant at $p \leq 0.05$, ** = Not Significant at $p \leq 0.05$***

The Table 4.8 of the result of the two-way analysis of variance statistics showed that there is significant effect of gender on the mean retention ability of students in geometry of those taught with ICT and those taught using lecture method. Significant difference exists between treatment and gender in relation to the students' retention ability. The reasons being that that intercept p value of 0.001 was found to be lower than the 0.05 alpha level. Individual analysis also confirmed this position. On treatment basis significant difference was established among the groups since calculated p value of 0.001 was found to be lower than the 0.05 alpha. However, on the Basis of gender no significant difference since calculated p value of 0.47 was found to be higher than the 0.05 alpha. More importantly on the basis of Gender versus treatment group, significant differences were recorded as the calculated p value of 0.01 was found to be lower than the 0.05. Consequently, the null hypothesis which state that sex and group do not have significant interactive effect on students' retention ability, was here by rejected.

4.3Summary of Major Findings

A total of four research questions were formulated and they were answeredby descriptive statistics and their corresponding hypotheses were tested at 0.05 level of significant. The statistics employed for the work were Independent t-test and two-way analysis of variance (two-way ANOVA). Basedontheanalysisofdataandinterpretationofresults,asetoffindingsandconclusionsweredrawnandonthebasisoftheirdiscussions,awiderangeofimplicationsandsuggestionswerefocusedonforfurtherresearchinthefieldrelatedtothisstudy.Someofthesignificantfindingsofthisresearchareasfollows.

1. The results arrived at during this study showed that the post-test performance means scores of experimental group and control groups, matching on their treatment, geometry performance differ significantly in favour of the experimental group. This implies that the students who were taught using ICT showed significant improvement in their performance in mathematics than the students who received instruction through the traditional lecture method. It suggests that ICT used teaching method contributes towards raising the performance of students in Mathematics (geometry).
2. ThegroupofstudentstaughtusingICTshowedsignificantlyhighermeansgaininperformancethanthegroupofstudentstaughtthroughlecture method.
3. The group of students taught geometry using the ICT has significantly higher retention ability than those taught using lecture method.

4. No significant effect of gender on the mean performance in geometry of those taught using ICT method has been observed, so the use of ICT is gender friendly.
5. On the basis of gender, there was no significant difference in their academic performance, but on the basis of treatment groups significant differences existed.
6. There was significant effect of gender on the mean retention ability between the groups of students taught geometry with ICT and those taught using lecture method. More importantly, gender and group have interactive effect on students' retention ability.

4.4 Discussions

The major discussions emanating from the results of this study are anchored on the views of some of the researchers considered in the literature review of this work, many of which argued against the ICT method while others are in support. These discussions are based on the findings on the variables of this study, that is; the learning strategy, especially ICT used strategy the learning outcomes in terms of performance or achievement; the retention level measured by the post post-test and gender differential effect.

In Table 4.1 and 4.5, the result showed that there was significant difference in the geometry performance at the senior secondary level between the control and experimental groups in favour of the experimental group, meaning that the findings were in agreement with that of; Adeyegbe *et al*., (2003) who conducted a research on the feasibility of teaching and assessing STM with ICT in Nigeria. Brantmayer (1994), comparing the effectiveness of *hypermedia* to traditional lecture for graduate students studying safety and industrial hygiene, in retention to the topic of instruction noise and hearing conservation. Dede (1994) too found that *hypermedia* tools offer new methods for structured discovery, address varied learning styles, motivate and empower students and allow educators to present information as a web of interconnections rather than a stream of facts. Gerretson (1998), comparing the geometry performance of two groups of pre-service elementary teachers enrolled in a mathematics methods course. Gerretson (1998), comparing the geometry performance of two groups of pre-service elementary teachers enrolled in a mathematics methods course. White and Norwich (1997), presenting nine exercises on using different technological tools – GSP one of them – in explaining *Calculus* Concepts. These are pointers that the present study is of great impact in the teaching and learning of mathematics, moreover the only way to justify any investment either by government or public private is good performance in subjects of endeavor in which mathematics is paramount.

Nevertheless, Wheeler *et al*. (1999), exposed ninth graders enrolled in algebra classes with traditional instruction to one of three conditions: (1) a control group; (2) a Placebo condition, where students were given a computerized word problem environment without active tutoring; and(3) an experimental group that received a computerized word problem environment with native tutoring, found that students who received *computerized tutoring system performed* better both on abstract and concrete reasoning word problem tasks than their age- mates in the other two conditions. However, they did not do better than students given human tutoring as a supplement to traditional instruction. Notwithstanding its limitations, the study provided limited support for the argument that the use of computer tutorial programs has the potential to help students with problem solving skills, which is a concrete position that this research justifies.

In Table 4.2 and 4.6, the result showed that students taught geometry using the ICT has significantly higher retention ability than those taught using lecture method.

The finding was in agreement with; Bell and Bell (2003). Smith (1996) who reported that developmental mathematics students at a community college learned significantly more from an-hour *animated software* tutorial on *matrix Algebra* than from a *static one*. Animation used mostly to highlight symbols, objects, and "Morphing of addition elements and multiplication factors into sums and products." equally had a *positive impact* on content retention for students in this study.

Boster*et al*. (2002), examining the integration of standards-based *video clips* into lessons developed by classroom teachers found increase in learning by students exposed to the video clip application compared to students who received traditional instruction alone. Lehrer (1993), in a study of eighth graders using a *hypertext/ multimedia* tool to design their own lessons about the American civil war, revealed that the scores of students using the *multimedia tool* did not differ from the scores of the control group on a test given at the completion of the lesson. However, when tested one year later by an independent interviewer, the *multimedia group* displayed elaborate concepts and ideas that they had extended to other areas of history. In contrast, the control group of students remembered almost nothing about the historical content of the civil war lesson. The results revealed that multimedia tends to have long term effects on understanding and retention.

Johnson (1993) however, in comparing the effects of three instructional approaches for teaching college-level lessons in human resource development; that is, conventional lecture-demonstration*;* interactive video with students handling the computer controls; and interactive video with the instructor handling the computer controls found no significant achievement differences between students though both videodisc approaches resulted in significantly higher levels of student achievement than conventional instruction in a test of initial learning and a delayed test to measure retention

In Table 4.3 and 4.7, the result showed that no significant difference existed between treatment and gender in relation to the students' academic performance which was in agreement with Etukudo (2002) and few others. There is no gain saying that gender disparity may have been found to exist in mathematics achievement, but Etukudo (2002) emphasized that this is in the face of weak methods. The search for a good instructional delivery process that could balance the gender inequality in mathematics cannot, therefore, be over-emphasized. Thus, the need to make ICT (PowerPoint animated and video presentations) as instructional strategy is capable of eradicating this gender related differences in mathematics performance among students. The study had been able to;

1. Ascertain that there was no gender disparity in the performance of male and female students in geometry when taught using ICT (PowerPoint animated presentations) method.
2. Ascertain that there was no gender disparity in the retention ability of male and female students in geometry when taught using ICT (PowerPoint animated presentations) method.

Considering the results in Table 4.4 and 4.8, which showed that there was significant effect of gender on the mean retention ability of students in geometry of those taught with ICT and those taught using lecture method. The significant difference existed only between treatment groups and gender in relation to the students' retention ability.

Tiedemann (2000) conducted a 2-year longitudinal study of boys and girls in grades four, five, and six to determine if boys were mathematically superior to girls in the early grades concluded no significant difference based on the gender of the students. Students in the present study were evaluated and the study established that there indeed was interaction between the use of ICT, mathematics performance and gender as the study promote equivalent performance and retention ability with the ICT method.

Many research findings in Nigeria have shown that boys perform better than the girls in mathematics generally despite the fact that they are put under the same classroom situation (Agwagah, 1993; Alio and Harbor-Peters, 2000; Ezeugo and Agwagah, 2000; Jahun and Momoh, 2001; Etukudo, 2002). To the contrary, Agwagah (1993) had reported that female students perform significantly better than their male counterparts. Etukudo (2002) shares similar view. Meanwhile other research findings have debunked the idea of sexual differentiation in ability. This school of thought said that there is no disparity in the performance of both boys and girls (Olagunju, 2001; Gbodi and Laleye, 2006). These conflicting views necessitated the present study with a view to lending support to the actual situation in Nigeria, and consequently the result showed no respect for gender disparity especially with the use of ICT method of teaching.

ThepresentstudyhasgeneratedsomeinterestingfindingsconcerningthebenefitofusingICTinteachingaMathematicstopicascomparedtothetraditionallecture methodofteaching.ResultsindicatedthatICTusedmethodofteachingsignificantlyimproved students'performanceontheperformance test and their retention level in answeringthequestionsafterthisintervention.However,thereweresignificantdifferencesinstudents'performanceandretention levelwhenthestudentswhoweretaughtusingICTwerecomparedtothosetaughtusingtraditionalmethods.ICT-usedmethodofteachingseemedtobeveryeffectiveinenhancingstudents'conceptualunderstandingaswellasimprovingtheirretentionlevel.Also, the fact that no significant difference existed between the mean of male and female of those students exposed to ICT power point teaching method is a sign of the effectiveness and uniqueness of the special features in PowerPoint presentation programme. It can, therefore, be inferred and summarized that ICT-used teaching strategy is effective for the teaching of Mathematics.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The study dealt with the effects of Information Communication Technology on Senior Secondary School Students' Geometry Performance and Retention in Bauchi State, Nigeria. This chapter presents a discussion of the findings of the study in the following sub-headings:

5.2 Summary

5.3 Conclusions

5.4 Contributions of the Study to Knowledge

5.5 Recommendations

5.6 Limitations of the Study

5.7 Suggestions for Further Studies

5.2 Summary

The research work explored to find the effects that ICT method of teaching has over the lecture method. Several literatures were reviewed in the course of this study ranging from the theoretical framework, teaching of geometry at senior secondary schools, ICT and mathematics teaching, retention and performance in geometry, gender and performance in geometry, gender and ICT, overview of similar studies to the implications of all these literatures on the present study. Two senior secondary schools were randomly selected out of twenty-four state owned senior secondary schools making a total of eight thousand four hundreds and forty-two (8200) students in the Bauchi metropolis. One hundred and twenty-eight students were sampled although the initial numbers were more, those who scale through the three tests, their scores formed the data of this study. The instrument used, Geometry Performance Test, validated by three experts (Professors in the faculty of education) was pilot tested with the reliability coefficient as 0.86 using the spit-half (odd-even) ranking method. The researcher taught both the control and the experimental groups on curved and lateral surface areas, volumes and other parameters of the solid shapes popularly known as mensuration. Four research questions were formulated and their corresponding hypotheses were tested at 0.05 level of significance. Independent t-test and two-way ANOVA were the statistics employed for the work. The findings of the research revealed that the student who weretaughtusingICTmethodofteachingshowedsignificantimprovementintheir performance in geometry than the students who received instruction through the traditional method. Reason being that the calculated p value of 0.001 is lower than the 0.05 alpha level of significance while the t-calculated value of 9.62 is higher than the t-critical value of 1.96, at df 126. The calculated mean performance of students taught geometry using lecture method and those taught geometry using the ICT method were 36.85 and 46.20 respectively, indicating a mean difference of 9.35which suggested that ICT used in the teaching contributed towards raising the performance of the students in geometry and their retention ability since the calculated mean retention ability of students taught using the lecture method and those taught using the ICT method were also 36.00 and 40.89 respectively particularly when their respective p-values were less than equal to 0.05. The research also revealed that male and female taught using ICT method did not differ significantly both in performance and retention in geometry.

5.3 Conclusions

It may be concluded from the findings of this study that

1. ICT used teaching strategy significantly improved students’ performance on the performance test and their retention level also proved that learning through ICT proves more meaningful and effective than the traditional classrooms trategy.

2. Using ICT was gender friendly in that male and female taught using ICT did not differ significantly both in performance and retention in geometry.
3. Although significant differences have been found within the two groups, it is noteworthy to point out that the retention and performance of the students taught using ICT outweighed those taught using conventional method, hence ICT be used to teach mathematics particularly geometry.

The fundamental variables of the study included: (1) The learning strategy, especially ICT used strategy; (2) the learning outcomes in terms of performance; (3) the retention level measured by the post post-testquestions were all significantly in favour of ICT use.

5.4 Contributions of Study to Knowledge

The study showed that ICT has portrayed an alternative and more effective teaching and learning tool in mathematics education. The study showed that students can indeed develop deep understanding that does not fade overtime. Computerand related tools actively engage students in the learning process. Other researchers can adapt or adopt as the case may be the PowerPoint animation package developed with many adapted images to teach geometry.

The findings of the study have added frontier knowledge to the existing literature. The ICT method provides the three-dimensional pictures of the content to motivate the students and to satisfy the queries and curiosity about various scientific concepts, which a teacher may generally fail to do in the classroom teaching. While mathematics is strongly related to abstractions that require particular representations or forms that allow students to relate concepts to what they already know, teachers need to know how to translate these abstractions into understanding representation as established by this study.

The findings were to establish that the use of ICT particularly in teaching geometry has enhanced students' academic performance and retention ability of many senior secondary school students in Bauchi state. ICT can have appositive effecton students' motivation on their attitude toward technology, instruction and the subject matter they are expected to learn and absorb. The study revealed that changing from a traditional lecture method to an ICT used teaching method did not simply enrich class room teaching, it also significantly improved their performance.

These all imply that ICT used teaching strategy proves to be more tangible in its effectiveness on performance than the traditional classroom approach. It seems more practical and is widely acceptable to students and has no repute for individual differences and enables all types of students to perform better. In a nutshell, ICT is gradually growing aloft to provide an chorage to prop up the process of schooling in quite a big way. It is high time for the teachers, teacher educators and the teaching–learning community to make the best use of technological inputs, as available, to improve the quality of schooling at all levels and in turn raise the quality of life of the people in knowledge society. When these are expressed in terms of their global importance for educational purposes vis-à-vis the tested hypotheses of the study, prima-facie, the main focus of the study address esthemulti-sensorial approach of the innovative learning process and its impact on education for sustainable development of each and every individual learner in a school situation which is deemed to be a miniature technology-based society in itself.

5.5 Recommendations

Based on the findings of the study, the following recommendations are therefore made:

i. Relevant curriculum should be developed or upgraded periodically where in existence by the Nigerian Educational Research and Development Council (NERDC) to accommodate dynamism of ICT applications in all levels of mathematics teaching in secondary schools

ii. The government of Bauchi state should seek partnership with private and non-governmental organizations to provide the ICT facilities like LCD projectors, slide screens, laptops and improvise for alternative source of power supply like solar panels for consistent power supply in schools since the use of ICT depends largely on power. The government should fast-track efforts to procure and provide necessary ICT materials.

iii. Bauchi state ministry of education should organize mathematics teachers' forum and workshop periodically (during long vacation or at the end of each term) to share updates and development on this strategy to enhance teaching capability.

iv. The ministry of education, in Bauchi state should train teachers on the use of ICT to teach other science based subjects such as Biology, Chemistry and Physics among others in secondary schools.

v. Textbook writers should include ICT as formal, convenient and not a supplement approach for teaching geometry (mensuration) in their materials.

vi. Challenge Your Disabilities Programme (CYDP) unit established in Bauchi, might find the method more interactive for better performance in mathematics to the hearing-impaired students such as dump and deaf but with sight.

5.6 Limitations of the Study

The following are the limitations of the studies;

1. This study was carried out in Bauchi State metropolis only and consequently does not permit generalization for the population of class students in Nigeria.

2. Insufficient time allocation by the Ministry of Education (four weeks)and the school time table(four periods of 35 minutes per week as against five period of 40 minutes) as a result of other newly introduced core subjects, although the school principals permitted extra afternoon and Saturday classes when they discovered the students' willingness in the programme. All of these limited the time spent for the research.
3. The research was conducted in schools where inadequate power supply and equipment hindered full maximization of the strategy, although power generator and other equipment were made available by the researcher, the situation could have been made better.

5.7 Suggestions for Further Studies

The following suggestions are offered for further research investigations:

1. There is need to compare or study the integrated effect of ICT-used method with other institutional treatments and methods. Hence, further researches be done with ICT.
2. ICT teaching modules should be developed and extended to other subjects other than Mathematics for the purpose of comparative performance index computation. There may have been some use of ICT in other subjects but application across the curriculum was still largely undeveloped.
3. Further research could be needed to study the effect of ICT on special groups of students such as gifted, the learning disabled and other mildly handicapped.

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APPENDIX A

Lesson Presentation Plan for Experimental Group (Using slides)

Asmanyas300slideswereprepared(APPENDIX H)anddemonstratedbeforethestudentsintheexperimentalclassroomsituationtoexplainandelaboratetheteachingofdifferent sub-topicslistedabovetoenrichtheteaching-learningprocessandtoimprovethequalityofschooling.Theirdetailsarebrieflysummarizedlesson-wiseasfollowsaspartofthedeliveryofdemonstrationandteachingtopic-wisetofacilitateunderstandingthemeritoftheuseofICTintheclassroom.

ContentSpecifications

Thecontentspecifications were selected fromthesenior secondary curriculum of mathematicsof Nigerian Educational Research and Development Council (NERDC) and wasanalyzedandarrangedsequentially.Forexample,SurfaceAreaswerediscussedbeforediscussingtheVolumesofSolids.Thegeneral topic**"SurfaceAreasandVolumes"** wasdividedintotwounitsSurfaceAreasandVolumes.Contentofeachunitwasfurtherdividedintofivesub-unitssothateachsub-unitmaybe taughtinto 40minutes duration. Care was takento placeeachsub-unitinto a logicalandpsychologicalsequence.

S. No	**Units**	**Sub-units**	**Contents**
		1.1Cuboids	Definition,Geometricalrepresentation,Derivationofsurfacearea,Derivationoflateralsurfacearea,Solutionofrelatedproblems
		1.2Cube	Definition,Geometricalrepresentation,Derivationofsurfacearea,Derivationoflateralsurfacearea,Solutionofrelatedproblems

1.	**Surface Areas**	1.3RightCircularCylinder	Definition,Geometricalrepresentation,Derivationofsurfacearea,Derivationoflateralsurfacearea,Solutionofrelatedproblems
		1.4RightCircularCone	Definition,Geometricalrepresentation,Derivationofsurfacearea,Derivationoflateralsurfacearea,Solutionofrelatedproblems
		1.5Sphere	Definition,Geometricalrepresentation,Derivationofsurfacearea,Derivationoflateralsurfacearea,Solutionofrelatedproblems
2.	**Volumes**	2.1Cuboid	Definition,Derivation of volume, Solutionofrelatedproblems
		2.2Cube	Definition,Derivation of volume, Solutionofrelatedproblems
		2.3RightCircularCylinder	Definition,Derivation of volume, Solutionofrelatedproblem
		2.4RightCircularCone	Definition,Derivation of volume, Solutionofrelatedproblems
		2.5Sphere	Definition,Derivation of volume, Solutionofrelatedproblems

Objectives of the study

At the end of the study presentation, the students are expected to be able to do the following:

1.11 RecognizetheobjectofCuboidalshapefromtheirsurroundings.Dra
1.12 wthediagramofaCuboid
1.13 RecalltheformulaforthecomputationoftheSurfaceAreaofaCuboid
1.14 RecalltheformulaforthecomputationoftheLateralSurfaceAreaofaCuboidSolve the
problemsrelatedto the computationof the
1.15 surfacearea/LateralSurfaceareaofaCuboidthrough directuseofthededucedformula

1.21 RecognizetheobjectofCubicalshapefromtheirsurroundings.Dra
1.22 wthediagramofaCube
1.23 RecalltheformulaforthecomputationoftheSurfaceAreaofaCube
1.24 RecalltheformulaforthecomputationoftheLateralSurfaceAreaofaCubeDifferen
tiatebetweencubeandcuboid
1.25 Solve the problemsrelatedto the computationof the
1.26 surfacearea/LateralSurfaceareaofaCubethrough directuseofthededucedformula

1.31 RecognizetheobjectofCylindricalshapefromtheir
1.32 surroundings.DrawthediagramofaRightCircularCylinder
1.33 RecalltheformulaforthecomputationoftheSurfaceAreaofaRightCircularCylinder
RecalltheformulaforthecomputationoftheCurvedSurfaceAreaofaRightCircularCyl
1.34 inder
DifferentiatebetweenCircleandCylinder
1.35 Solve the problemsrelatedto the computationof the
surfacearea/LateralSurfaceareaofCubethroughadirectuseofthededucedformula
1.36

1.41 RecognizetheobjectofConicalshapefromtheirsurroundings.Dra
1.42 wthediagramofaRightCircularCone
RecalltheformulaforthecomputationoftheSurfaceAreaofaRightCircularCone
1.43

1.44 RecalltheformulaforthecomputationofthecurvedSurfaceAreaofaRightCircularCon
e

1.45 SolvetheproblemsrelatedtothecomputationoftheSurfaceArea/CurvedSurfaceareaof
aconethrough directuseofthededucedformula

1.51 RecognizetheobjectofSphericalshapefromtheirsurroundings.Dra

1.52 wthediagramofaSphere
RecalltheformulaforthecomputationoftheSurfaceAreaofaRightSphereRecallthefor

1.53 mulaforthecomputationofthecurvedSurfaceAreaofaSphereSolvetheproblemsrelate

1.54 dtothecomputationofthe
SurfaceArea/CurvedSurfaceareaofaSpherethroughdirectuseofthe deducedformula

1.55

2.11 RecalltheformulaforthecomputationoftheVolumeofaCuboid

2.12 Solvetheproblemsrelatedtothecomputationof theVolumeofaCuboid
throughdirectuseofthededucedformula

2.21 RecalltheformulaforthecomputationoftheVolumeofaCube

2.22 SolvetheproblemsrelatedtothecomputationoftheVolumeofaCubethrough
directuseofthededucedformula

2.31 RecalltheformulaforthecomputationoftheVolumeof aRightCircular
Cylinder

2.32 Solvetheproblemsrelatedtothe computation oftheVolumeofa Right Circular
Cylinderthroughdirectuseofthededucedformula

2.41 RecalltheformulaforthecomputationoftheVolumeofaRightCircularCone

2.42 SolvetheproblemsrelatedtothecomputationoftheVolumeofa Right Circular
Conethroughdirectuseofthededucedformula

2.43 UnderstandrelationshipbetweentheVolumeofaconeandaCylinder

2.51 RecalltheformulaforthecomputationoftheVolumeofaSphere

2.52 RecalltheformulaforthecomputationoftheVolumeofaHemi-Sphere

2-53 UnderstandrelationshipbetweentheVolumeofaSphereandaHemi-Sphere

2.54 Solvetheproblems relatedtothecomputationoftheVolumeofaSphere/Hemi-Spherethroughdirectuseofthededucedformula

Lesson No	Topical Sub-units	Material Used	Presentation Details
1	Surface area of Cuboids	PowerPoint animated CDwith LCDprojector	Step1: The teacher: - made some introduction about the lesson asked studentsquestionstoknowtheirpreviousknowledgeandmotivatethem (Slide-1). - announcedthetopic'SurfaceAreaofcuboids' andshoweditonscreen(slide2-3). Step2:The teacher: - explained itsGeometricalRepresentationandalsotoldthemthatincuboidstherewere8vertexes,12edgesand6rectangularfaces(slide4-5). Conceptofacuboidwasmadeclearbyshowingtheexamplesrelatedtodailylife,i.e., pictureofamatchboxandpictureofabook(slide6-8) - explainedtheprocedureaboutderivingtheformulaforfindingthe'.SurfaceAreaofcuboids' (slide10). Toexplainit,followedthefollowingsteps: Explainedthatpairofoppositerectangularfacesisofsameareawhichwereofdifferentcolors (slide9-12). WiththehelpofMSAnimationClipsexplainedthattofindthe 'SurfaceAreaofcuboids'wehavetoaddthesurfaceareasofallits6faces(slide13-15). Step3:The teacher also explainedthestepsforsolutionofaproblembasedonthe'SurfaceAreaofcuboids'(slide16-17). Step4:The teacher: - gavethestudentsoneExercisebasedontheabovetopictosolveintheirnotebooks(slide-18) andalsochecktheirnotebooks. - gavethestudentsoneExercisebasedontheabovetopictosolveintheirnotebooksattheir(slid

			e-19).

Lesson No	Topical Sub-units	Material Used	Presentation Details
2	LateralSurfaceAreaofcuboids	PowerPoint animated CDwithLCDprojector	Step1:The teacher: - askedsomequestionsfromthestudentsto knowtheirpreviousknowledgeand m o t i v a t e themandthenannouncedthetopic'LateralSurfaceAreaofcuboids'andshowe ditonscreen. (Slide-20) Step2:The teacher: - explainedtheprocedureaboutderiving theformulaforfindingthe'LateralSurfaceAreaofcuboids'.Toexplainit,theresearcherfollowedthefollowingsteps - explainedthatpairofoppositerectangularfacesisofsameareaswhichwereofdifferentcolors.WiththehelpofMS AnimationClips,explainedthattofindthe'LateralSurfaceAreaofcuboids' wehavetoaddthesurfaceareasofallits 4facesleavingthebottomandtopfaces.(slide 21-23). Step3:The teacher: - also explained the stepsfor solutionofaproblembased onthe'LateralSurfaceAreaofcuboids'(slide 24-25). Step4:The teacher: - gavethestudentsoneExercisebasedontheabovetopictosolveintheirnotebooks(slide-26) andalsocheckedtheirnotebooks. - gavethestudentstwoExercisesbasedontheabovetopictosolveintheirnotebooksathome(slide-27).

Lesson No	Topical Sub-units	Material Used	Presentation Details
3	SolutionsoftheProblems basedon'SurfaceAreaofcuboids	PowerPoint animated CDwith LCDprojector	Step1: The teacher: - asked somequestions from the studentsto ascertaintheirpreviousknowledgeandtomotivatethem. Step2:The teacher: - explainedthestepsforsolutionofaproblembasedonthe'SurfaceAreaofcuboids'(slide-

			28). Step3:InQuestionNo.1(slide-30). The teacher: -alsostatedtheformulatocalculatetheareaofsheetrequiredformakingtheboxaswellasthestepstobefollowedforitscalculation. InQuestionNo.2(slide-31). - explainedthe formulaforcalculating the areaof four wallsoftheroomsaswellasthestepsforitscalculation. - alsostated themtoaddtheareasoffourwallsoftheroomsandareaoftheceiling. - explainedthatto calculatetotalcostofwhite washing we havetomultiplytheTotalAreabyCost permetersquare. InQuestionNo.3(slide-32). - Explainedthe formulaforcalculating the area of four wallsoftheroomsaswellasthestepsforitscalculation. - Explainedtheformulaforcalculating thePerimeterofthehallaswellasthestepsforitscalculation. - Alsotoldthemtheprocedureofcalculatingtheheightofthehall. Step4:The teacher: -gavethestudentsoneExercisebasedontheabovetopictosolveintheirnotebooks(slide-33)andalsochecktheirnotebooks. - gavethestudentstwoExercisesbasedontheabovetopictosolveintheirnotebooksathome(slide-34).

Lesson No	Topical Sub-units	Material Used	Presentation Details
4	SurfaceArea ofcube	PowerPoint animated CDwith	Step1: The teacher: - asked somequestionsfromthestudentstoascertaintheirpreviousknowledgeandmotiv

		LCDprojector	atethem and afterthatannouncedthetopic‘SurfaceAreaof acube’andshoweditonscreen.(Slide35-37) Step2:The teacher: -explainedaboutitsGeometricalRepresentationandalsotoldthemthatincuboidstherewere 8vertexes,12edgesand6squarefaces(slide38-40).Conceptofacubewasmadeclearbyshowingtheexamplesrelatedtodailylifei.e.Picture ofaRubycubeandpictureoficecubes(slide45-46) Step3:The teacher: -explainedtheprocedureaboutderivingtheformulaforfindingthe‘.SurfaceAreaofcuboids’(slide41-42). Toexplainit, followedthefollowingsteps:- - Explainedthatpairofoppositesquaredfacesareofsameareawhichwereofsamecolors(slide44). - WiththehelpofMSAnimationClipsexplainedthattofindthe‘SurfaceAreaofacube’wehavetoaddthesurfaceareasofallits6faces(slide45-47). - also explained the stepsfor solutionofaproblembased onthe‘SurfaceAreaofacube’’(slide-49). Step4:The teacher: -gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooks(slide-50)andalsocheckedtheirnotebooks. - gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooksathome (slide-51).

Lesson No	**Topical Sub-units**	**Material Used**	**Presentation Details**
5	LateralSurfaceAreaofacube	PowerPoint animated CDwith LCDprojector	Step1:The teacher: -askedsomequestionsfromthestudentstoascertaintheirpreviousknowledgeandtomotivatethem.Afterthat,announcedthetopic‘Lateral SurfaceAreaofacube’andshoweditonscreen. (Slide-52)

			Step2: The teacher: -explainedtheprocedureaboutderivingtheformulaforfindingthe ‘LateralSurfaceAreaofacube’.Toexplainit,followedthefollowingsteps -Explainedthatpairofoppositesquarefacesisofsameareaswhichwereofsamecolors. -said, withthehelpofMSAnimationsClips,explainedthattofindthe-‘LateralSurfaceAreaof acube’wehavetoaddthesurfaceareasofallits 4facesleavingthebottomandtopfaces.(Slide 53-55). Step3:The teacher: -alsoexplainedthestepsforsolutionofaproblembasedon the‘LateralSurfaceAreaofa cube’(slide56-57). Step4:The teacher: - gave tothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooks(slide-58) andalsocheckedtheirnotebooks. -gavetothestudentstwoexercisesbasedontheabovetopictosolveintheirnotebooksathome (slide-59).

Lesson No	Topical Sub-units	Material Used	Presentation Details
6	Solutionsofthe Problembased on‘Surface Areaofcube’	PowerPoint animated CDwith LCDprojector	Step1: The teacher: - asked some questions to the studentsto ascertaintheir previousknowledgeandtomotivatethem. Step2: The teacher: -alsoexplainedthestepsforsolutionofaproblembasedonthe‘SurfaceAreaofcube’(slide-60). Step 3: QuestionNo.4(slide-61).The teacher-explainedtheformulatocalculatetheareaofa brickandalsotoldthemtheprocedureoffindingthenos.ofbricksrequiredwhenthetotalsurfaceareaaswellassurfaceareaofabrickwasgiven. InQuestionNo.5(slide62-63).

			- Explainedtheformulaforcalculating theLateralSurfaceAreaofacubeando facubicalbox. - AlsotoldthemtosubtracttheLateralS urfaceAreasofacubicalboxfromacu be. - Explainedtheformulaforcalculatingt heTotalSurfaceAreaofacubeandofa cubicalbox. - AlsotoldthemtosubtracttheTotalSur faceAreasofacubicalboxfromacube. Step4: The teacher: - gavetothestudentstwoexercisesbasedonthe abovetopicto solveintheirnotebooksandalsocheckedtheir notebooks(slide64-65). - gavetothestudentstwoexercisesbasedonthe abovetopictosolveintheirnotebooksathome (slide-66).

Lesson No	**Topical Sub-units**	**Material Used**	**Presentation Details**
7	Solutionsoft heProblemb asedon ‘SurfaceAre aofcuboids’	PowerPoint animated CDwith LCDprojector	Step1 The teacher: - asked some questions from thestudentsto ascertain their previousknowledgeandtomotivatethem. Step2: The teacher: - alsoexplainedthestepsforsolutionofaproble mbasedonthe‘SurfaceAreaofcuboids’(slide -67). Step3: InQuestionNo.6(slide-68). The teacher - Explainedthestudentsthatthesurface areaofaglasscanbecalculatedbyusin gthesurfaceareasofcuboids. - The teacher alsoexplainedthestudentsthatlength oftapecanbecalculatedbycalculatin gthelengthof12edges. Step4: The teacher: - gavetothestudentsoneexercisebasedonthea bovetopictosolveintheirnotebooksandalsoc heckedtheirnotebooks.(Slide-69) -

gavetothestudentstwoexercisesbasedonthe abovetopictosolveintheirnotebooksathome (slide-70).

Lesson No	Topical Sub-units	Material Used	Presentation Details
8	Solutionsoft heProblems basedon'Sur faceAreaofc uboids'	PowerPoint animated CDwith LCDprojector	Step1: The teacher: - asked some questions to the studentsto ascertaintheir previousknowledgeandtomotivatethem. Step2: The teacher: - alsoexplainedthe stepsfor solutionof a problembasedonthe 'SurfaceAreaofcuboids'. Step3: InQuestionNo.7(slide72-75).The teacher; - Explainedtothestudentsthatthesurfaceareaofabiggerboxcanbecalculatedbyusingthesurfaceareasofcuboids. - Explainedtothestudentsthatthesurfaceareaofa250biggerboxescanbecalculatedbymultiplyingthesurfaceareaofabiggerboxby250. - Alsoexplainedtothestudentsthatthesurfaceareaofasmallerboxcanbecalculatedbyusingthesurfaceareasofcuboids. - Explainedto the studentsthatthesurfaceareaofa250smallerboxescanbecalculatedbymultiplyingthesurfaceareaofasmallerboxby250. Toldthestudentstoaddtheareasofbothtypeofboxes - Explainedtothestudentsabouttheareaofsheetrequiredformaking250boxesofincludingextrarequiredareaof5%foroverlaps. - Explainedtothestudentsabouttotalcostofsheetattherateof N4.00for1000 cm^2. QuestionNo.8(slide76-77). The teacher explainedtothestudentsthattheareaoftarpaulinrequiredtocoverfoursidesandtheroofcanb

			ecalculatedbytheformulai.e.lxb+2(l+b)xhin whichl=4m,b=3m,h=2.5m. Step4: The teacher: -gavetothestudentsoneexercisebasedonthe a b o v e topictosolveintheirnotebooksanda lsocheckedtheirnotebo o k s.(Slide-78). -gavetothestudentstwoexercisesbasedonthea bovetopictosolveintheirnotebooksathome(s lide-79).

Lesson No	**Topical Sub-units**	**Material Used**	**Presentation Details**
9	SurfaceArea ofrightcircul arcylinder	PowerPoint animated CDwith LCDprojector	Step1:The teacher: -askedsomequestionstothestudentstoascerta intheirpreviousknowledgeandtomotivateth em.Afterthatannouncedthetopic'SurfaceAr eaofa r i g h t circularcylinder'andshoweditonscree n. (slide-80) Step2: The teacherwiththehelpofMSAnimationClips,e xplainedthatinarightcircularcylindertheang lebetweenradiusandheightisof90^{0}. (slide81-82)Described also some other types of cylinder such as oblique cylinder. - ExplainedaboutitsGeometricalRepr esentation(slide-84)andalsotoldthemthatinarightcirc ularcylindertherewere3surfaces(sli de-83)andalsoexplainedthemtheshapes ofthesethreesurfaces(slide-84). - alsoexplainedthedefinitionofarightc ircularcylinder(slide-85). -Explainedtheprocedureaboutthederivingth eformulaforfindingthe' SurfaceAreaofarightcircularcylinder(slide8 6-94). Toexplainit,followedthefollowingsteps - Explainedthatinarightcircularcylind erareasoftop

			andbottomcirclesareofsamearea. - WiththehelpofMSAnimationClipsexplainedthattofindthe'SurfaceArea ofrightcircularcylinder'wehavetoaddthesurfaceareasofall its3surfaces. Step3:The teacher-alsoexplainedthestepsforfindingtheareaof middlepartwhichisofcurvedshape.With thehelpofMSAnimationClips,explained thestudentsthatareaofcurvedsurfaceisequaltotheareaofarectangleoflength*2Πr*andbreadth*h*. - alsotoldthemtocalculatethetotalsurfaceareaofarightcircularcylinder as well as how to calculate the surface area of oblique cylinder. - alsoexplainedthestepsforsolutionof aproblembasedonthe'SurfaceAreaofarightcircularcylinder'(slide95). Step4: The teacher:-gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooks(slide-96)andalsocheckedtheirnotebooks.-gavethestudentstwoexercisesbasedontheabovetopictosolveintheirnotebooksathome(slide97-98).

Lesson No	**Topical Sub-units**	**Material Used**	**Presentation Details**
10	SolutionsoftheProblembasedon 'SurfaceAreaofrightcircularcylinder'	PowerPoint animated CDwith LCDprojector	Step1:The teacher:-askedsomequestionsfromthestudentstoascertainthepreviousknowledgeand tomotivatethem. Step2:The teacher:-alsoexplainedthestepsforsolutionofaproblembasedonthe'SurfaceAreaofrightcircularcylinder. Step3:QuestionNo.2(slide100). The teacher:-explainedthestudentsthatthesurfaceareaofacylindricaltankcanbecalculatedbyusingtheformulaofsurfaceareasofrightcircularcylinder. QuestionNo.3 (slide101-102) - Explainedtothestudentsthattheinner

			curvedsurfaceareaofametalpipecan becalculatedbyusingtheformula2Πr hinwhich‘r’is2.2cmand‘h’is77cm. - Alsoexplainedthestudentsthattheou tercurvedsurfaceareaofapipecanbec alculatedbyusingthesurfaceareaofri ghtcircularcylinderinwhich‘R’is2.2 cmandheight‘77’cm. - Alsotoldthestudentsthatthetotalsurf aceareacanbecalculatedbyaddingth ecurvedsurfaceareaofahollowpipea ndareaofinnerandoutercurvedsurfac eareas. QuestionNo.4(slide103) - Explainedthestudentsthattheareaco veredbyonerevolutioncanbecalculat edbyusingtheformulaofcurvedsurfa ceareaofarightcircularcylinderinwh ichheightis120cmandradiusis42cm. - Toldthestudentstomultiplytheareac overedbyonerevolutionby500tofind areaoftheplayground. Step4 :The teacher:- gavetothestudentsoneexercisebasedonthea bovetopictosolveintheirnotebooks(slide-104)andalsochecktheirnotebooks.- gavetothestudentstwoexercisesbasedonthe abovetopictosolveintheirnotebooksathome (slide-105-106).

Lesson No	**Topical Sub-units**	**Material Used**	**Presentation Details**
11	Solutionsoft heProblems basedon ‘SurfaceAre aofrightcirc ularcylinder ’	PowerPoint animated CDwith LCDprojector	Step1: The teacher:- askedsomequestionsfromtothestudentstoas certainthepreviousknowledgeandtomotivat ethem. Step2:The teacher:- alsoexplainedthestepsforsolutionofaproble mbasedonthe‘SurfaceAreaofrightcircularc ylinder. QuestionNo.5(slide108). - Explainedthestudentsthatthecurved surfaceareaofacylindricalpillarcanb ecalculatedbyusingtheformulaofsur

faceareasofrightcircularcylinderinwhich‘r’is25cmand‘h’is3.5cm.

- Explainedthemthattotalcostofpaintingthecurvedsurfaceofthepillarcanbecalculatedbymultiplyingitscurvedsurfaceareabycostofpaintperm^2.

QuestionNo.6(slide-109)

- Explainedthestudentsthattheinnercurvedsurfaceareaofawellcanbecalculatedbyusingtheformula2Πrhinwhich‘2r’is3.5mand‘h’is10m.

Step 3: QuestionNo.7(slide-110) The teacher:-

- alsotoldthestudentsthatthetotalcostofplasteringthiscurvedsurfaceareacanbecalculatedbymultiplyingitscurvedsurfaceareabycostofplasteringper m^2.

QuestionNo.8(slide-111)

- Explainedthestudentsthatthetotalradiatingsurfaceareacanbecalculatedbyusingthecurvedsurfaceareaofacylinderinwhichr=5/2cmandh=28m.
- Gavetothestudentstwoexercisesbasedontheabovetopictosolveintheirnotebooks(slide-112).

Step4: The teacher:- gavetothestudents’oneexercisebasedontheabovetopictosolveintheirnotebooksathome(slide-113).

Lesson No	Topical Sub-units	Material Used	Presentation Details
12	Solutionsoft heProblems basedon ‘SurfaceAre aofrightcirc ularcylinder ’	PowerPoint animated CDwith LCDprojector	Step1:The teacher:- askedsomequestionstothestudentstoascertaintheprevious knowledgeandtomotivatethem.Theresearcheralsoexplainedthestepsforsolutionofaproblembasedonthe‘LateralSurfaceAreaofrightcircularcylinder an some features of oblique cylinder. Step2: QuestionNo.9(slide115). The

teacher:- explainedtothestudentsthatthelateralsurfaceareaofaclosedcylindricaltankcanbecalculatedbyusingtheformulaofsurfaceareasofrightcircularcylinderinwhich‘2r’is4.2mand‘h’is 4.5m.

- Explainedtothestudentsthatthetotalsurfaceareaofaclosedcylindricaltankcanbecalculatedbyusingtheformulaofsurfaceareasofrightcircularcylinderinwhich‘2r’is4.2mand‘h’is4.5m.

Step3: QuestionNo.10(slide-116)The teacher:- explainedtothestudentsthatthetotalheightofaframeofaLampshadeis35cm,i.e.,30+2.5+2.5andthelengthoftheclothrequiredforcoveringthelampshadecanbecalculatedbyusingtheformula$2\Pi rh$inwhich‘r’is10cmand‘h’is35cm.

QuestionNo.11(slide117-118)

- Explainedthestudentsthecardboardrequiredforonepenholdercanbecalculatedbyusingtheformula($\pi r^2+2\pi rh$)inwhich‘r’is3cmand‘h’10.5cm.
- Explainedthestudentsthecardboardrequiredfor35penholderscanbecalculatedbymultiplyingcardboardrequiredforonepenholderby35.

Step4 The teacher:- gavetothestudentstwoexercisesbasedontheabovetopictosolveintheirnotebooks(slide-119). - gavetothestudentstwoexercisesbasedontheabovetopictosolveintheirnotebooksathome (slide-120).

Lesson No	Topical Sub-units	Material Used	Presentation Details
13	SurfaceArea ofrightcircularcone	PowerPoint animated CDwith	Step1: The teacher:- askedsomequestionstothestudentstoascertaintheirpreviousknowledgeand

LCDprojector	tomotivatethem. Afterthatannouncedthetopic‘SurfaceAreaofarightcircularcone’andshoweditonscreen. (Slide-121-122) Step2: The teacher:-alsoexplained thedefinitionofarightcircular cone(slide-123). -explainedaboutitsGeometrical Representation(slide124-126)andalsotoldthemabout‘vertex’‘height‘ radius’and‘slantheight’. Step 3:The teacher:-withthehelpofMSAnimationClips,explainedthattherearetwosurfacesina rightcircularcylinder.one isflatbasecircularinshapeandsecondisalateralsurfacecurvedinshape(slide-127). -explainedtheprocedureaboutderivingtheformulaforfindingthe‘.SurfaceAreaofarightcircularcone (slide128-140). Toexplainit,followedthefollowingsteps - ExplainedthatinarightcircularconeareaofbaseisΠr^2. - WiththehelpofMS AnimationClips,explainedthattofindthe‘SurfaceAreaofrightcircularcone’wehavetoaddthesurfaceareasofallits2surfaces. -Alsoexplainedthestepsforfindingtheareaofcurvedsurface.WiththehelpofMSAnimation Clips,explainedtothestudentsthatareaofcurvedsurfaceisequaltohalfofthelengthofentire curved boundary. -Alsotoldthemtocalculatethetotalsurfaceareaofarightcircularcone. - Alsoexplainedthestepsforsolutionofaproblembasedonthe‘SurfaceAreaofarightcircularcone’ (slide-141). Step4:The teacher:-gave tothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooks(slide-

142)andalsochecktheirnote books.-gavetothestudentstwoexercisesbasedonthe abovetopictosolveintheirnotebooksathome (slide-143-144).

Lesson No	Topical Sub-units	Material Used	Presentation Details
14	Solutionsoft heProblemb asedon ‘SurfaceAre aofrightcirc ularcone’	PowerPoint animated CDwith LCDprojector	Step1: The teacher:-askedsomequestionstothestudentstoascerta inthepreviousknowledgeandtomotivatethe m. Step2: The teacher:-alsoexplainedthestepsforsolutionofaproble mbasedonthe‘SurfaceAreaofrightcircularc one. QuestionNo.2(slide146).-explainedtothestudentsthatthetotalsurfacea reaofaconecanbecalculatedbyusingtheform ulaofsurfaceareasofrightcircularcylinderin which‘r’is12cmand‘l’is21cm. QuestionNo.3(slide147-148) - Explainedtothestudentsthattheradiu sofaconecanbeobtainedbydividingit scurvedsurfaceareawithΠtimesitssl antheight. - Alsotoldthestudentsthatthetotalsurf aceareacanbecalculatedbysubstituti ngthevalueof‘r’and‘h’. QuestionNo.4(slide149-150) - Explained,thestudentsthattheslanth eightofarightcircularconecanbecalc ulatedbyusingthePythagorastheore m. - Alsotoldthestudentsthatareaofcanv ascanbecalculatedbycurvedsurface areaofarightcircularcone. Step3: The teacher:-alsotold the students thatcost ofcanvascan becalculatedbymultiplyingitscurvedsurface areabyN70. QuestionNo.5(slide151) - Explainedtothestudentsthattheslant

			heightofarightcircularconecanbecalculatedbyusingthePythagorastheorem. - Alsotoldthestudentsthatareaofcanvascanbecalculatedbycurvedsurfaceareaofarightcircularcone. - Also told the students thatcost ofcanvascan becalculatedbymultiplyingitscurvedsurfaceareaby N70. - Explainedtothestudentsthatthelengthofcanvasrequiredcanbecalculatedbyaddingitscurvedsurfaceareaandstitchingmargins. Step4:Gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooksat home(slide-152). - gavetothestudentstwoexercisesbasedontheabovetopictosolveintheirnotebooksathome (slide-153).

Lesson No	**Topical Sub-units**	**Material Used**	**Presentation Details**
15	Solutionsof theProblem basedon 'SurfaceAreaofrightcircularcone'	PowerPoint animated CDwith LCDprojector	Step1:The teacher:- askedsomequestionstothestudentstoascertainthepreviousknowledgeandtomotivatethem. Step2: QuestionNo.6(slide155)The teacher:- - Explainedtothestudentsthatthecurvedsurfaceareaofaconecanbecalculatedbyusingitsformulainwhich'r'are7mand'l'is25cm. - Alsoexplainedtothestudentsthatthecostofwhite washingcanbecalculatedbymultiplyingitscurvedsurfacebyN.210per100 m^2. QuestionNo.7(slide156) - Explainedtothestudentsthattheareaofthesheetrequiredtomakeonecanbecalculatedbyusingcurvedsurfaceareaofarightcircularcone.

- Alsotoldthestudentsthatsheetrequiredfor10capscanbecalculatedmultiplyingcurvedsurfaceareaofarightcircularconeby10.

Step3: QuestionNo.8(slide157) The teacher:-

- Explainedtothestudentsthattheslantheightofarightcircularconecanbecalculatedbyusingthe Pythagorastheorem.
- Explainedtothestudentsthatthecurvedsurfaceareaof50conescanbecalculatedmultiplyingcurvedsurfaceareaofarightcircularconeby50.
- AlsotoldthestudentsthatcostofpaintingalltheseconescanbecalculatedmultiplyingcurvedsurfaceareaofarightcircularconebyN12 perm^2

Step4: The teacher:- gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooks(slide-158). - gavethestudentsoneexercisebasedontheabovetopictosolveintheirnotebooksathome(slide-159).

Lesson No	Topical Sub-units	Material Used	Presentation Details
16	SurfaceArea ofSphere	PowerPoint animated CDwith LCDprojector	Step1:The teacher:- askedsomequestionsfromthestudentstoascertaintheirpreviousknowledgeand tomotivate.Afterthat,announcedthetopic'SurfaceAreaofaSphere'andshoweditonscreen(slide-160). Step2: The teacher:- alsoexplainedthedefinitionofarightSphere(slide-162). - ExplainedaboutitsGeometrical Representationandalsotoldthemaboutits'radius'and'centre' (slide163). - Explained that the ConceptofaSpherewould beclearbyshowing

- examplesrelatedtodailylife,i.e.,MarbleBall, Ball, footballglobe.(Slide164-168)

Step3:The teacher: -explainedtheprocedureaboutthederivingthe formulaforfindingthe‘.SurfaceAreaofaSphere.(slide169-177

Toexplainedit,he followedthefollowingsteps

- WiththehelpofMSAnimationClips, explainedthatthe‘SurfaceAreaofSphereisequaltothefourtimesareaofa circlehavingradius‘r’.
- Also explainedthe stepsfor solution of a problembasedonthe‘SurfaceAreaof aSphere’.

QuestionNo.1(slide178)-Explainedthestudentsthatthesurfaceareaofa Sphereconecanbecalculatedbysubstitutingthevalue‘r’intheformula($4\Pi r^2$).

QuestionNo.2(slide179).Heexplained to the studentsthat thesurfacearea of a Sphereconecan becalculatedbysubstitutingthevalue‘2r’intheformulaa($4\Pi r^2$).

InQuestionNo.4(slide180). He explainedto the studentsthat theratio oftwo surface areas ofsphericalballooncanbecalculatedbydividingtheirsurfacearea.

Step4: The teacher: -gavethestudentsoneexercisebasedontheabovetopictosolveintheirnotebooks(slide-181).-gavethestudentsoneexercisebasedontheabovetopictosolveintheirnotebooksathome(slide-182).

Lesson No	Topical Sub-units	Material Used	Presentation Details
17	CurvedSurfaceAreaofa Hemisphere	PowerPoint animated CDwith LCDprojector	Step1: The teacher: -explained the area of base as area of the circle (Slide 183) and asked the students some questions.Area of the curved surface *as a half* of the area of

			the sphere and *r* as the radius of the sphere of which hemisphere is a part.(Slide 184-186) Step2: The teacher: -withthehelpofMSAnimationClips,explainedthatthe'TotalSurfaceAreaofaHemisphereissumoftheareasofbothsurfaces(areaofBaseandareaofcurvedsurface). (Slide 187-188) Step3: The teacher: -alsoexplainedthe stepsfor solutionof a problembasedon the'SurfaceAreaofaHemisphere'. (Slide 189) QuestionNo.3(slide190). Explainedtothestudentsthatthesurfaceareaofa Hemisphereconecanbecalculatedbysubstitutingthevalue'r'intheformula($3\Pi r^2$). QuestionNo.5 (slide191) - Explainedtothestudentsthattheinnersurfaceareaofa Bowl canbecalculatedbysubstitutingthevalue'2r'intheformula($2\Pi r^2$). - Also explainedto the studentsthat thecostoftin paintingcan becalculatedmultiplyingitsinnersurfaceareabyN16per100cm^2. Step4: The teacher: -gavetothestudentsoneexercisebasedontheabove topictosolveintheirnotebooks(slide-192).-gavetothestudentstwoexercises basedontheabovetopictosolveintheirnotebooksathome(slide-193).

Lesson No	**Topical Sub-units**	**Material Used**	**Presentation Details**
18	Solutionsofthe Problembasedon 'SurfaceAreaofSphere'	PowerPoint animated CDwith LCDprojector	Step1: The teacher: -asked somequestions from the studentsto ascertaintheirpreviousknowledgeand tomotivatethem. Step2: The teacher: -also explained the steps for solution of a problembased on the SurfaceAreaofaSphere'.

QuestionNo.6(slide195) - Explainedtothestudentsthattheradius’r’ofa Spherecanbecalculatedbysubstitutingtheva luesintheformula($4\Pi r^2$).

QuestionNo.7(slide196). - Explainedtothestudentsthattheratioofthesur faceareaofmoonandearthcanbecalculatedby dividingtheirsurfaceareas.
QuestionNo.8(slide197)

- Explainedtothestudentsthattheradiu sofouterradiuscanbec a l c u l a t e d byaddingradiusofinnerradiusandthi cknessofsteelsheet.
- Also explained thestudentsthatthe outercurvedsurface areaofasphericalbowlcanbecalculat edbyusingformula$2\Pi R^2$.

Step3:QuestionNo.9(slide198-199The teacher

- Explainedtothestudentsthattheradiu sofarightcircularcylinderisequaltot hat ofaSphere(r).andheightofacylinderi s twicethat the heightofaSphere.
- Explainedtothestudentsthattheratio ofthesurfaceareaofaSpheretothatofc urvedsurfaceareacanbecalculatedby dividingthem.

Step4: The teacher: - gavetothestudentsoneexercisebasedonthea bovetopictosolveintheirnotebooks(slide-200).- Gavetothestudentstwoexercisesbasedonthe abovetopictosolveintheirnotebooksathome (slide-201).

Lesson No	**Topical Sub-units**	**Material Used**	**Presentation Details**
19	Volumeofcu be	PowerPoint animated CDwith LCDprojector	Step1:The teacher: - askedsomequestionsfromthestudentstoasce rtaintheirpreviousknowledgeandtomotivate them.Afterthat, announced

			thetopic'Volumeofcube'andshoweditonscreen.(slide-203) Step2:The teacher: -Explained the procedureaboutthederivingtheformula forfindingthe'Volume ofcube'(slide204-205). Step3: The teacher asked the studentsobjectivetypequestionsrelatedtothe topictoascertainwhethertheyunderstoodornot(slide206). Step4: The teacher gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooksathome(slide-207).

Lesson No	Topical Sub-units	Material Used	Presentation Details
20	Solutionofproblembased on Volumeofcube	PowerPoint animated CDwith LCDprojector	Step1:The teacher: -askedsomequestionsfromthe studentstoascertain theirpreviousknowledgeandtomotivatethem. Step2: The teacher alsoexplainedthestepsforsolutionof problemsbasedonthe 'Volumeofcube'. Step3: QuestionNo.8(slide-209) Explainedtothestudentsthatthelengthofthesideofthe newcubecanbecalculatedbyequatingthevolumeofeightcubeswiththevolumeofacubewhoseedgeis'a'. Step4: The teachergavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooks(slide-210).-Gavethestudentsoneexercisebasedontheabovetopictosolveintheirnotebooksathome(slide-211).

Lesson No	Topical Sub-units	Material Used	Presentation Details
21	Solutionofproblembased	PowerPoint animated CDwith	Step1: The teacher: -askedsomequestionsfromthe studentstoascertaintheirpreviousknowledg

	On'Volume ofcube	LCDprojector	eandtomotivatethem. Step2: The teacher alsoexplainedthestepsforsolutionofaproblembasedonthe'Volumeofcube'. Step3:Question(slide-213).The teacherExplainedtothestudentsthattheedgecubecanbecalculatedbyequatingthevolumeofcubewiththe(edge)^3. Step4: The teacher:-Gavethestudentsoneexercisebasedontheabovetopictosolveintheirnotebooks(slide-214). -Gavethestudentsoneexercisebasedontheabovetopictosolveintheirnotebooksathome(slide-215).

Lesson No	Topical Sub-units	Material Used	Presentation Details
22	Volumeof acuboid	PowerPoint animated CDwith LCDprojector	Step1: The teacher: -askedsomequestionsfromthestudentstoascertaintheirpreviousknowledgeand tomotivatethem. Afterthat, announcedthetopic'Volumeofacuboids'andshoweditonscreen(slide-218). Step2: The teacher: -explainedtheprocedureaboutthederivingtheformulaforfindingthe'Volumeofacuboids'(slide219-224). Toexplainit,asked the students to followthefollowingsteps - WiththehelpofMSAnimationClips, explainedthattofindthe'Volumeofacuboids'fillthebottomofthecuboids witharectangleuntilthecuboidsiscompletelyfilled. - WiththehelpofMSAnimationClips, Alsoexplainedthatthevolumeofacuboidscanbecalculatedmultiplyingtheareaoftheplaneregionoccupiedbyeachrectanglebyheight. - Alsotoldthemtocalculatethevolumeofacuboids. - Also explainedthestepsfor solutionofa problem basedon the

			'Volumeofacuboids'. Step3: QuestionNo.1(slide-225) - Explainedtothestudentsthatthevolumeofapacketcontainingonematchboxbecalculatedbyusingthevolumeofacube. - Explainedtothestudentsthatthevolumeof12packets canbecalculatedbymultiplying thevolumeofonematchboxby12. QuestionNo.2(slide-226) - Explainedtothestudentsthatthecapacityofwatertankcalculatedbyusingthevolumeofacube. Step4: Gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooks(slide-227). -Gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooksathome(slide-228).

Lesson No	Topical Sub-units	Material Used	Presentation Details
23	Solution to problems based on volume of cuboids	PowerPoint animated CDwith LCDprojector	Step1: The teacher: -asked somequestionsfromthestudents to ascertain their previousknowledgeand tomotivatethem. Step2: The teacher: -alsoexplainedthestepsforsolutionofaproblembasedonthe'Volumeofacuboids'.QuestionNo.3(slide-230). -Explainedtothestudentsthatthehighofacubicalvesselcanbecalculatedbyusingthevolumeofcuboidshavingitslength10mandwide8m. Step3: QuestionNo.4(slide-231) Explainedtothestudentsthattheinternalspaceofthepit can becalculatedby usingthevolumeofacuboidsinwhich'l'is8m, 'b'is6mand'h' is 3m. -Explainedtothestudentsthatthecostof diggingacubicalpitcanbecalculateditsvolumebyN30. QuestionNo.5(slide-232).Explainedto

			thestudentsthatthebreadthcanbecalculated dividingits volumebytheproductoflengthanddepth. Step4: The teacher: -Gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooks.(Slide-233). -Gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooksathome(slide-234).
Lesson No	**Topical Sub-units**	**Material Used**	**Presentation Details**
24	Solutionofproblemsbasedon 'Volumeofa cuboids'	PowerPoint animated CDwith LCDprojector	Step1: The teacher: -askedsomequestionsfromthestudentstoascertaintheirpreviousknowledgeand tomotivatethem. Step2: The teacher alsoexplainedthestepsforsolutionofa problembasedonthe 'Volumeofacuboids'. Step3: QuestionNo.6(slide-236). The teacher: -explainedtothestudentsthatthenumberofdays can becalculatedbydividingthecapacityoftankbyquantityofwaterperday. QuestionNo.7(slide-237). -Explainedtothestudentsthatthemaximumnumberofwoodencrates canbecalculatedbydividingthecapacityofgodownbyvolumeofonewoodcrate. QuestionNo.8(slide-238). -Explainedtothestudentsthatthesideofanewcubecanbecalculatedbyequatingthevolumes ofeightcubeswiththevolumeofa cubehavingedge'12'. Step4: Gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooks.(Slide-239). -Gavetothestudentsoneexercisebasedontheabove topictosolveintheirnotebooksathome(slide-240).
Lesson	**Topical**	**Material Used**	**Presentation Details**

No	Sub-units		
25	Volumeofrightcircularcylinder	PowerPoint animated CDwith LCDprojector	Step1: The teacher: -asked some questionsfrom thestudentsto ascertaintheir previousknowledgeand tomotivatethem. Afterthat,announcedthetopic'Volumeof rightcircularcylinder' andshoweditonscreen(slide-244). Step2: The teacher: -explainedtheprocedureaboutderivingtheformulaforfindingthe. 'Volumeofrightcircularcylinder' (slide245-253). Toexplainit,He followedthefollowingsteps - WiththehelpofMSAnimationClips, explainedthattofindthe'Volumeofrightcircularcylinder'fillthebottomofthecylinderwithacircleofradius'r' untilthecylinderiscompletelyfilled. - WiththehelpofMSAnimationClips, alsoexplainedthatthevolumeofacylindercanbecalculatedmultiplyingthe BaseAreabyheight. - Alsotoldthemtocalculatethevolume ofrightcircularcylinder. - Also explainedthestepsfor solutionofa problem basedon the 'Volumeofrightcircularcylinder'. Step3: QuestionNo.1(slide-254). The teacher: -Explainedtothestudentsthatthevalueofradius'r'ofacylindricalvesselcanbecalculateddividingthediameterby2. Vesselcanbecalculatedbysubstitutingthevaluesof'r'and'h'involumeformula. Step4: The teacher:-Gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooks.(Slide-255). -Gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooksathome(slide-256).

Lesson No	Topical Sub-units	Material Used	Presentation Details
26	Solutiontoproblemsbase	PowerPoint animated	Step1: The teacher: -askedsomequestionsfromthestudentstoasce

	don 'Volumeofa cylinder'	CDwith LCDprojector	rtaintheirpreviousknowledgeand tomotivatethem. Alsoexplainedthestepsforsolutionofaproblem basedonthe'Volumeofa cylinder'. Step2: QuestionNo.2(slide-258). The teacher: -Explainedtothestudentsthatthevolumeofwoodcanbecalculatedbyusingtheformula$\Pi(R^2 - r^2)$ xh.-Alsoexplainedtothestudentsthatthemassofthepipecanbeobtainedby multiplyingthevolumeofwoodby0.6. Step3: QuestionNo.3(slide-259). The teacher: -Explainedtothestudentsthatthevolumeofatinwitharectangularbasecanbecalculatedbyusingthevolumeformulaofcuboid. - Alsoexplainedtothestudentsthatthe volumeofaplasticcylinderwithcircularbasecanbecalculatedbyusingthevolumeformulaofcylinder. - Alsotoldthestudentstocomparetheir volumestofindoutthecontainerhavingthegreatercapacityandhowmuch. QuestionNo.4(slide-260). -Explainedtothestudentsthattheradiusofacylindercanbecalculatedbysubstitutingthevaluesof'volume'andheight'h'inthe formulaandvolumecanbecalculatedbyusingthevaluesof'r'andheight's'. Step4: The teacher: -gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooks(slide-261). -Gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooksathome(slide-262).

Lesson No	**Topical Sub-units**	**Material Used**	**Presentation Details**
27	Solutionofproblemsbasedon 'Volumeofa cylinder'	PowerPoint animated CDwith LCDprojector	Step1: The teacher: -asked some questionsfrom thestudentsto ascertaintheir previousknowledgeand tomotivatethem. Alsoexplainedthestepsforsolutionofaproblembasedonthe'Volumeofacylinder'.

			Step2:QuestionNo.5(slide263-264) The teacher: - Explainedtothestudentsthattheinner curvedsurfaceareaofacylindricalves selcanbeobtaineddividingthetotalco stbycostofpaintingperm^{2}. - Alsotoldthattheradius‘r’ofthecylind ricalvesselcanbecalculatedbysubstit utingthevaluesof‘h’inthecurvedsurf acearea. - Alsoexplainedthatthecapacityofthe vesselcanbeobtainedbysubstitutingt hevalueof‘r’and‘h’. Step3: QuestionNo.6(slide-265) The teacher: - Explainedthattheradius‘r’ofthecyli ndricalvesselcanbecalculatedbysub stitutingthevaluesof‘h’initsvolumef ormula. Step 4: The teacher: - gavetothestudentsoneexercisebasedonthea bovetopictosolveintheirnotebooks(slide-266). - Gavetothestudentsoneexercisebasedonthea bovetopictosolveintheirnotebooksathome(s lide-267).

Lesson No	**Topical Sub-units**	**Material Used**	**Presentation Details**
28	Solutionofp roblemsbase don ‘Volumeofa cylinder’	PowerPoint animated CDwith LCDprojector	Step1:The teacher: - askedsomequestionsfromthestudentstoasce rtaintheirpreviousknowledgeand tomotivatethem.Alsoexplainedthestepsfors olutionofaproblem basedonthe‘Volumeofacylinder’. Step2:QuestionNo.7(slide-269) The teacher: - explainedtothestudentsthatthevolumeofGr aphitecanbeobtainedbyusingthevolumefor mulaofcylinder. - Alsoexplainedthemethodforthecalculation ofthevolumeofwood. Step3: QuestionNo.8(slide-270). The

			teacher: -explainedthatthecapacityofonebowlcanbeobtainedbyusingthevolumeformulaofacylinder. Step4: The teacher: -gavetothestudentsoneexercisebasedontheabovetopic tosolveintheirnotebooks(slide-271).-gavetothestudentsoneexercisebasedontheabovetopictosolveintheirnotebooksathome(slide-272).

Lesson No	**Topical Sub-units**	**Material Used**	**Presentation Details**
29	Volumeofright circularcone	PowerPoint animated CDwith LCDprojector	Step1: The teacher: -askedsome questionsfromthe studentstoascertaintheirpreviousknowledgeand tomotivatethem. Afterthat,announcedthetopic'Volumeofrightcircularcone'canbedeterminedfromthevolumeformulaforacylinderandshoweditonscreen.(slide274) Step2: The teacher: -explainedtheprocedureaboutderivingtheformulaforfindingthem.'Volumeofrightcircularcylinder'(slide275-281). Toexplainit,followedthefollowingsteps - WiththehelpofMSAnimationClips, explainedthattofindthe'Volumeofrightcircularcone'takeacylinderandaconehavingtheequalheights(h)andradii(r)andfilltheconeuptothebrimwithsandonce. - WiththehelpofMSAnimationClips, alsoexplainedthemtoemptythesandintothecylinder.Itfillsuponlyapartofthecylinderandwhenthe coneisfilledupforthe thirdtime,andemptiedintothecylinder,itcanbeseenthatthecylinderisalso fulltothebrim. - WiththehelpofMSAnimationClips, alsoexplainedthatthevolumeofa cone is 1/3 that of the cylinder. Alsotoldthemtocalculatethevolume ofrightcircularcylinder.

			Step3: The teacher: - alsoexplainedthestepsforsolutionofaproble mbasedonthe 'Volumeofrightcircularcylinder'. QuestionNo.1(slide-282). - Explainedtothestudentsthatthevolumeofthe rightcircularconecanbecalculatedbysubstit utingthevalueofradius'r'anditsheight. QuestionNo.2(slide283-284). -Explainedto the studentsthat thecapacityof a conical vesselcan becalculatedbysubstitutingthevaluesof'r'an d'h'in volumeformula. Step 4: The teacher: - gavetothestudentsoneexercisebasedonthe abovetopictosolveintheirnotebooks(slide-285). - Gavetothestudentsoneexercisebasedonthea bovetopictosolveintheirnotebooksathome(s lide-286).

Lesson No	**Topical Sub-units**	**Material Used**	**Presentation Details**
30	Solutionof problemsba sedon 'Volumeofa cone'	PowerPoint animated CDwith LCDprojector	Step1: The teacher: - askedsomequestionsfromthestudentsto ascertaintheirpreviousknowledgeand tomotivatethem. Alsoexplainedthestepsforsolutionofaproble mbasedonthe'Volumeofacone'. Step2: QuestionNo.3(slide-288). The teacher explainedto thestudentsthat the radiusofthebaseofa conecan becalculatedbyusingtheformulaofaconehav ing'h'asitsheight. Step3: QuestionNo.4(slide-289). The teacher: - Explainedtherelationshipofradiusanddiame terandalsoexplainedthemthattheradiusofthe baseofaconecanbecalculatedbyusingthefor mulaofaconehaving'h'asitsheight. QuestionNo.5(slide-290). - Explainedto the studentsthatthecapacityof a conicalvesselcan becalculatedbysubstitutingthevaluesof'r'an d'h'involumeformula. Step4: Gaveto

			t h e studentsoneexercisebasedontheabovet opictosolveintheirnotebooks(slide-291). -Gavetothestudentsoneexercisebasedonthea bovetopictosolveintheirnotebooksathome(s lide-292).
Lesson No	**Topical Sub-units**	**Material Used**	**Presentation Details**
31	Solutionofp roblemsbase don ‘Volumeofa cone’	PowerPoint animated CDwith LCDprojector	Step1:The teacher: -askedsomequestionsfromthestudentstoasce rtaintheirpreviousknowledgeand tomotivatethem. Alsoexplainedthestepsforsolutionofaproble mbasedonthe‘Volumeofacone’. Step2:QuestionNo.6(slide293-294).The teacher: - Explainedtothestudentsthattheheigh tofaconecanbecalculatedbyusingthe formulaofaconehaving*r* asradius. - Explainedtothestudentsthatthecurv edsurfaceareacanbecalculatedbysub stitutingthevalueof‘*r*’and‘h’inthefo rmula. Step3: QuestionNo.7(slide-295). The teacher: -explainedtothestudentsthatrevolutionofarig httriangleABCabouttheside12cm,willtaket heshapeofaconeandvolumeofthissolidcone canbecalculatedbysubstitutingthevalueof‘*r* ’and‘*h*’inthevolumeformula. QuestionNo.8(slide-296). Explainedtothestudentsthatrevolutionofari ghttriangleABCabouttheside5cmitwilltaket heshapeofaconeandvolumeofthissolidcone canbecalculatedbysubstitutingthevalueof‘r’ and‘h’inthevolumeformula. Alsotoldthemtofindtheratioofthesevolumes . QuestionNo.9(slide-297) - Explainedtothestudentsthatvolume ofaconecan becalculatedbysubstitutingthevalue of’ *r*’and‘*h*’intheformula. - Explainedtothestudentsthattheareao

fcanvascanbecalculatedbyusingthe curvedsurfaceformulaofacone.

Step4: The teacher: -gavetothestudentsoneexercisebasedontheabovet o p i c tosolveintheirnotebooks(slide-298). -Gavetothestudentsoneexercisebasedonthe a b o v e topictosolveintheirnotebooksathome(slide-299).

Lesson No	Topical Sub-units	Material Used	Presentation Details
32	Volume of a Sphere	PowerPoint animated CDwith LCDprojector	Step1:The teacher: -askedsomequestionsfromthestudentstoascertaintheirpreviousknowledgeandtomotivatethem.Afterthat,announcedthetopic'Volume ofaSphere'thatcanbedeterminedfromthevolumeformulaforacylinderandshoweditonscreen.(slide303) Step2: The teacher: -explainedtheprocedureaboutthederivingthe formulafor findingthe.'VolumeofaSphere'(slide304-309). Toexplainit,followedthefollowingsteps - WiththehelpofMSAnimation Clips,explainedthattofindthe 'VolumeofaSphere'takeacylinderandspherehavingtheequalandradii(r) andheightofacylinderisequaltotheDiameterofasphereandfillthesphereuptothebrimwithsandonce. - WiththehelpofMSAnimationClips, alsoexplainedtothemtoemptythesandintothecylinder.Itfillsuponlyapartofthecylinder. - WiththehelpofMSAnimationClips, alsoexplainedthatthevolumeofasphereisequalto2/3volumeofacylinder. - Alsotoldthemtocalculatethevolume ofasphere. - Also explainedthestepsfor solutionofa problem basedon the 'Volumeofasphere'.

			Step3:QuestionNo.1(slide-310). The teacher: -Explainedtothestudentsthatthevolumeofa spherecanbecalculatedbysubstitutingthevalueofradius‘r’initsvolumeformula. QuestionNo.2(slide311). -Explainedtothestudentsthattheamountofwaterdisplacedcanbecalculatedby substitutingthevaluesof‘r’and‘h’in volumeformulaofasphere. QuestionNo.7(slide312). -Explainedtothestudentsthatthevalueoftheradius‘*r*’of aspherecanbecalculatedbyusingthesurfacearea. -Alsoexplainedtothestudentsthatthevolumeofa spherecanbecalculatedbysubstitutingthevalueofradius‘r’initsvolumeformula. Step4: The teacher: -gavetothestudentsoneexercisebasedonthe abovetopictosolveintheirnotebooks(slide-313). -Gavetothestudentsoneexercisebasedonthe abovetopictosolveintheirnotebooksathome(slide-314).

Lesson No	Topical Sub-units	Material Used	Presentation Details
33	Solutionofproblemsbasedon ‘Volumeofa sphere’	PowerPoint animated CDwith LCDprojector	Step 1:The teacher: -askedsomequestionsfromthe students toascertaintheirpreviousknowledgeandtomotivatethem.Alsoexplainedthestepsforsolutionofaproblem basedonthe‘VolumeofaSphere’. Step2: QuestionNo.3(slide-316)The teacher: - Explainedtothestudentsthatthevolumeofametallicballcanbecalculatedbyusingthe volumeformulaofaspherehaving‘r’asradius. - Explainedtothe studentsthatthemassof the ballcanbe

			calculatedbymultiplyingvolumeofa spherebydensityofthemetal. Step3: QuestionNo.4(slide-317). The teacher: -Explainedtothestudentsthattheshapeof bothmoonandearthareofsphereandtherecan be calculatedbyusingthevolumeformulaofasp here. Alsotoldthestudentstocomparethevolumeso fbothmoonandearth. QuestionNo.5(slide-318). -Explainedtothestudentsthecapacityofthebo wlcanbe calculatedbyusingthevolumeformulaofahe misphere,i.e. ($\frac{1}{2}$volumeofasphere). QuestionNo.6(slide-319)The teacher: - ExplainedtothestudentsthatRadiuso fouterhemisphericalbowlcanbecalc ulatedbyaddingthevalueoftheinnerr adiusand1/100m. - Alsoexplainedtothestudentsthatvol umeofouterhemisphericalbowlcanb ecalculatedbyusingitsVolumeformu la. Step4: The teacher: -gavetothestudentsoneexercisebasedonthea bovetopic to solveintheirnotebooks(slide-320). -Gavetothestudentsoneexercisebasedonthea bovetopictosolveintheirnotebooksathome(s lide-321).

Lesson No	Topical Sub-units	Material Used	Presentation Details
34	Solution ofproblems basedon Volume ofasphere and hemisphere	PowerPoint animated CDwith LCDprojector	Step1: The teacher: -askedsomequestionsfromthestudentstoasce rtaintheirpreviousknowledgeand to motivatethem. Alsoexplainedthestepsforsolutionofaproble mbasedonthe'Volumeofasphere'. Step2: QuestionNo.7(slide-323). The teacher: -Explainedtothestudentsthatradiusofasphere

canbecalculatedbyusingitssurfaceareaform ula.
Alsoexplainedtothestudentsthatvolumeofs pherecanbecalculatedbyusingitsVolumefor mula.
QuestionNo.8(slide-324)

- Explainedtothestudentsthattheinner surfaceareaofhemisphericaldomeca nbecalculateddividingthetotalcostof whitewashedbypersquaremeter.
- Alsotoldthestudentstocalculatethein nerradiusofhemisphericaldomeusin gsurfaceareaofhemisphere.
- Explainedtothestudentsthatthevolu meofinsideofthedomecanbecalculat edbyusingVolumeformulaofaspher e.

QuestionNo.9(slide-325)

- Explainedtothestudentsthattheradiu sofnewspherecanbecalculatedbyeq uatingthevolumeofnewspherewitht heVolumeoftwentysevenironsphere .
- Explainedtothestudentstocalculatet hesurfaceareaofbothspheressurface.
- Explainedtothestudentstocomparet heirsurfaceareas.

Step3: QuestionNo.9(slide-326)The teacher:

- Explainedtothestudentsthattheradiu s(r')ofnewspherecanbecalculatedby equatingthevolumeofnewspherewit htheVolumeoftwentysevenironsphe reshavingradius'r'.
- Alsoexplainedtothestudentstofinds urfaceareas(*s*)and(*s'*).
- Explainedtothestudentstofindoutthe ratioof*s*and*s'*.

QuestionNo.10(slide-327)

- Explainedtothestudentsthatcapacity ofthecapsulecanbecalculatedbyusin gtheformula'4/3Πr^3,where'*r*'is3.5/

2m.

Step 4: The teacher: - gavethestudentsoneexercisebasedontheabovetopictosolveintheirnotebooks(slide-328).

- Gavethestudentsoneexercisebasedontheabovetopictosolveintheirnotebooksathome(slide-329)
- Thanked the students for their cooperation and requested them to get set for assessment on what they had been taught as a day was fixed for the Geometric Performance Test after revision.

APPENDIX B

Lessons Plan for Control Group

Module 1: General concepts of mensuration.

Date:

Class: SS II

Topic: Cuboids, Cube, Cylinder, Cone, Sphere and Hemisphere among others.

Time: 40 minutes

Behavioral Objectives: At the end of the lesson, the student should i) use appropriate geometric vocabulary to describe properties and attributes of two- and three-dimensional figures. ii) examine, recognize, name and explore the properties of geometric solids. iii) identify geometric solids in the world around them and iv) evaluate problems involving areas, volumes and other parameters.

Instructional Materials: Textbooks, Chalk, Cardboard

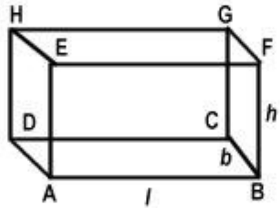
Previous knowledge: Students should have known how to use appropriate geometric vocabulary to describe properties and attributes of two and three dimensional figures. They should also be able to recognize, name and explore the properties of geometric solids. Students are expected to identify geometric solids in the world around them.

Lesson1: General concepts of mensuration.

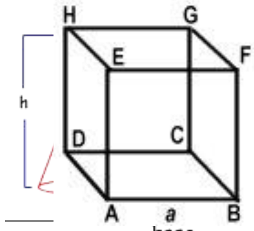
Presentation	**Teacher's activities**	**Students' Activities**	**Techniques**
Introduction of the topics. Mensuration.	Mensuration: the branch of mathematics which deals with the study of Geometric shapes, their areas, volumes and related parameters.	Responding to the shapes presentation	Induction and Questioning skills
Steps: Types	Using appropriate	Students identifying	

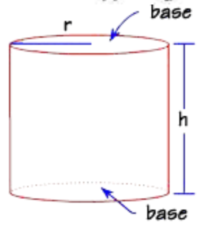
<table>
<tr>
<td>explained to students.</td>
<td>geometric vocabulary to describe properties and attributes of two and three dimensional figures.

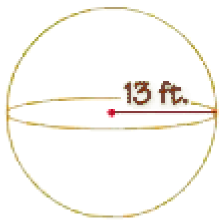
Some of these features include: Vertex, edge, surface, height, angles and so on.</td>
<td>geometric solids in the



world around them.





</td>
<td></td>
</tr>
<tr>
<td>Evaluation</td>
<td>A half of the sphere is referred to as hemisphere. Other shapes include pyramid which has same features with cone in terms of no uniform cross-section and frustum. Parallel cut of both pyramid and cone are known as frustums of both.</td>
<td>


</td>
<td></td>
</tr>
<tr>
<td>Closure</td>
<td>Assignment: Students are expected to identify geometric solids in the world around them.</td>
<td>Solve assignments at home</td>
<td>Marking and correction</td>
</tr>
</table>

Module 2.1: Cuboids

Date:

Class: SS II

Topic: Finding the diagonal of a cuboid

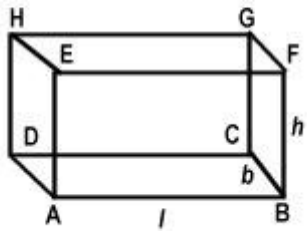
Time: 40 minutes/Period

Behavioral Objectives: The students should be able to find the diagonal of any face by Pythagoras rule, and use derived formulae to find the diagonal of the cuboid.

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students are expected to have known how to use Pythagoras theorem to find a particular side of a right angled triangle and also be able to find the square root of number.

Lesson2: Cuboids

Presentation	**Teacher's activities**	**Students' Activities**	**Techniques**
Introduction of the topic	A cuboid is a rectangular solid which has six rectangular faces, 8 vertices and 12 edges.	Responding to the shapes presentation	Questioning skills
Steps	In the figure alongside of the cuboid, length = AB = CD = EF = GH. In the figure alongside of the cuboid, breadth = AD = BC = EH = FG. In the figure alongside of the cuboid, height = AE = BF = CG = DH. In the figure alongside of the cuboid, diagonal	 Diagonal of cuboid= $\sqrt{\mathbf{AB^2+BC^2+BF^2}}$ $= \sqrt{\mathbf{Length^2 + Breadth^2 + Height^2}}$	
Evaluation	Find the diagonal (in m up to two decimal places) of a cuboid 8 m long, 4 m broad and 2 m high.	$= \sqrt{\mathbf{AB^2+BC^2+BF^2}}$ $=\sqrt{\mathbf{8^2+4^2+2^2}}$ $=\sqrt{\mathbf{84}}$ $=\mathbf{9.17m}$	
Closure	Assignment: Find the diagonal (in m up to two decimal places) of a cuboid 8 m long, 4 m broad and 2 m high.	Solve assignments at home	Marking and correction

Module 2.2: Cuboids

Date: 3

Class: SS II

Topic: Total Surface Area of Cuboids

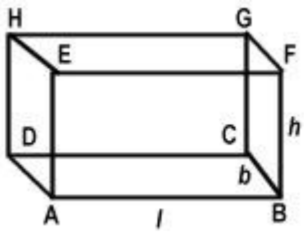
Time: 40 minutes

Behavioral Objectives: The students should be able to find the area of each face of the cuboids in pairs and sum them all to get the total surface area.

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students are expected to know the properties of the shape and distinguish same from other shapes. Also find area of rectangle or square as the case may be.

Lesson3: Cuboids

Presentation	**Teacher's activities**	**Students' Activities**	**Techniques**
Introduction of the topic	Total surface area of a cuboid = 2(Length x Breadth + Breadth x Height + Length x Height	Responding to the shapes presentation	Questioning skills
Steps	In the figure alongside of the cuboid, total surface area = 2 (AB × BC + BC × BF + AB × BF). $=lb + lb + bh + bh + lh + lh = 2lb + 2bh + 2lh$ **$= 2(lb + bh + lh)$**		
Evaluation	Example: Given l = 4 yds, b = 2 yds, and h = 5 yds, the surface area would be...	SA = 2(lb + bh + lh) SA = 2[(4yds)(2yds) + (2yds)(5yds)+(4yds)(5yds)] SA = 2(8 yds^2 + 10 yds^2 + 20 yds^2) SA = 2(38 yds^2) SA = 76 yds^2	
Closure	Assignment: The length, breadth and, height of a cuboid are 8cm, 6cm, and 4cm respectively. Find the total surface area of the cuboid.	Solve assignments at home	Marking and correction

Module 2.3: Cuboids

Date: 4

Class: SS II

Topic: Lateral surface area and volume of cuboids.

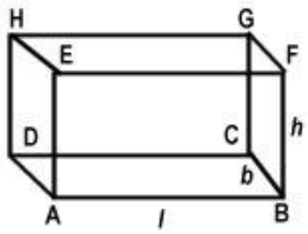
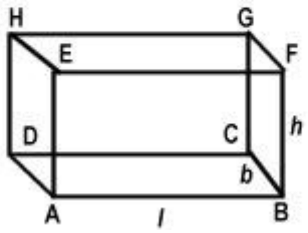
Time: 40 minutes

Behavioral Objectives: At the end of the lesson, the students should be able to find the lateral surface area and volume of cuboids

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students are expected to have known how to find the surface area of a cuboid.

Lesson 4: Cuboids

Presentation	**Teacher's activities**	**Students' Activities**	**Techniques**
Introduction of the topic	This implied the two top and bottom surfaces are removed.	Responding to the shapes presentation  	Questioning skills
Steps	Lateral surface area of a cuboid = 2 (Length + Breadth) × Height In the figure alongside of the cuboid, lateral surface area = 2 (AB + BC) × BF. = **2(l + b)h**	 	
Evaluation	The length of a hall is 20 m and breadth 16m. The sum of the areas of the floor and the flat roof is equal to the sum of the areas of the four walls. Find the height of the hall.	l=20m b=16m Area of the floor = l x b =20x16 =320 m^2 Area of the flat roof = lxb =20x16 =320m^2 Sum of the areas of the floor and flat floor = 320+320 =640m^2 Sum of the areas of the four walls of the halls =2 (l+b)xh =2(20+16)x h 72h=640 h=640/72=80/9m =8.88m	
Closure	Assignment: Find the lateral surface area and total surface area of a cuboid of length 80 cm, breadth 40 cm	Solve assignments at home	Marking and correction

and height 20 cm.

Module 2.4: Cuboids

Date: 5

Class: SS II

Topic: Properties and surface areas of a Cube

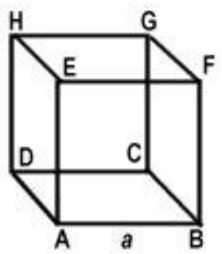
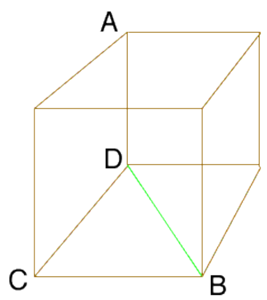
Time: 40 minutes

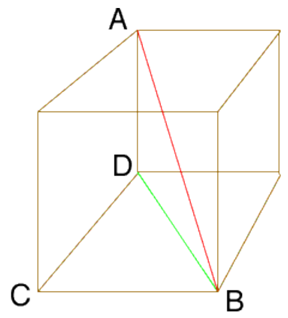
Behavioral Objectives: The students should be able to calculate the diagonal of a cube, as well as the total surface area.

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students are expected to have known the properties of a cube and how to calculate the area of a square, as well as using Pythagoras theorem to find any required side of a right angled triangle.

Lesson5: Cuboids

Presentation	**Teacher's activities**	**Students' Activities**	**Techniques**
Introduction of the topic	A cube is a rectangular solid which has six square faces, 8 vertices and 12 edges.	Responding to the shapes presentation	Questioning skills
Steps 1. 2. 3.	1. In the figure alongside of the cube, side = AB = CD = EF = GH = AD = BC = EH = FG = AE = BF = CG = DH. 2.See diagonals The line from D to B in the diagram completes the triangle DCB, which has a right angle at C. Total surface area: since the area of a face edge "a" = a x a = a^2 and there are six faces, it implies 6 x a^2 = $6a^2$	  Now consider the triangle ADB	



Evaluation	Evaluation A cube has a volume of 64 cubic inches. What is the length of segment AB? Segment AB is a straight line from the top left corner of the cube to the lower right bottom corner.	Thus, by Pythagoras' Theorem $\|DB\|^2 = \|DC\|^2 + \|CB\|^2 = 4^2 + 4^2 = 2 \times 4^2$ and thus $\|DB\| = 4 \times \sqrt{2}$. Triangle ABD is also a right triangle, this time with the right angle at D. Hence, using Pythagoras' Theorem again $\|AB\|^2 = \|AD\|^2 + \|DB\|^2 = 4^2 + 2 \times 4^2 = 3\times 4^2$ and thus $\|AB\| = 4 \times\sqrt{3}$ So the length is **exactly** $4 \times \sqrt{3}$ units, which is approx. 6.93 units.	
Closure	Assignment: A 5 cm cube is cut into as many 1 cm cubes as possible. What is the ratio of the surface area of the larger cube to that of the sum of the surface areas of the smaller cubes?	Solve assignments at home	Marking and correction

Module 2.5: Cuboids

Date: 6

Class: SS II

Topic: lateral surface area and volume of cube

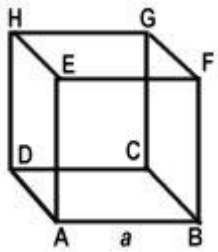
Time: 40 minutes

Behavioral Objectives: At the end of the lesson the student should be able find the lateral surface area and volume of a cube or cubical object.

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students are expected to have known the total surface area of a cube as well as how the volume of cuboid was calculated.

Lesson 6: Cuboids

Presentation	**Teacher's activities**	**Students' Activities**	**Techniques**
Introduction of the topic	Lateral surface area and volume of cube. Lateral implied the top and bottom surfaces are removed and left with 4 faces.	Responding to the shapes presentation	Questioning skills
Steps	**1. Lateral surface area of a cube = 4 × Side^2** In the figure alongside of the cube, lateral surface area = 4 × AB^2 = $4a^2$ 2.Volume = length x breadth x height = a x a x a = $\mathbf{a^3}$		
Evaluation	1. Find the Lateral Surface Area of a cube with side 4 cm. 2. A solid cube of side 12 cm is cut into eight cubes of equal volume. What will be the side of the new cube? Also, find the ratio between their surface areas.	Let 'a' be the side a = 4 cm Lateral Surface Area of a cube = 4 a^2**=** $\mathbf{4(a)^2}$**= 4x4x4** **=64cm^2** Lateral Surface Area of a cube **= 64cm^2** Let the side of the new cube be *a* cm. Then 8x$\{a\}^3$ = $\{12\}^3$ $(2a)^3 = (12)^3$ $a^3 = (6)^3$ $a = 6$ Hence, the length of the side of the new cube is 6 cm. Required ratio =$6(6)^2/ 6(12)^2$ =1/4 = 1:4	
Closure	Assignment: Find the Lateral Surface Area of a cube whose side length is 3 feet.	Solve assignments at home	Marking and correction

Module 3.1: Cylinder

Date: 7

Class: SS II

Topic: Surface areas of cylinder

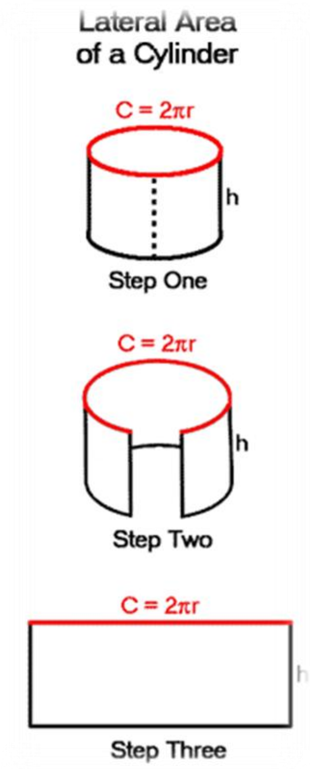
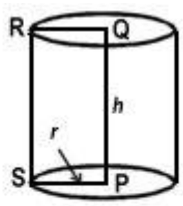
Time: 40 minutes

Behavioral Objectives: The students should be able to know each surface part of a cylinder and calculate the area and find the Total Surface Area as well as Lateral Surface Area.

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students are expected to have known how to calculate the area of a circle and rectangle as well.

Lesson7: Cylinder

Presentation	**Teacher's activities**	**Students' Activities**	**Techniques**
Introduction of the topic	A cylinder has a total of three surfaces: a top, bottom, and middle. The top and bottom, which are circles, are easy to visualize.The third surface, the lateral surface area is the curved wall of the cylinder.	Responding to the shapes presentation	Questioning skills
Steps		 Where r is the radius and h is the height. In the figure alongside of the cylinder, r = PS = QR. In the figure alongside of the cylinder, h = PQ = RS. **Curved/lateral surface area of a cylinder = 2 π rh**	

Evaluation	The diameter of a roller is 84 cm and its length is 120 cm. It takes 500 revolutions to move once over to level a playground. Find the area of the playground in m^2.	Sol. height (h) =120cm Diameter =84 cm Curved surface area $=2\Pi r\ h$ $= 2x22/7x42x120$ $=31680cm^2$ Area covered by one revolution=$31680cm^2$ Areacoveredby500 revolutions $=(31680x500)/1000m^2$ $=1584m^2$	
Closure	Assignment: The diameter of a garden roller is 2.8 m and it is 1.5 m long. How much area will it cover in 100 revolutions?	Solve assignments at home. 2.Fill in the blank; Curved surface area of a cylinder is----	Marking and correction

Module 3.2: Cylinder

Date: 8

Class: SS II

Topic: Total surface area of a cylinder.

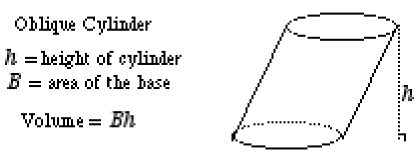
Time: 40 minutes

Behavioral Objectives: The students should be able to know the difference between right circular cylinder and oblique cylinder and find the total surface area.

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students are expected to have known the three component parts of a cylinder (such as; top, bottom and the curved area).

Lesson8: Cylinder

Presentation	**Teacher's activities**	**Students' Activities**	**Techniques**
Introduction of the topic Steps	Total surface area of a cylinder. Finally, if we put all the three surfaces together, we can arrive at the formula for the complete surface area of a cylinder. The top, the bottom, and the walls of the cylinder (the lateral surface area) determine the total	Responding to the shapes presentation Total surface area of a cylinder = $\mathbf{2\pi r(r + h)}$ A cylinder with bases that are not aligned one directly above the other is said to be ***oblique cylinder***.  Whose height taken as the	Questioning skills

	surface area. Those values are $\pi r^2 + \pi r^2 + 2\pi rh = 2\pi r^2 + 2\pi rh$. Which is sometimes written as $2\pi r(r + h)$ in certain textbooks. [Can you see how $2\pi r^2 + 2\pi rh$ is equal to $2\pi r(r + h)$ by the distributive property?]	perpendicular height shown.	
Evaluation	<u>Example</u>: If r = 5 cm and h = 2 cm, then the total surface area (TSA) would be... $TSA = 2\pi r^2 + 2\pi rh$ $TSA = 2(3.142)(5\ cm)^2 + 2(3.142)(5\ cm)(2\ cm)$ $TSA = 2(3.142)(25\ cm^2) + 2(3.142)(10\ cm^2)$ $TSA = 157.0795\ cm^2 + 62.8318\ cm^2$ $TSA = 219.9113\ cm^2$ $TSA = 219.9\ cm^2$ (rounding to the nearest tenth)	***Class work*** If r = 6ft and h = 4ft, then the surface area would be...	
Closure	Assignment: The total surface area of a cylinder is $260cm^2$, if the radius of its base is 5cm, find the height of the cylinder.	Solve assignments at home	Marking and correction

Module 3.3: Cylinder

Date: 9

Class: SS II

Topic: Total surface area of cylinder with an end open.

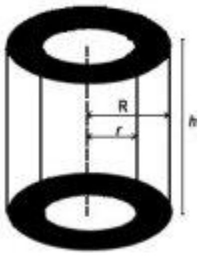
Time: 40 minutes

Behavioral Objectives: At the end of the lesson the students should be able to find the total surface area of cylinder with one end open.

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students are expected to have known how to calculate the area of each component of a cylinder.

Lesson9: Cylinder

Presentation	Teacher's activities	Students' Activities	Techniques
Introduction of the topic	**Curved surface area of a hollow cylinder** and ***Total surface area with one end open.***	Responding to the shapes presentation	Questioning skills
Steps	**1.Curved surface area of a hollow cylinder=2 π** Rh **+ 2**πrh where R is the external radius and r is the internal radius. 2. Cylinder with one end open.	 Cylinder with one end open= **2π**rh+**π**r^2	
Evaluation	1. Find the curved surface area (in cm^2) of a hollow cylinder of external radius 7 cm given that its thickness is 1 cm and height is 21 cm. 2	**=2π**Rh**+2π**rh =2x212/7x21{7+6) =1716cm^2 Cylinder with one end open= **2π**rh+**π**r^2	
Closure	Assignment: QUES. The Surface Area of a right circular cylinder of an open end of height 14 cm. is 88cm^2 Find the diameter of the base of the cylinder	Solve assignments at home	Marking and correction

Module 3.4: Cylinder

Date: 10

Class: SS II

Topic: Volume of a Cylinder

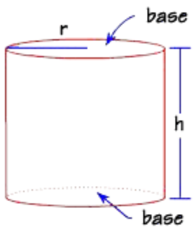
Time: 40 minutes

Behavioral Objectives: The students should be able to know that the volume of a cylinder equals the area of cross section (circle) multiplied by the eight of the cylinder.

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students should have understood that the volume of a regular prism is area of base (cross section) multiply by perpendicular height.

Lesson10: Cylinder

Presentation	Teacher's activities	Students' Activities	Techniques
Introduction of the topic; Cylinder	In this lesson, we study some common space figures that are not polyhedra.	Responding to the shapes presentation	Questioning skills
Steps	These figures have some things in common with polyhedra, but they all have some curved surfaces, while the surfaces of a polyhedron are always flat.		
Evaluation	The cylinder is somewhat like a prism. It has parallel congruent bases, but its bases are circles rather than polygons. You find the volume of a cylinder in the same way that you find the volume of a prism: it is the product of the base area times the height of the cylinder: We'll use 3.14 for pi. Then we perform the calculations like this: $V = 3.14\ (9\ in. \times 9\ in.) 20\ in$ $V = 3.14\ (81\ in^2)\ 20\ in.$ $V = 3.14\ (1620\ in^3)$ $V = 5{,}086.8\ in^3$	$V = Bh$ Since the base of a cylinder is always a circle, we can substitute the formula for the area of a circle into the formula for the volume, like this: $V = \pi r^2 h$ Let's find the volume of a can of milk with radius 9inches and height 20inches.	
Closure	Assignment:The Lateral Surface Area of a cylinder is 440 cm^2,the height of this cylinder is 10 cm, Find the diameter (cm).	Solve assignments at home	Marking and correction

Module 4.1: Cone

Date: 11

Class: SS II

Topic: Total Surface Area and Volume of a right circular Cone

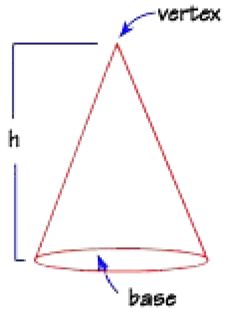
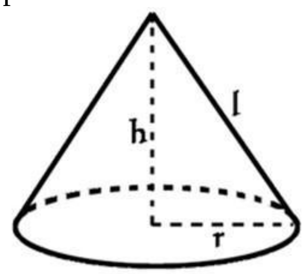
Time: 40 minutes

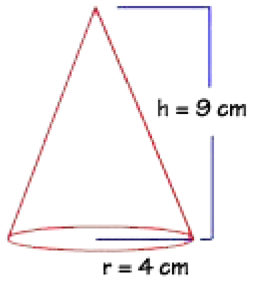
Behavioral Objectives: At the end of the lesson, the students are to be able to evaluate, using the derived formulae, the total surface area and the volume of a cone.

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students supposed to have known how to find the area and volume of a cross section shapes.

Lesson11: Cone

Presentation	**Teacher's activities**	**Students' Activities**	**Techniques**
Introduction of the topic	A cone has a circular base and a vertex that is not on the base. Cones are similar in some ways to pyramids. They both have just one base and they converge to a point, the vertex.	Responding to the shapes presentation 	Questioning skills
Steps	Since the base area is a circle, again we can substitute the area formula for a circle into the volume formula, in place of the base area.  Where *r* is the radius, *h* is the height and *l* is the slant height. The area of the curved (lateral) surface of a cone = πrl and area of base circle = πr^2 **Note:** *A cone does not have uniform (or congruent) cross-sections.*	The formula for the volume of a cone is: $V = \frac{1}{3}Bh$ The final formula for the volume of a cone is: $V = \frac{1}{3}\pi r^2 \cdot h$ The total surface area of the con = Area of the base circle + Area of the curved surface. TSA = $\pi r^2 + \pi rl$	

Evaluation	Qtn.1 A cone has a radius of 3cm and height of 5cm, find total surface area of the cone. 2. Let's find the volume of this cone. We can substitute the values into the volume formula. When we perform the calculations, we find that the volume is 150.72 cubic centimeters.	**Sol.1**.To begin with we need to find slant height of the cone, which is determined by using Pythagoras, since the cross section is a right triangle. $l^2 = h^2 + r^2$ $l^2 = 5^2 + 3^2$ $l^2 = 25 + 9$ $l=\sqrt{(34)}$ $l=5.83cm$ And the total surface area of the cone is: $SA= \pi r^2 + \pi rl$ $SA= \pi \cdot r \cdot (r + l)$ $SA= \pi x3x(3+5.83)$ $SA=83.17cm^2$ Therefore, the total surface area of the cone is 83.17cm^2 **Sol. 2.**  $V = \frac{1}{3}\pi r^2 \cdot h$ $V = \frac{1}{3}(3.14)(4cm)^2 \times 9cm$ $V = \frac{1}{3}(3.14)(16cm)^2 \times 9cm$ $V = \frac{1}{3}(50.24cm)^2 \times 9cm$ $V = \frac{1}{3}(452.16cm^3)$ $V = 150.72\ cm^3$	
Closure	Assignment:Find the capacity in liters of a conical vessel with (i) radius 7 cm, slant height 25 cm (ii) radius 12 cm, slant height 13 cm	Solve assignments at home	Marking and correction

Module 4.2: Cone

Date: 12

Class: SS II

Topic: Frustum of a cone.

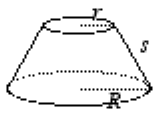
Time: 40 minutes

Behavioral Objectives: The students at the end of the lesson should know how to calculate the frustum of a cone as similar object.

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students should have known how to find the volume of a cone.

Lesson12: Cone

Presentation	**Teacher's activities**	**Students' Activities**	**Techniques**
Introduction of the topic Steps	Finding the frustum of a cone. A truncated cone or pyramid in which the plane cutting off the apex is parallel to the base. The formulae for parameter needed is given as stated.	Responding to the shapes presentation Frustum of a Right Circular Cone r = radius of upper base R = radius of lower base s = slant height  Volume $= \frac{1}{3}\pi h\left(r^2 + rR + R^2\right)$ Lateral Surface Area $= \pi(r + R)s$ $= \pi(r + R)\sqrt{(R-r)^2 + h^2}$ Total Surface Area $= \pi(r + R)s + \pi r^2 + \pi R^2$ $= \pi(r + R)\sqrt{(R-r)^2 + h^2} + \pi r^2 + \pi R^2$	Questioning skills
Evaluation	Find the volume of a frustum of a cone with its height as 4cm and the radii of its ends are 5cm and 8cm respectively	Sol. $\frac{vo}{vm} = \frac{8}{5}$ $\frac{x+4}{x} = \frac{8}{5}$:- 5(x+4) = 8x 5x + 20 = 8x 3x = 20 :- x = $\frac{20}{3}$ **SO,** $h_1=6\frac{2}{3}$ and $h=10\frac{2}{3}$ Substituting, Volume = $\frac{1}{3}\pi R^2 h - \frac{1}{3}\pi r^2 h_1$ $= \frac{1}{3}\pi(8^2 \times \frac{32}{3} - 5^2 \times \frac{20}{3})$ $= \frac{1}{3}\pi \times \frac{1548}{3} = 172\pi$ $= 540.57cm^3$	
Closure	Assignment: Find the total surface area and volume of a frustum of a cone whose slant height is 8cm and the upper and lower ends are	Solve assignments at home	Marking and correction

	circle radii 3.5cm and 4.2cm respectively.		

Module 5.1: Sphere

Date: 13

Class: SS II

Topic: Total Surface Area of a Sphere

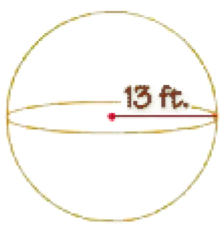
Time: 40 minutes

Behavioral Objectives: The students will be able to calculate the surface area of a sphere.

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students are expected to have been able to identify similar shapes within the world around them.

Lesson13: Sphere

Presentation	**Teacher's activities**	**Students' Activities**	**Techniques**
Introduction of the topic	We'll examine the sphere, a space shape defined by all the points that are the same distance from the center point. Like a circle, a sphere has a radius and a diameter. The shape of the earth is like a large sphere -- it has radius of about 4000 miles (6400 km). A tennis ball is a sphere with a radius of about 2.5 inches.	Responding to the shapes presentation	Questioning skills
Steps	Surface area of Sphere = **4лr**^{2}	 TSA = **4лr**^{2}	
Evaluation	Find the surface	(i) Surface area = 4x	

	area of a sphere of radius : (i) 10.5 cm (ii) 5.6 cm	22/7 x $(10.5)^2$ cm^2 = 1386 cm^2	
Closure	Assignment: The surface area of a sphere is 452.16 cm^2. Find the radius of the sphere. (Take=3.14)	Solve assignments at home	Marking and correction

Module 5.2: Sphere

Date: 14

Class: SS II

Topic: Volume of a Sphere

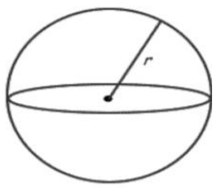
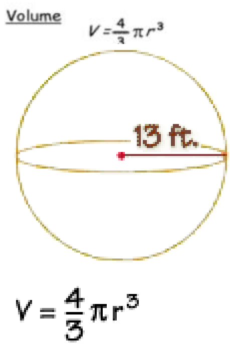
Time: 40 minutes

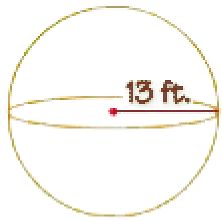
Behavioral Objectives: The students should at the end the lesson be able to calculate the volume of a sphere (any spherical object).

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students should have known that it suffices to know the radius of any spherical object in order to calculate the volume.

Lesson14: Sphere

Presentation	**Teacher's activities**	**Students' Activities**	**Techniques**
Introduction of the topic		Responding to the shapes presentation	Questioning skills
Steps	Since a sphere is closely related to a circle, you won't be surprised to find that the number pi appears in the formula for its volume:	 	

Evaluation	Let's find the volume of this large sphere, with a radius of 13 feet. Notice that the radius is the only dimension we need in order to calculate the volume of a sphere. If we substitute 13 feet for the radius, then we get 9,198.11 cubic feet.	 $V = \frac{4}{3}\pi r^3$ $V = \frac{4}{3}(3.14)(13\text{ ft.})^3$ $V = \frac{4}{3}(3.14)(2{,}197\text{ ft.}^3)$ $V = \frac{4}{3}(6{,}848.58\text{ ft.}^3)$ $V = 9{,}198.11\text{ ft}^3$	
Closure	Assignment: Find the volume of a spherical object whose radius is 16 cm	Solve assignments at home	Marking and correction

Module 6.1: Hemisphere

Date: 15

Class: SS II

Topic: Total surface area of a hemisphere

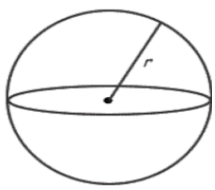
Time: 40 minutes

Behavioral Objectives: The students should be able to know what constitutes a hemisphere. Find the area of the plane surface (circle) and the area of the curved surface which is half that of the sphere.

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students are expected to have known the total surface area of a sphere.

Lesson15: Hemisphere

Presentation	**Teacher's activities**	**Students' Activities**	**Techniques**
Introduction of the topic	Total surface area and volume of a hemisphere. Hemi means half.	Responding to the shapes presentation	Questioning skills
Steps	Find the formulae for a solid hemisphere of radius *r*. Hence find the total surface area of a solid hemisphere of radius 2.1cm (correct to 3 s. f.)	 Total surface area of a	

		hemisphere = area of base circle + area of curve surface (which is half that of the sphere) T.S.A. = $лr^2$ + $4лr^2/2$ $= лr^2 + 2лr^2 = 3лr^2$	
Evaluation	Hence find the total surface area of a solid hemisphere of radius 2.1cm (correct to 3 s. f.)	T.S.A. = $3лr^2$ = 3x22/7x 21/10 = 9x11/5 = $19.8cm^2$	
Closure	Assignment: Find the total surface area of a hemisphere of radius 10 cm. (Use π = 3.14)	Solve assignments at home	Marking and correction

Module 6.2: Hemisphere

Date: 16

Class: SS II

Topic: Volume of a Hemisphere

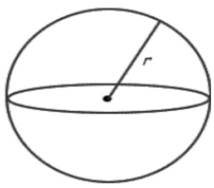
Time: 40 minutes

Behavioral Objectives: At the end of the lesson the students should be able to find the volume of a hemispherical object

Instructional Materials: Textbooks, Chalk, Cardboard

Previous knowledge: The students must have known how to find the volume of a sphere

Lesson16: Hemisphere

Presentation	**Teacher's activities**	**Students' Activities**	**Techniques**
Introduction of the topic	The volume of a hemisphere is simply a half of the volume of that of the sphere.	Responding to the shapes presentation	Questioning skills
Steps	$V = \frac{4}{3}лr^3 \times \frac{1}{2} = \frac{2}{3}лr^3$	 $V = \frac{2}{3}лr^3$	
Evaluation	What is the volume of a hemispherical solid of diameter 8.4cm?	d = 8.4cm, r = 4.2cm $V = \frac{2}{3}лr^3 = \frac{2}{3} x \frac{22}{7} x\ (4.2)^3$	

		$= \frac{3259.872}{21} = $ **155.23cm^3**	
Closure	Assignment: Find the surface area of a hemispherical bowl whose volume is 47.82cm^3	Solve assignments at home	Marking and correction

APPENDIX C

Geometry Performance Test (GPT)

Name: ____

Class: ____

Serial No. : ____

School: ____

Gender: ____

Instruction: This Geometry Performance Test (GPT) on the topic; **Surface Areas and Volumes of Geometric Shapes** appears in three different categories; Fill in the blanks, Alternative response (True-False) type, and Multiple Choice. **Time Allowed:** $\mathbf{1\frac{1}{2}}$ **hrs**

A. There are several important things to remember; Read each question carefully. Think about what is being asked.

B. Don't spend too much time on one question. Go on to the next question and return to the question skipped after answering the remaining questions.

C. Write the answers to questions **1** to**21** in the blank space provided in each question.

D. Questions **22** to **44** are true and false. Write T against each true statement and F against each false statement in the blank space provided for the answer in each case.

E. In each of the questions **45** to **76** there are four possible responses marked a, b, c, d. Indicate the correct answer in the bracket.

F. If you are to change an answer make sure that you erase your old answer completely.

Fill-in the Blanks

1. Cubic units is a standard measures of _______

2. Half of a sphere is called a_______________

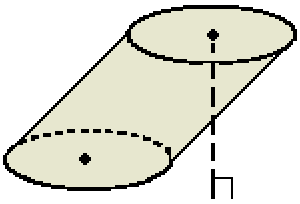
3. Half of a diameter is a ____________

4 List two prominent features of a solid i __________ ii __________

5 If 'r' is the radius of the sphere then surface area of the sphere is _________

6. When the centers of the bases of a cylinder are not aligned directly one above the other, as

in Fig.1 it is called an ________________

Fig. 1 

7 ______________________ is the segment formed when two edges of a solid figure meet.

8 Sum of the number of edges and number of vertices of a cuboids is__________

9. If the axis of a circular cylinder is not perpendicular to the bases, it is called a _________ circular cylinder.

10. A cylinder whose bases are circles, the line connecting the centers of the base is called the __________

11. The sum of the areas of a plane figures making up the boundary of a solid object is called its______________.

12. A ________________ is a solid generated by revolution of a rectangle about one of its sides, which remains fixed.

13. The Lateral Surface Area of a cube is _____whose side length is '*a*'.

14. The volume formula for the cylinder is V = _______________________

15. The corners of a solid shape are called its_________.

16. The shapes using the volume formula $V=\frac{1}{3}$Area of base x h, all have a "top" that is a ___

17. The surface area of a cube is $6s^2$, where _________________ is the length of one edge.

18. The height and radius of a right circular cylinder are both in centimeters, and then volume will be in ___________________

19. A cube has _______________________ faces.

20. The volume of a sphere is _______________________ the radius cubed.

21. The height and radius of a right circular cone are both in centimeters, and then volume will be in ___________________

Insert True OR False (T/F) for your answer in question 22- 44

22. If you know the diameter of a sphere, you can find its surface area**.**

True ( ) or False ( )

23. The surface area of a cube of side length "a" centimeters is 6a squared centimeter

True ( ) or False ( )

24 The slant height of a cone of radius 5cm and height 12cm is 13cm.

True ( ) or False ( )

25. Each plane end of a right circular cylinder is called its base

True ( ) or False ( )

26. The line segment forming the vertex of the cone to the center of its base is called the axis of the cone; the length of the area is called the height of the cone.

True ( ) or False ( )

27. A sphere with center 'O' and radius 'r' is the figure (in space) consisting of all points (in space) which are at a distance r from O.

True ( ) or False ( )

28. The curved surface connecting the vertex to the circular edge of the right circular cone is called its lateral surface.

True ( ) or False ( )

29. Total surface area of the cylinder = Curved surface area + Area of the bases.

True ( ) or False ( )

30. The larger cube occupies less space.

True ( ) or False ( )

31. The volume of a cone is one third the volume of a cylinder having the same radius and same height.

True ( ) or False ( )

32. Total surface area of a hemisphere of radius r is $3\pi r^2$.

True ( ) or False ( )

33. Plane figures are of two-dimensions (2D) and the solid shapes are of three dimensions (3D)

True ( ) or False ( )

34. The circle, the square, the rectangle, the quadrilateral and the triangle are examples of plane figures; the cube, the cuboids, the sphere, the cylinder, the cone and the pyramid are examples of solid shapes.

True ( ) or False ( )

35. Solid shapes can be drawn on a flat surface (like paper) realistically. We call this 2-D representation of a 3- D solid.

True ( ) or False ( )

36. The area of a circle with the same radius as a sphere is the same as the surface area of the sphere.

True ( ) or False ( )

37. The radius of a sphere is the longest segment possible inside the sphere.

True ( ) or False ( )

38 The radius of a cylinder is doubled but its lateral surface is unchanged, then its height halved.

True ( ) or False ( )

39. The volume of a cylinder is found by multiplying the area of one end of the cylinder by its height.

True ( ) or False ( )

40. A cube has six faces which are all rectangle.

True ( ) or False ( )

41. The axis of a cylinder is parallel to the base.

True ( ) or False ( )

42. If you know the volume of a cube, you can find the length of its edge

True ( ) or False ( )

43. Surface area of a sphere is the sum of the five times the area of the circle having same radius.

True ( ) or False ( )

44. If you know the volume of a sphere you can find the volume of a hemisphere having the same radius.

True ( ) or False ( )

45. Surface area of a cube is the sum of the areas of all its faces of a solid figure

True ( ) or False ( )

Multiple choice type questions: Indicate the correct answer by cycling in items 45-75

Q.46 ThevolumeofacubeisV.Thetotallengthofitsedgesis:

a)$6V^{1/3}$

b)$8\sqrt{V}$

c)$12V^{2/3}$

d)$12V^{1/3}$

Q.47 Two cubes have volume in the ratio 1:27 find the ratio of the area of the face of one to that of the other is:

a) 1:3

b) 1:6

c) 1:9

d) 1:18

Q.48. How many cubes of 10cm edge can be put in a cubic box of 1m edge?

a) 10

b) 100

c) 1000

d) 10,000

Q.49.The areas of three adjacent faces of a cuboids are a, b and c. If the volume of the cuboids is V, then V is equal to:

a) a b c

b) (ab+bc+ac)

c) c/ab

d) None of these

Q.50. Three cubes of a metal are of edges 3cm, 4cm and 5cm are melted together to form one new cube. Find the edge of the new cube.

a) 8cm

b) 10cm

c) 9 cm

d) 6cm

Q51. The volume of a cube is numerically equal to the sum of its edge. What is its total surface area in square units?

a) 66

b) 183

c) 36

d) 72

Q.52 A Solid shapes;

a) 3 dimensions

b) 4 dimensions

c) 2 dimensions

d) 5 dimension

Q53. When all the sides of cuboids are equal in length, it is called:

a) Plane cuboids
b) Equilateral cuboids
c) Cube
d) Cylinder

Q54. If the length, breadth and height of cuboids are 2cm, 2cm and 1cm respectively, find its surface area (in cm^2)
a) 8
b) 12
c) 16
d) 24

Q55. To find surface area of a rectangular solid there is need to find the area of each face and
a) multiplying by six
b) add to the areas
c) divide the number of faces
d) None.

Q.56 Example of one dimensional figure is
a) Cube
b) line
c) square
d) cuboids

Q.57.The radius of a cylinder is doubled and height is halved, find the ratio between the new volume and the previous volume.
a) 2:1
b) 1:2
c) 2:3
d) 3:2

Q.58. A right circular cone and a right circular cylinder are of the same radius and height, find the volume of the cylinder.
a) Twice that of the cone
b) Thrice that of the cone
c) Half that of the cone
d) Equal to that of the cone

Q.59. The diameter of the base of a right circular cylinder is 42cm, and the area of the curved surface is $1320cm^2$, find the height of the cylinder.
a) 8 cm
b) 9 cm
c) 10 cm

d) 12 cm

Q60. Find the number of iron rods, each of length 7m and diameter 2cm that can be made out of 0.88 cubic meters of iron .(**use** $\boldsymbol{\pi = \frac{22}{7}}$)

a) 300
b) 400
c) 500
d) 600

Q.61. A sphere and a cube are the same height, find the ratio of their volume.

a) 11:21
b) 21:11
c) 3:4
d) 4:3

Q.62. Find the volume of a cylinder with a base area of 10 cm^2 and a height of 25 cm.

a) 321cm
b) 250 cm
c) 350 cm
d) 502cm

Q.63.The lateral surface of a cylinder is 440sq cm. the height of this cylinder is 10 cm, find the diameter of the cylinder (cm).

a) 14
b) 7
c) 28
d) 21

Q.64. The capacity of a cylinder tank is 1848 cm^3 and the diameter of its base is 14cm find the depth of the tank.

a) 6cm
b) 7cm `
c) 24cm
d) 12cm

Q65. The radius and height of a right circular cone are 3 cm and 7cm respectively, find the curved surface area of the right circular cone.

a)156cm^2
b) 66cm^2
c) 65cm^2
d)46cm^2

Q66. Find the curved surface of a right circular cone of height 15 cm and base diameter16cm.
a) 120π cm^2
b) 60π cm^2
c) 136π cm^2
d) 68π cm^2

Q.67. The volume of a cone, whose height ‘h’ is twice the radius ‘r’ of its base is:
a) $\frac{2}{3}\pi r^3$
b) $\frac{1}{3}\pi r^2 h$
c) $3\pi r^2 h$
d) $\frac{1}{3}\pi r^2$

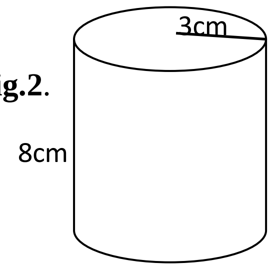
Q.68. The curved surface area of a cone of radius ‘r’, height h and slant height ‘l’ is:
a) $\pi r^2 h$
b) πrl
c) $\pi rl + 2\pi rh$
d) $\frac{1}{3}\pi rhl$

Q.69. If the radius of the base and the height of a right circular cone are doubled, find its change in volume.
a) 2 times
b) 3 times
c) 4 times
d) 8 times

Q.70. The radii of two spheres are in the ratio 2:3, find the ratio of their surface area
a) 4:3
b) 4:5
c) 4:7
d) 4:9

Q.71. The surface area of the given **Fig.2**. is;
(a) 72π
(b) 66π
(c) 80π
(d) 90π

Fig.2.



Q.72. The curved surface area of a sphere is 616 sq cm^2, find the radius of a hemisphere of this sphere.
a) 7cm
b) 14cm

c) 21cm
d) None

Q.73. The radius of a spherical balloon increases from 7 cm to 14 cm as air is being pumped into it. Find the ratio of surface areas of the balloon in the two cases.
a) 7:1
b) 1: 3
c) 1: 4
d) 3:2

Q.74. Find the volume of the sphere with a radius of 14cm.
a)14888.21cm^2
b) 18488.12cm^2
c)11488.22cm^2
d)14182.32cm^2

Q.75. A cuboids has:
a) 6 edges
b) 12 edges
c) 18 edges
d) 17 edges

Q76. Find the surface area of the sphere with a radius of 14 cm,
a) 264.76cm^2
b) 2464cm^2
c) 246.67cm^2
d) 624.76cm^2

Solutions. (Although the items of the instruments above were in three categories, they were all objective questions and were scored equally, one mark each).

1 Volumes	21 cm^3	41 F	61 A
2 Hemisphere	22 T	42 T	62 B
3 Radius	23 T	43 F	63 B
4 Height	24 T	44 T	64 D
5 $4\pi r^2$	25 T	45 T	65 B
6 Oblique Cylinder	26 F	46 D	66 A
7 Vertex	27 T	47 C	67 A
8. 20	28 T	48 C	68 B

9 Non-Circular	29 T	49 D	69 D
10 Height	30 F	50 D	70 D
11 Total Surface Area	31 T	51 D	71 B
12 Cuboids	32 T	52 A	72 A
13. $4a^2$	33 T	53 C	73 C
14 πr^2h	34 T	54 C	74 D
15 Edges	35 T	55 D	75 B
16 Vertex	36 T	56 B	76 B
17 S	37 F	57 A	
18 cm^3	38 T	58 B	
19 6 faces	39 T	59 C	
20 $\frac{4}{3}\pi r^3$	40 F	60 B	

APPENDIX D

	APPENDIX D	SCHOOL A				
S/NO	**Names**	**Maximum Marks**	**Pre Test Marks**	**Post Test Marks**	**Post Post Test Marks**	**Sex**
1	Nelson Justine	76	26	56	31	1
2	Nenlap Isa	76	32	65	37	1
3	Hussaini Godiya	76	17	64	42	1
4	Salisu Mohammed	76	23	50	29	1
5	Peace Simon	76	22	30	31	1
6	Ayatullah Musa	76	13	35	19	1
7	Hamza Ibrahim	76	20	60	22	1
8	Lawal Musa	76	25	59	45	1
9	Godfrey Paul	76	16	47	38	1
10	Askaranda Yakubu	76	23	62	42	1
11	Rufai Davadi	76	7	32	28	1
12	Yohana Daniel	76	21	67	39	1
13	Abubakar Hassan	76	26	46	25	1
14	Saminu Musa	76	21	56	32	1
15	Abednego Micheal	76	17	30	35	1
16	Christopher Iliya Kaura	76	30	60	43	1
17	Rafai Saidu	76	18	48	23	1
18	Sirajo Musa	76	24	66	30	1
19	Josiah John	76	22	65	45	1
20	Progress Philip	76	26	61	36	1
21	Rilwanu Salihu	76	25	19	26	1
22	Yakubu A. Sabo	76	26	43	25	1
23	Blessing Dominic	76	21	63	43	2
24	Laraba C. Mungak	76	24	65	42	2
25	Wunga Luckson	76	25	61	42	2
25	Regina Isaac	76	21	67	46	2
27	Yaldam Samaila	76	24	53	41	2
28	Tabitha Luka	76	23	62	37	2
29	Alheri Anthony	76	22	58	43	2
30	Chongdah Yakubu	76	21	62	45	2
31	Ladi Yakubu	76	18	49	46	2
32	Magret Gawan	76	23	58	37	2
33	Mopshi James	76	23	57	38	2
34	Patience Peter	76	25	65	41	2
35	Sarah Yusuf	76	23	62	45	2
36	Hussaina Adamu	76	24	50	29	2
37	Tabitha Gideon	76	20	38	32	2
38	Gamvwa David	76	25	19	30	2
39	Recheal Iliya	76	24	60	32	2
40	Precious D. John	76	24	60	24	2
41	Tamidah Silas	76	21	61	32	2

42	Iyatu Ya'u	76	22	58	38	2
43	Chritiana Joshua	76	25	54	29	2
44	Tabitha Dan'Azumi F.	76	13	55	38	2
45	Mariya Paul Yake	76	25	52	43	2
46	Linda Dauda	76	8	49	28	2
47	Agnes Ibrahim	76	9	52	41	2
48	Jermimah John	76	22	48	34	2
49	Bizum Solomon	76	17	54	38	2
50	Rahinatu Bala	76	17	39	48	2
51	Keziah Alhassan	76	18	64	44	2
52	Zara'u Saidu	76	7	35	47	2
53	Grace Samson	76	21	47	42	2
54	Grace M. Haruna	76	16	61	36	2

APPENDIX D **SCHOOL B**

S/NO	Names	Maximum Marks	Pre Test Marks	Post Test Marks	Post Post Test Marks	Sex
1	Sulaiman A. Sulaiman	76	26	67	41	1
2	Adamu Munskaila	76	14	70	51	1
3	Auwal adamu	76	14	66	30	1
4	Abdumudallib Sulaiman	76	32	67	59	1
5	Usman Idris	76	22	64	39	1
6	Ibrahim Adamu	76	25	67	64	1
7	Isma'il Ahmad	76	26	64	47	1
8	Temple Valentine	76	22	63	42	1
9	Ibrahim Idris	76	22	61	41	1
10	Sadam Muhammad Haladu	76	19	67	52	1
11	Ameachi Samuel	76	33	67	44	1
12	Abdul Karim Abdullahi	76	24	66	34	1
13	Faruok Umar	76	22	65	40	1
14	Ibrahim Nuhu Kobir	76	10	62	45	1
15	Rilwanu Adamu	76	17	65	41	1
16	Ahmeed Zakariya Abubakar	76	27	69	39	1
17	Abubukar Sanusi	76	25	68	38	1
18	Mohammed Aadamu Buba	76	23	64	42	1
19	Kamalu Danjuma	76	28	60	51	1
20	Isma'il Ibrahim Kangere	76	34	66	39	1
21	Ahmad Abba	76	31	67	30	1
22	Timothy Paul	76	14	49	40	1
23	Abdulmajid Sirajo	76	16	65	42	1
24	Umar Suleiman	76	24	66	40	1
25	Zumji Isaac	76	26	67	46	1
26	Ibrahim Yau Tama	76	26	63	42	1
27	Aliyu Hudu	76	25	67	45	1
28	Abdulrahman Abdulrazak	76	28	66	35	1
29	Faith Chizoba Romanus	76	21	69	55	2
30	Ladi Danjuma	76	25	71	47	2
31	Aminat Mahamood	76	22	69	32	2
32	Victoria Simon Egbunu	76	25	70	42	2
33	Hajara Muh'd Umar	76	19	72	32	2
34	Cynthia Agbenyi	76	23	72	38	2
35	Nzisaiba Muh'd Usman	76	23	73	29	2
36	Peace Iliya Aliyu	76	22	70	43	2
37	Charity Samaila Balami	76	25	73	41	2
38	Mercy Yusuf	76	24	71	37	2
39	Esther Monday Akpan	76	25	73	66	2
40	Abigail Daniel	76	26	71	30	2
41	Ummahani Ridwan	76	24	67	35	2
42	Hajara Musa	76	32	73	56	2
43	Mary Daniel	76	23	73	51	2
44	Mary Yakubu	76	31	71	34	2

45	Hajji Ibrahim Mala	76	22	68	30	2
46	Khadija Musa Usman	76	25	68	34	2
47	Asiya Abubakar Sadeeq	76	24	65	48	2
48	Shamsiya Sa'idu	76	23	68	40	2
49	Halima Musa	76	22	67	49	2
50	Hafsat Muhammad Sani	76	22	59	36	2
51	Peace J. Awang	76	32	71	43	2
52	Hajara Muh'd Sabo	76	30	67	30	2
53	Zainab Haruna	76	27	72	51	2
54	Ikilima Bala	76	24	73	28	2
55	Zainab Yakubu	76	26	70	33	2
56	Maryam Abubakar	76	31	71	30	2
57	Fatima A. Garba	76	25	71	35	2
58	Zainab S. Garba	76	24	65	28	2
59	Fabila Muhammad Isma'il	76	18	64	32	2
60	Rashida Lawal	76	21	63	29	2
61	Maijidda Abdullahi	76	22	68	32	2
62	Ikilima Abdullahi	76	22	64	36	2
63	Maryam Rabiu	76	28	72	33	2
64	Maryam Haruna	76	27	71	35	2
65	Zainab Zailani	76	20	72	30	2
66	Fatima Kabiru Bello	76	23	71	44	2
67	Amina Yahaya	76	28	71	45	2
68	Mercy Makeri	76	32	70	51	2
69	Endurance John	76	26	73	57	2
70	Zahra'u Garba Abdullahi	76	24	71	44	2
71	Maimunat Shamsuddeen	76	29	72	34	2
72	Habiba Olatunde	76	28	73	41	2
73	Muhibbat Muhammad	76	26	73	66	2
74	Aisha Bello	76	31	72	35	2

APPENDIX E

Appendix E: Coefficient of Reliability

Odd (A)	Even (B)	Rank A	Rank B	*d*	d^2
39	55	2	7	-5	25
45	46	5	3	2	4
49	59	7	9	-2	4
38	48	1	4	-3	9
61	65	14	14	0	0
57	11	10	1	9	81
42	40	3	2	1	1
50	60	8	10	-2	4
67	63	18	12	6	36
58	57	11	8	3	9
71	72	20	21	-1	1
60	64	13	13	0	0
66	71	17	20	-3	9
59	68	12	17	-5	25
43	52	4	5	-1	1
70	70	19	19	0	0
62	66	15	15	0	0
64	67	16	16	0	0
56	62	9	11	-2	4
47	54	6	6	0	0
73	69	21	18	3	9
Total					**222**

Using

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)}$$ Where n = 21

$= 1 - \frac{6\ (222)}{9240}$ = 1- 0.144156 = 0.855844

= 0.86

APPENDIX F

Statistical Output of the Analysis

APPENDIX G

APPENDIX H

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