

**EFFECT OF COMPUTER ASSISTED INSTRUCTION ON STUDENTS'  
ACHIEVEMENT AND ATTITUDE TOWARDS LATITUDE AND LONGITUDE IN  
OGUN STATE, NIGERIA**

by

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## DECLARATION

I, **CALEB AYODELE AKINTADE**, declare that the “**Effect of Computer Assisted Instruction on students’ Achievement and Attitude towards Latitude and Longitude in Ogun state, Nigeria**” is my original work, and has not been submitted for any degree or examination at any other university. All the sources used or quoted in the study are duly acknowledged by means of complete references.



MR AKINTADE, CALEB AYODELE

29/3/2017

DATE

## DEDICATION

The project is dedicated to my Creator and His Loving Son Jesus, who has preserved, sustained and kept me in the FAITH throughout my programme and enabled me to actualize my lifelong dream. All to you, and none of mine!

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## ABSTRACT

For the past few years, the West African Examination Council (WAEC) Chief Examiners' reports on students' performance in mathematics have indicated that some topics (e.g. concepts of latitude and longitude) have posed a major problem for students at the senior secondary school level. This poor achievement of students in understanding the topic may be associated with the traditional "chalk and talk" method that teachers use in teaching the concept.

Education reforms in recent years, have advocated for a student-centred method of teaching; a method that allows individual student to work at his own pace or in groups. Various researchers have encouraged the use of different forms of ICT, such as computer-assisted instruction (CAI), in the teaching of mathematics to improve students' learning of topics in mathematics perceived to be difficult. With all the efforts concentrated on improving students' performance in mathematics, no research studies have been conducted on the effectiveness of CAI on students' achievement and attitude towards the learning of the concepts of latitude and longitude in Nigerian secondary schools.

The study employed pre-test, post-test non-equivalent control group, quasi-experimental design involving two groups: experimental group (162) and control group (158) research design to investigate the effect of the CAI method of teaching on 2<sup>nd</sup> year senior secondary school students' achievement and attitude to latitude and longitude. Instruments for the research study were Achievement test in latitude and longitude (**ATLL**); questionnaire on students' attitude to latitude and longitude (**QSALL**); semi-structured interview and class observations protocol. The instruments were validated, and found reliable via a pilot study before they were employed for the main study. Data collected were analysed using both the descriptive and inferential statistics to answer the research questions and to test the stated null hypotheses. Results showed a statistically significant difference in the post-test mean scores of the experimental and the control groups, whereas there was no statistically significant difference in the pre-test mean scores of these two groups. In addition, the results revealed non-significant difference between the mean scores of girls and boys in the post-test. Furthermore, there was no significant difference between science students' post-test mean scores and their counterparts in the arts and commercial classes, and there was no interactive effect related to treatment, gender and students' subject area in the post-test. Specifically, the knowledge in this study has added another dimension to everyday experiences of students in

mathematics when the software was used to teach the perceived difficult topics, and they were actively involved in the learning process through the use of CAI techniques. The study concludes with recommendations for future research, because even though it is limited to Ogun State, it has potential for future research to be undertaken by expanding its scope to cover many other states in Nigeria. This study also recommends that efforts be made to integrate the philosophy of CAI to the teaching curriculum in Nigerian secondary schools. Furthermore, applications of the recommendations would be appropriate for the improvement to the teaching methodology of mathematics and other science-related subjects in Nigerian secondary schools.

**Key terms:**

Computer-assisted instruction, Traditional method, latitude and longitude, students, mathematics, senior secondary school, gender, achievement, attitude

## ACRONYM

<b>ANCOVA</b>	.....	Analysis of Covariance
<b>ANOVA</b>	.....	Analysis of Variance
<b>CAI</b>	.....	Computer Assisted Instruction
<b>CAIP</b>	.....	Computer Assisted Instruction Package
<b>CBL</b>	.....	Computer-Based Learning
<b>CK</b>	.....	Content Knowledge
<b>ATLL</b>	.....	Achievement Test in Latitude and Longitude
<b>FME</b>	.....	Federal Ministry of Education
<b>FRN</b>	.....	Federal Republic of Nigeria
<b>ICT</b>	.....	Information and Communication Tecnology
<b>JSSS</b>	.....	Junior Secondary Schools Students
<b>MDGs</b>	.....	Millennium Development Goals
<b>NECO</b>	.....	National Examination Council
<b>NCE</b>	.....	National Council on Education
<b>NCTM</b>	.....	National Council of Teachers of Mathematics
<b>NERDC</b>	.....	Nigerian Educational Research and Development Council
<b>NEEDS</b>	.....	National Economic Empowerment and Development Strategy
<b>NPE</b>	.....	National Policy on Education
<b>NRC</b>	.....	National Research Council
<b>QSALL</b>	.....	Questionnaire on Students' Attitude to Latitude and Longitude
<b>SSS</b>	.....	Senior Secondary School Students
<b>TM</b>	.....	Traditional Methods
<b>UTC</b>	.....	Universal Time Coordinated
<b>UTME</b>	.....	Unified Tertiary Matriculation Examination
<b>WAEC</b>	.....	West Africa Examination Council
<b>WASSCE</b>	.....	West African Senior Secondary School Certificate Examination



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# CHAPTER ONE

## INTRODUCTION

In this chapter, the introduction and background to the study are discussed. In addition, the problem statement, objectives of the study, research questions and research hypotheses are clearly stated. This chapter also presents the significance of the study, statistics of students' achievement in mathematics over a period of 5 years (2011–2015), the motivation for the study, its scope, and limitations. The chapter concludes with definitions of operational terms.

### 1.1 BACKGROUND OF THE STUDY

In Nigeria, the government and the people place a high premium on the teaching and learning of mathematics in schools. That is why mathematics is a compulsory school subject at the primary, junior secondary and senior secondary school's level (equivalent to grade 1 to grade 12).

On the directive of the National Council on Education (NCE), all school curricula have been reviewed by the Nigerian Educational Research and Development Council (NERDC) to meet the challenges of primary and secondary education in the context of the home grown National Economic Empowerment and Development Strategy (NEEDS) and to achieve the critical targets of the millennium development goals (MDGs). To actualize these objectives, subjects at the secondary school level are grouped into four specialized fields of study, namely: Humanities, Science and Mathematics, Technology, and Business Education; each made up of five compulsory cross-cutting core subjects in addition to core subjects in each one of the specialized fields of study. Mathematics is one of such compulsory cross-cutting core subjects, which every student must pass in order to proceed to higher studies (Abakpa&Iji, 2011; Fatade, 2012).

Despite the status of mathematics in the National Policy on Education (FRN, 2004), and its attendant importance to science and technology as a roadmap to nation building, it is evident that students' performance in the subject have not witnessed any improvement over the years (Abiam&Odok, 2006). This problem of students' poor performance in mathematics, at both internal and external examinations, has remained a source of concern to all stakeholders in education including mathematics educators, and those in the field of the mathematical sciences.

Consequently, the problem has eaten deep into the foundation of the nation's technological growth and its national development. Researchers such as Abakpa and Iji (2011) as well as Akinsola and Igwe (2011) have reported that topics such as construction, geometrical proofs, locus, latitude and longitude, equip students with the mathematical knowledge and skills that are basic requirements for all engineering courses in tertiary institutions. They stress that students equipped with this mathematical knowledge and these skills will be active players in technology and vocational areas that are the foundation of the economic development and transformation of any country.

Mathematics educators and researchers in Nigeria have made significant efforts aimed at identifying the major problems associated with the teaching and learning of mathematics as it relates to the concepts of latitude and longitude as a topic in the nation's schools. Salman, Muhamed, Ogunlade and Ayilara (2012) have identified students' negative attitude towards mathematics as one of the factors affecting their performance in the subject. Yara (2009) has attributed students' poor performance in mathematics to the attitudes of teachers towards the subject. Yusuf and Afolabi (2010) have pointed out the role played by teachers' resistance to change their methods of instruction; they are convinced that traditional strategies are better than newer ones when dealing with large classes in Nigerian secondary schools. According to Adolphus (2011), factors responsible for students' poor performance in latitude and longitude include the following: students' poor background in mathematics; unqualified teachers in the system; students' negative attitude towards mathematics; and students' psychological fear of mathematics.

Conscious of these factors, the federal government of Nigeria stipulates in the National Policy on Education (NPE) that for a student to be admitted to any institution of higher learning in Nigeria, such candidate should obtain credit pass in mathematics and English language (FRN, 2004). The policy further stipulates that admission to Nigerian tertiary institutions shall be in the ratio 60:40 in favour of the sciences for university candidates, while polytechnics and colleges of education/technology shall be in the ratio 70:30 in favour of the sciences and technical/vocational courses, in order to encourage more students to register for science-related subjects (FRN, 2004). However, this projection as planned by the government is difficult to achieve because many prospective science

students fail to obtain credit in mathematics, and as a result cannot gain admission to the institution of higher learning of their choice.

Table 1.1 below revealed Nigerian students' performance in the West African Senior Secondary Certificate Examination (WASSCE) in mathematics over five consecutive years.

**Table1.1: Statistics of students' performance in mathematics (2011 -2015)**

Year	Total entries	No. present for exam	No. obtained 50% pass and above	No. failed (below 50% pass)
2011	1,587630	1,580630	540,250 (34.25)	1,040,380(65.75)
2012	1,768924	1,768923	635,634(38.83)	1,133,289(61.17)
2013	1,689188	1,543683	564,987(38.30)	978,696(61.70)
2014	1,705976	1,692435	529,425(31.28)	1,163010(68.72)
2015	1,593442	1,593442	616,370(38.68)	977,072(61.32)

**Source:** Test Development Division West African Examinations Council (WAEC, 2011–2015), Yaba, Lagos.

The results indicate that majority of the students failed to obtain a 50% pass in mathematics. For instance, in 2011, 1,587630 candidates sat for the examination. Of these, only 540,250 representing 34.25 % obtained the 50% pass mark while the remaining 1,040,380 candidates, representing 65.75 % of the total, failed. In 2012, out of a total number of 1,768923 students examined, 635,634 candidates representing 38.83% of the total failed to obtain a 50% pass. In 2014out of 1,692435 candidates examined, only 529,425 representing 31.28% passed with 50% while 1,163010 representing 68.72% of the students failed to obtain a 50% pass in the subject. This trend has continued with little or no improvement in 2015. Out of the 1,593442candidates examined, only 616,370 (38.68%) passed at the 50% credit level while the remaining,977,072 representing 61.32% candidates failed the subject(The *Guardian Nigeria Newspapers*, 2012;The *Vanguard Newspapers*, 2013;This *Day Newspaper*, August 11, 2015;WAEC, 2011-2015).

In addition to students' poor performance in mathematics, the Chief Examiners' reports have also indicated that the concepts of latitude and longitude have posed a major problem area for students at the senior secondary school level. According to the reports (WAEC, 2007; 2010), candidates have generally shown a lack of understanding of the questions and have failed to address them adequately, according to the reports:

Many of the candidates could not read and carry out the instructions needed to solve problems. The candidates sometimes misread the questions and thus failed to understand what they were required to find. They lacked the skills and techniques of presenting their answers coherently (WASCE, 2007, p. 237).

Latitude and longitude questions were popular among the candidates. However, many of them failed to find the latitude of a point. The barrier was their inability to form the equation such as  $D = \frac{\theta}{360} \times 2\pi R$ " (WASSCE, 2010, p. 242).

Report findings over the years indicate that topics such as construction, geometrical proofs, locus, latitude and longitude that prepare students for all engineering courses in tertiary institutions are difficult for many candidates in Nigerian secondary schools (Adedamola, 2015; Adeyemi, 2012; Ahmed, 2013; Awofala, 2013; WAEC, 2010). According to the researchers, students equipped with mathematical knowledge and skills would be active players in technology and vocational areas that are crucial to the economic development and transformation of any country. Akintade, Ogbonnaya & Mogari, (2013) have reported that some Nigerian mathematics teachers lacked a pedagogical approach to teaching some topics such as latitude and longitude to their students. This assertion was consistent with Shulman (1986) submission, that when a teacher lacks the approach to teach a particular content, it becomes difficult for him to transform content knowledge into a form that students can easily understand. The conventional teaching methods adopted by subject teachers could be one of the reasons for students' inability to address latitude and longitude questions adequately during the examination.

Education forms in many countries in recent years have advocated for a student-centred method of teaching (Clarke, 2004; Hansson, 2010; Panaoura, 2012; Van le Walle, 2007). Many reforms have also encouraged the use of different forms of ICT to teach mathematics in order to improve students' learning (Adedamola, 2015; Ahmed, 2013; Chang, Sung & Lin, 2006). Panaoura and Philippou (2007) consider computer-assisted

instruction (CAI) as a learner-centred method that allows students to work individually or in groups at their own pace. According to these researchers, the CAI can be used to teach a concept through attractive animations, sound and demonstrations. The teaching approach provides immediate feedback for students to enable them know whether their answers are correct or not. Because the strategy is users' friendly, it gives prompts/tips to enable students answer the question. One of the advantages of the CAI software is the ability to link to an array of related websites that can further help students in mathematics. The use of CAI have been found by some studies not only to have enhanced students' achievement in various mathematical concepts, but also motivated them to learn more, and aided the development of their social skills and sustained their understanding (Hung, Lee&Wei, 2010).

With all the efforts concentrated on improving students' performance in mathematics in Nigeria, there seems to be a dearth of studies on how students' achievement and attitude towards latitude and longitude can be enhanced through the use of CAI strategy (Awolola 2011; Salman, et al, 2012). The apparent lack of literature on the effectiveness of CAI strategy to teach this aspect of mathematics, and the diverse findings of studies on the effectiveness of CAI in teaching other aspects of mathematics and other subjects, make a case for this study.

It is against this background that the introduction of CAI to teach latitude and longitude may help to foster students' achievement and attitude on the topic that the researcher was motivated to carry out the study. Specifically, the study investigates the nature of effects of Computer Assisted Instruction on 2<sup>nd</sup> year senior secondary school students' academic achievement in and attitude towards the concept of latitude and longitude in Ogun state, Nigeria (equivalent to grade 11) students' in Ogun State, Nigeria.

## **1.2: CATEGORIES OF TEACHING APPROACH IN EDUCATION**

Effective teaching is based on helping students progress from one level to another in a sociable interactive environment and help them to be independent (Muijs&Reynolds, 2005). Although there are various scholarly articles on teaching approaches that could enhance students' understanding and knowledge in mathematics, this notwithstanding, three major categories are considered in this section, namely: teacher-centred, learner-centred and subject-centred approaches.

### **1.2.1 Teacher-centred approach**

The teacher-centred teaching approach according to Fatade (2012), is a teaching method that focuses on the teacher's efforts in the classroom system whereby the curriculum, teaching and learning process radiates around the teacher who uses force, commands and even threats against the personal status of an individual. The teacher is rigid, inflexible, and autocratic. He fails to recognize the psychological inevitability of individual differences among the students. In addition, the teaching approach is formal and permits the instructor to direct how, what, and when students learn (Dupin-Bryant, 2004).

In a teacher-centred approach setting, the focus is primarily on getting answers to a given problems. Students are not given the opportunity to actively construct their own mathematical knowledge but rather, depend on the teacher to determine the validity of their answer. In effect, learners view mathematics as a series of rules that arbitrarily emanate from the teacher (Akay & Boz, 2010; Azuka & Awogbemi, 2012; Mji, 2003). Fatade, (2012) stressed further that many students in the mathematics classroom did not find the teaching method exciting, but try only to memorize the rules and algorithms of the subject to obtain good grades. Indeed, the method offers little opportunity to do mathematics but merely rewards the learning of rules (Brown, 2008; Van de Walle, 2007).

### **1.2.2 Learner-centred approach**

Various researchers (e.g, Panaoura & Philippou, 2007; Panaoura; 2012; Zeki, & Guneyli, 2014) have called for an approach that makes learners more responsible for their own learning. According to Brown (2008), students nowadays are not simply required to acquire knowledge in their fields but rather to make use of their knowledge outside the educational system and context. The Professional Standards for Teaching Mathematics in schools posits that teachers must shift from a teacher-centred to a learner-centred approach in their methods of instruction (NCTM, 2006). This is consistent with Dupin-Bryant (2004), submission that learner-centred teaching approach as a method of instruction is responsive, collaborative, problem-centered and democratic, in which both students and the instructor decide how, what, and when learning occurs. The approach focuses on the growth of the learner through visible active experience where the elements of the design are structured with the learners' felt needs and interests in mind. Hansson (2010) stressed that the approach fixes the learner as the starting point, the centre and the end. Wolk (2006), stressed that in a learner-centred classroom settings, learners' opinions or ideas must be considered.

The teacher merely applies or enlarges on those opinions or ideas by praising or encouraging the participation of students, or clarifying and accepting their feelings.

In order to achieve learner-centred teaching according to Weimer (2002), the following has to be changed. (i) The choice of content (ii) the instructor's role (iii) responsibility for learning (iv) the process of assessment, and (v) the power of the relationship between teachers and learners. It is argued that learners need to have ownership of their own learning, and take responsibility for some levels of instruction. This view is consistent with Bain (2004)'s claim that instructors should touch the lives of their learners; place a strong emphasis on learners' learning and outcomes by using varied forms of assessment and its effect on career goals. For a teacher using this approach which is consistent with the concept of growth and learning, it is generally believed that learners will achieve better academically because of the teacher's flexibility and scientific approach to teaching.

Several studies (e.g. Ng&Lai, 2012; Okpala, 2006; Saulnier, Landry&Wagner, 2008) are in support of learner-centred learning activities. Their studies revealed that learner centred method allows students to learn more, build academic relationships among peers and provide a more authentic students' assessment. The findings of Walsh and Vandiver (2007) supported the claims that learners performed better academically because they had a say in what they learned, and that teachers acted only as facilitators in order to allow the learners to learn actively. The study by Wohlfarth, Sheras, Benett, Simeon, Pimental & Gabel, (2008) indicated that the learner-centred approach focused on students' more than on teachers and on learning more than on teaching.

The following are considered important in learner-centre approach classroom setting. First, the focus will be learner-centred, with higher rates of retention attained rather than the mere traditional training of those learners (McCombs, 2004; Sternberg&Grigorenko, 2002). Second, successful students are actively involved and monitor their thinking, and take responsibility for it. Third, learner-centre approach increases motivation for learning and gives greater satisfaction with school, which eventually leads to greater achievement (Chang, Sung&Lin, 2006).

### 1.2. 3 Subject-centred approach

The organization of the curriculum to focus on the subject matter is referred to as a subject-centred curriculum (Rizvi&Lawson, 2007). The subject-centred curriculum on its own could not be effective in the mathematics classroom unless other components, such as subject content and pedagogical content knowledge (PCK), are taken into consideration (Ball, Hill&Bass, 2005; Shulman, 1986).

Several research studies have reported the positive influence of teachers' content knowledge on students' success in learning mathematics (Ahmad, 2008; Hills, Rowan&Ball, 2005). Ingvarson, Beavis, Bishop, Peck & Elsworth, (2004) showed the positive influence of teachers' pedagogical knowledge on students' performance. Their findings indicate that teachers play a significant role in the life of any student that desires to move from the world of life into the world of symbols and in addition move within the world of symbols itself. Therefore, for any teacher to effectively teach at all levels of education, a deeper and more profound understanding of fundamental skills is required. They should not only have a strong background in mathematics, but also a thorough understanding of pedagogy (Akintade, Ogbonnaya&Mogari, 2013; Ingvarson et al., 2004). In addition, a competent teacher should have a solid foundation of both procedural and conceptual knowledge of the subject, which is known as a profound fundamental knowledge of mathematics teaching (Hills et al., 2005).

Procedural knowledge, according to Isleyen and Isik (2003) is described as knowing how to solve mathematical problems. For instance, students who know how to apply the rules and formulas to calculate the distance between two points on a parallel of latitude in order to determine the position of a point on the surface of the earth, and to calculate the speed and distance between two points on a great circle, exhibit procedural knowledge. Teaching for procedural knowledge, therefore, means that students are taught to solve a problem through the manipulation of mathematical skills such as procedures, rules, formulas, algorithms, and symbols that are used in mathematics.

However, conceptual knowledge is characterized most clearly as knowledge that is rich in relationships (Isleyen&Isik, 2003). Hence, conceptual knowledge provides the reason why the formulas work. For example, if a student knows why angle ranges from  $0^\circ$  at the equator to  $90^\circ$  at the North and South Poles of the earth is called latitude, and why longitude is referred to as a distance measured from  $0^\circ$  east and  $180^\circ$  west of the prime meridian, the student has then exhibited conceptual knowledge. Teaching for conceptual knowledge,



therefore means to teach students to understand mathematical concepts by making them able to interpret and apply rules and formulas correctly in a variety of situations, as well as to translate these concepts into verbal statements and their equivalent mathematical expressions (Skemp, 1987).

### **1.3: TRADITIONAL VERSUS CAI METHOD OF TEACHING**

Nowadays, our society is divided into two major streams of thought on education. Some believe that traditional methods of teaching are better than modern methods while others support both. However, it is widely accepted that to arrest the attention of students of this generation, and make them interested in mathematics and other science-related subjects, it is essential to involve them through hands-on activities (Spradlin, 2009).

#### **1.3.1 Traditional method of teaching (TM)**

The traditional method of teaching refers to the old school of teaching which was teacher-centred, old fashioned and a routine type of teaching; in other words, archaic (Wolk, 2010). This method includes lecturing, dictation, “chalk and talk” method of teaching, drill, teacher-led activities, discussion and explanation. Research indicates that students perform better, have higher achievement and are more attentive in class when given direct instruction with traditional teaching method (Alsup&Springer, 2003; Flores &Keylor, 2007). However, it is argued that these students only rely on their teachers to determine if their answers are correct or not when performing a task in the classroom. Obviously, students emerge from these experiences with a view that mathematics is a series of arbitrary rules, handed down by the teacher (Dupin-Bryant, 2004; Wolk, 2010). According to Wolk (2010) the method is boring for students particularly those in primary schools. There is little student participation, little adaptation or creativity when compared to the CAI method of teaching (Akengin, 2011; Dupin-Bryant, 2004; Fatade, 2012).

In Nigerian schools, the traditional approach to teaching is more widespread than the modern method of teaching. Teachers illustrate a concept to students with the help of chalk and the blackboard. Everything of importance regarding the topic is written on the blackboard and students make notes from there (Fatade, 2012). In the traditional approach to teaching, the teacher follows the rules and gets answers for students to copy down (Dupin-Bryant, 2004). Akengin (2011) posits that numerous tasks which are difficult or impossible to administer in the traditional environment can be achieved with a computer. Bishaw and Egziabher (2013) also noted that in Ethiopia, the enactment of the new Education and

training Policy gave consideration to the students' cultural background in the curriculum and method of teaching. As a result, the government introduced various innovation/interventions on which learner- centred teaching approach is one of the packages.

### **1.3.2 CAI method of teaching**

Because of the rapid development of information and communication technology, the use of computers in mathematics education has become inevitable (Serin, 2011). The use of technology in education generally provides the students with a more suitable environment to learn, creates interest and learning atmosphere, and helps increase their motivation (Adedoyin, 2012). The use of technology in this way plays an important role in the teaching and learning process (İşman et al., 2002). For instance, in England the national curriculum (2008) encourages teaching mathematics by using information and communication technology. In the US, the National Council of Teachers of Mathematics (NCTM, 2000, p. 24), according to *Principles and standards for school mathematics*, encourages teachers to use computers in the classroom and states:

Computers are essential tools for teaching, learning and doing mathematics. They furnish visual images of mathematical ideas, facilitate organization, analyse data, and compute efficiently and accurately.

In parallel with technological advances, technological devices such as computers are used in educational environments to develop audio-visual materials, such as animation and simulation, which has resulted in the development of computer-based instruction techniques (Schorr&Gnoldin, 2008).

Although the use of computers is not new, CAI is a common terminology that is very popular in today's educational system and schooling process. Studies of how CAI programs compare with other methods of teaching dates back to the 1980s. Hartley (1981), was said to be the first person who meta-analysed the findings of CAI on mathematical achievement. He found that CAI had a significant effect on the achievement levels of primary and secondary school mathematics students. He pointed out that complex learning behaviours comprise a network of stimuli response associations which is the fundamental idea underlying the application of CAI programs. He stressed further, that stimulus response bonds are established by providing positive reinforcement, such as knowledge of results. The teacher as the organizer of the instruction is responsible for the selection and arrangement of content to help elicit desirable responses. This process leads to the discovery of feedback, which follows the response made

by the learner as a positive reinforcement for the learner (Serin, 2011; Spradlin, 2009; (Tabasssum, 2004).

In this process, CAI helps learners by presenting material and acting as a tutor (Li&Edmonds, 2005). CAI uses the computer to facilitate and improve student learning. Students interact with computers at their own pace and the role of the teacher becomes that of a facilitator or coach (Barad, 2010). It also brings the possibility that student interaction with the computer may result in less interaction with the teacher and the classmates. The program directs the learner's attention to different sections in a learning sequence without the direct assistance of a teacher, and provides an instructional interaction between the learner and the computer in a variety of contexts also with or without the assistance of a teacher (Aydin, 2005; Smith&Cook, 2012;Smith &Hardman, 2014).

In Nigerian schools however, the use of CAI in education is still in its infancy compared to other developed countries where it has become widespread from primary education, even in some pre-schools, through to university level (Ajaja, & Erawoke, 2010; Ogunleye, 2007). In most public institutions such as universities, polytechnics, primary and post-primary schools, and government ministries, access to the computer and its related infrastructure, if not completely lacking, is inadequate (Gambari, 2010). According to Chukwu, (2000) this should challenge all stakeholders in education, and ICT experts to address these inadequacies for global integration, economic development and growth as a matter of urgency.

#### **1.4: CAI AND STUDENTS' SUBJECT COMBINATION**

It is erroneously believed that students in the science classes always perform better in mathematics and other science subjects than their counterparts in both the arts and commercial classes, based on the assumption that the latter students are not always good at cognitive tasks (Gambari&Olumorin, 2013). This, however, is not always the case since there is complex confluence of factors that contribute to students' low achievement in mathematics (Tsanwani, Harding, Engelbecht&Maree, 2014). Many students, according to Adegoke, (2011) view mathematics as being a difficult subject to grasp due to their poor foundation in the subject and the lecture method often adopted by those who teach the subject. Some of them are frustrated, lack confidence in the subject and have developed poor study habits, which hinder the effective learning of mathematics (Aydin, 2005;Silver, Mamona-Downs, Leung &Kenny, 1996). Over the years, researchers have made several efforts to explore alternative ways of teaching mathematics to low-performing learners, irrespective of their

subject area in the mathematics classrooms (Gambari&Olumrin, 2013; Wang &Lu, 2011). According to (Adedoyin, 2012; Serin, 2011), the use ICT devices such as CAI in education help students increase their motivation, creates interest and learning atmosphere, and provides them with a more suitable environment to learn. The use of technology in this way plays an important role in the teaching and learning process (İşman et al., 2002). This is achieved by creating curricula and didactic materials that incorporate new tools, pedagogical approaches, models or methods to engage learners in a more pleasant mathematical learning process (Smith&Hardman, 2014).

As part of the objectives of this study, the researcher sought to explore if there was any difference in the science students' achievement in learning the concepts of latitude and longitude in comparison with students in commercial and arts classes, when exposed to the CAI method of teaching.

### **1.5: STUDENTS' ATTITUDE TO MATHEMATICS LEARNING**

Literature has revealed the complex nature of defining attitude (Barros&Marcos, 2010; Perry, Way, Southwell, White &Pattison, 2005). Attitudes are psychological constructs theorized to be composed of emotional, cognitive and behavioural components (Zan&Di Martino, 2007). Attitude is defined as the positive or negative degree of affect associated with a certain subject or learned predisposition to respond negatively or positively to certain objects, situations, concepts or persons (Bohner&Wanke, 2009; Bramlett&Herron, 2000; Ma &Kishor, 1997). It is a way someone thinks or behaves towards something, especially when it shows a person's feeling (Daskalogianni&Simpson, 2000). Attitude, according to Adebule and Aborisade, (2013), consists of three components, which include emotional response, beliefs regarding the subject, and behaviour related to the subject.

Findings on attitude and belief are inconclusive. The literature reveals an area of considerable complexity that results in disagreement over whether attitude and belief are expressions of knowledge or opinions and whether belief belongs to the cognitive or to the affective domain. Researchers such as De Corte and Opt Eynde, (2003) argued that students' attitude and beliefs play a very important role in the cognitive process, especially in the domain of learning and most importantly in mathematics. Odogwu, (2002) who noted that attitude drives students' behaviour in solving mathematical problems supports the claims. However, Zan and Di Martino (2007) argued that attitude is a pattern of beliefs and emotions associated with mathematics. They argued that a student's attitude towards mathematics is the emotion

that he/she associates with learning mathematics. The subject has positive or negative values according to that individual's beliefs about the subject and by how he/she behaves.

Students' attitude towards a subject, according to Barros and Marcos (2010), determines their success in the subject. A favourable attitude towards a particular subject will yield positive achievement while a negative attitude will always result in constant defeat in the subject. Diverse findings of studies on the complex nature of attitude motivated the researcher to explore whether the use of CAI to teach latitude and longitude in the mathematics classroom would positively influence students' attitude to learning the topic.

The role of gender in mathematics learning remains controversial and results of studies appear inconclusive. Gender is a socio-cultural category that sorts and organizes the social relationships between women and men; it plays a significant role in an educational setting that could militate against learners' superior achievement in mathematics (Akinsola & Igwe, 2002; Johnson, 1984). Some investigators (O'Connon-Petruso et al., 2004; Leigh, 2006) have pointed out that females often exhibit less confidence in performing problem-solving and high-level mathematical tasks when compared with their male counterparts. Geary, Saults, Liu & Hoard, (2000) have also stressed the differences in the biological structure of women and men. They note that because women are not as physically strong as men are, and also appear weaker, poor patronage of women is sometimes created in careers that are physically demanding. Mathematical learning strategies, sex hormones in the brain, cognitive and affective factors, as well as parental and peer influence, are among other factors responsible for gender imbalances in mathematics education (Gibb, Fergusson & Hoorwood, 2008; Kimura, 2002; Leahey & Guo, 2001).

Despite the giant steps taken by various organizations to bridge the gap, gender inequality in mathematical achievement has remained a perpetual, universal phenomenon (Abiam & Odok, 2006). Various research studies (for example, Arigbabu & Mji, 2003; Olawoye & Salman, 2008) have confirmed male superiority in mathematical achievement at virtually all levels of education. These research findings have revealed that boys show a more positive attitude towards mathematics and science-related subjects and perform better on achievement measures than girls students do. Notwithstanding, other research studies (for example, Agommuoh & Nzewi, 2003; Ogunleye & Babajide, 2011) have argued against male superiority in mathematical achievement. Ding, Song and Richardson (2007) reported an equivalent growth trend in mathematical achievement between the two genders from their longitudinal

research study. Archer and Yamashita (2003) confirmed that gender inequality is interwoven with social class, ethnicity, sexuality and disability. Meltem and Serap (2007) in their studies reported that a non-significant difference in mathematical achievement exists between girls and boys in the school system. This research study, therefore, has sought to examine whether gender has any effect on student learning of latitude and longitude when exposed to CAI in the mathematics classroom.

## **1.6 STATEMENT OF THE PROBLEM**

The problem of students' poor performance in mathematics, at both internal and external examinations, has remained a source of concern to all stakeholders in education including mathematics educators, and those in the field of the mathematical sciences see table 1.1. Researcher studies (Abakpa&Iji,2011; Akinsola&Igwe, 2011) revealed that topics such as latitude and longitude, construction, geometrical proofs, locus that are capable of equipping students with the mathematical knowledge and skills required for all engineering courses in tertiary institutions are not always pass by many students.

The poor achievement and bad attitude of students in understanding this aspect of mathematics in the WASCE may be associated with the traditional "chalk and talk" method that teachers use in teaching the topics. Computer- assisted instruction (CAI) is suggested as an alternative to this method, given its positive impact on the students' achievement in mathematics elsewhere (see, for example, Barros & Marcos 2010; Dupin-Bryant, 2004; Iskander&Curtis, 2005; Rivert, 2001;Schorr&Gnoldin, 2008). The study investigates the effect of Computer Assisted Instruction method on 2<sup>nd</sup> year senior secondary school learners' achievements, and attitudes towards latitude and longitude. The study also compares the learners' achievement and attitudes along gender lines and the learners' discipline background (i.e. learners in the science stream versus those in a non-science stream).

## **1.7 MOTIVATION FOR THE STUDY**

The students' poor performance in mathematics and in the latitude and longitude has eaten deep into the very foundation of the nation's technological growth and needs urgent intervention. If this problem is not urgently addressed and discontinued, Nigeria's technological development will be greatly endangered (Akinsola & Igwe, 2011). Conscious of this fact, the Nigerian government stipulates in the national policy on education that admission to a university shall be 60:40 in favour of the sciences, and 70:30 at polytechnics,

colleges of education/technology in favour of the sciences and technical/vocational courses. However, this projection is difficult to achieve as many prospective science students could not proceed to higher studies at a tertiary institution of their choice due to their poor performance in mathematics at the Unified Tertiary Matriculation Examination (UTME).

Reports over the years, couple with the researcher's personal classroom teaching experience in the past indicated that many candidates find difficulty in some aspects of mathematics such as the concept of latitude and longitude. Many of them also lack the skills and techniques of presenting their answers coherently (WAEC, 2010). I strongly opined that if students are equipped with mathematical knowledge and skills, they will be active players in technology and vocational areas that are crucial to the economic development and transformation of any country. It therefore becomes imperative for me to consider CAI as an alternative method of teaching to see if there will be an improvement in students' performance. Specifically, my research work has focused on the nature of effects of Computer Assisted Instruction on students' academic achievement in and attitude towards the concept of latitude and longitude in Ogun state, Nigeria.

## **1.8 OBJECTIVES OF THE STUDY**

The purpose of this study was to investigate the effect of CAI on students' achievement and attitude towards latitude and longitude in Ogun State, Nigeria. Specifically, the objectives of the research are as follows:

1. To examine the effect of the CAI method on students' achievements in latitude and longitude in comparison with the traditional method of teaching;
2. To compare the achievements of female students and their male counterparts in latitude and longitude;
3. To compare the achievements of science students and their counterparts in the Commercial and Art classes in latitude and longitude;
4. To examine the impact of computer assisted instruction strategy on students' learning attitude towards latitude and longitude; and,
5. To investigate participants' views and opinions on the implementation of computer assisted instruction.

Although, objectives 1, 2, 3 and 4 target the students' performance, it is also important to establish students and teachers' views and opinions towards the instructional approach that were used in both groups during the intervention. Hence, the need for objective 5 for the study.

## 1.9 RESEARCH QUESTIONS

The main research question of the study is: What is the effect of Computer Assisted Instruction (CAI) method on learning latitude and longitude?

The sub-research questions are as follows:

1. How can CAI affect students' academic achievements in latitude and longitude in comparison with the traditional method of teaching (TM)?
2. Will gender affect students' achievements in latitude and longitude when taught with CAI method?
3. Will science students achieve better in latitude and longitude than their counterparts in the commercial and art classes when taught with the CAI method?
4. What challenges, if any will the use of CAI method have on students' learning attitude towards latitude and longitude?
5. What are the participants' views and opinion when CAI method was implemented to teach latitude and longitude in their class?

## 1.10 RESEARCH HYPOTHESES

To empirically examine objectives 1,2,3,and 4 of the research, the study proposed to quantitatively test the following stated null hypotheses at  $P < 0.05$  level of significance; whereas, objective 5 of the study was examined qualitatively.

***H<sub>01</sub>:** There is no statistically significant difference between the students' academic achievements in latitude and longitude in comparison with the traditional method of teaching.*

***H<sub>02</sub>:** There is no statistically significant difference between students' achievement in latitude and longitude for both the control and the experimental groups based on gender.*



*H<sub>03</sub>: There is no statistically significant difference between the science students' achievement in latitude and longitude and their counterparts in the commercial and art classes for the experimental group.*

*H<sub>04</sub>: There is no statistically significant difference in students' learning attitude in latitude and longitude for the control and the experimental groups.*

### **1.11 SIGNIFICANCE OF THE STUDY**

The study investigated and identified the causes for Nigerian students' problems with the concepts of latitude and longitude and recommends a solution so that they will be able to grasp the fundamental skills in mathematics. Students equipped with mathematical knowledge and skills will be active players in technology and vocational areas that are the bases for the economic development and transformation of the country. The study is significant as it has an input to improve Nigeria's education policy specifically applicable to the methodology of mathematics teaching. The study contributes to the existing stock of knowledge and widens the literature in this area of education. The study has also identified gaps that serve as potential areas for future research by scholars who may be interested in undertaking such research.

### **1.12 SCOPE OF THE STUDY**

Even though the study is limited to Ogun State in the south-west geo-political zone, one of the educationally advantaged states in the country there exist potential for future research to be undertaken by expanding the scope of the study to include many other states. The investigation is limited to the problems encountered by students specifically on the concept of latitude and longitude in mathematics. Hence, the study is limited to situations similar to the context found in Ogun State, Nigeria.

Although I made efforts to minimize and control the basic and administrative research bias in advance, the inherent flaws of the methodology adopted in this research may have their effect on the analyses of the study. Furthermore, application of the recommendations would be appropriate for the improvement in the methodology of teaching mathematics and other science-related subjects in Nigerian secondary schools.

### **1.13: SUMMARY OF THE CHAPTER**

The chapter started with the introduction and background to the study. Categories of approaches to teaching, gender issues in mathematics, and motivation for the study are discussed in the chapter. Furthermore, in the chapter objectives of the study were discussed. The significance of the study, the research questions, and research hypotheses that are raised were also discussed in the study before the chapter concludes with a summary, and operational definitions of terms.

### **1.14: STRUCTURE OF THE THESIS**

The structure of the thesis is described in the next section.

#### **1.14.1 Chapter one: Introduction and background of the study**

In this chapter, the introduction and background to the study are discussed. In addition, categories of approaches to teaching, gender issues in mathematics learning, motivation for the study, objectives of the study, significance of the study, scope and limitations of the study are discussed. The research questions, research hypotheses and operational definitions of terms are discussed in this chapter. The chapter concludes with a summary.

#### **1.14.2 Chapter two: theoretical background**

Chapter two of the study reviews literature relevant to the study. The chapter looks at the theoretical framework for the study, theories of learning and their relevance to CAI, overview of latitude and longitude, the meaning, nature and use of CAI to teach latitude and longitude, and past successful stories of CAI. The chapter concludes with a summary.

#### **1.14.3 Chapter three: Research methodology**

Chapter three of the study focuses on the research methodology and procedure. The methodology followed in addressing the research questions raised in chapter one is discussed in this chapter. Furthermore, the research design adopted for the study, the study population, sample and sampling techniques, instrumentation and how it was developed, validation and reliability of the instruments used are explained in the chapter. In addition, the chapter discusses the procedure for data collection and the statistical methods used for data analysis.

#### **1.14.4 Chapter four: Findings**

Chapter four of the study discusses the quantitative and qualitative findings. Both descriptive and inferential statistics are employed in the quantitative analysis. However, content analysis,

are employed in the qualitative data analysis. Furthermore, the researcher used ANCOVA to test the statistical significance of the stated hypotheses.

#### **1.14.5 Chapter five: Discussion of findings, recommendations and conclusion**

The summary of the major findings of the study are discussed in this chapter. Based on this, suggestions, recommendations for further studies and a conclusion are presented.

### **1.15 OPERATIONAL DEFINITIONS OF TERMS**

#### **1.15.1 Traditional methods**

In this study the traditional method of teaching is known as back-to-basics; it refers to long-established customs found in schools that society has traditionally deemed appropriate. This is also called the conventional method of teaching. The traditional method of teaching mathematics in schools is referred to as “chalk and talk”; it is a normal and ordinary method and perhaps not very interesting. It is a teaching style in which technology is used very little; the blackboard, chalk (or similar instrument) and lectures are the primary teaching tools.

The traditional method of instruction was employed by the subject teachers to teach latitude and longitude to students in the control group in this study. The teacher takes control of the class during the teaching period. He dictates the pace and the direction of the presentation. The method of instruction places the students in a passive rather than an active role, which hinders learning indeed as against the computer-assisted instruction classes. The method encourages one-way communication therefore forced the teacher to make conscious efforts to become aware of students’ problems and students’ understanding of contents without verbal feedback.

#### **1.15.2 CAI**

CAI is an acronym for “Computer Assisted Instruction”. It is a common terminology that is very popular in today’s educational system and schooling process. CAI is a teaching process that uses a computer in the presentation of instructional materials, often in a way that requires the student’s interaction with it. In experimental schools participants were able to use CAI package that was installed in the computer to facilitate and improve their learning of longitude and latitude.

Students interacted with their computers at their own pace, and in groups while the instructor’s role becomes that of a facilitator or coach. The potential of the CAI and its related infrastructure have cut across all fields of human development. CAI helps learners by

presenting material and acting as a tutor. The use of CAI in the experimental classes helped the students to decide the next information needed to work upon.

### **1.15.3 Latitude and Longitude**

Latitude is an angle ranging from  $0^\circ$  at the equator to  $90^\circ$  north or south at the North and South Poles. On the other hand, longitude is described as angular distance measured east and west of the prime meridian (Greenwich meridian). The prime meridian is  $0^\circ$  longitude. As one travels east from the prime meridian, the longitude increases to  $180^\circ$ , while as one travels west from the prime meridian, longitude add degrees to 180

### **1.15.4 Mathematics**

Mathematics is a mental activity that consists of carrying out, one after the other, and those mental constructions that are inductive and effective. Mathematics is the manipulation of meaningless symbols of a first-order language according to explicit, syntactical rules.

### **1.15.5 WAEC**

The West African Examinations Council (WAEC) is the examination board formed out of concern for education in Africa and encompasses the Anglophonic countries of West Africa (Ghana, Liberia, Nigeria, Sierra Leone, and the Gambia).

## CHAPTER TWO

### THEORETICAL BACKGROUND

This chapter provides a brief review of the literature related to the study explored by the researcher. They include the following: theoretical framework of the study; relevant theories of learning and their application to CAI; overview of latitude and longitude; definitions of latitude and longitude; and mathematics of latitude and longitude. In addition, the meaning, nature, descriptions, and past stories of CAI are discussed. The chapter concludes with a summary.

#### 2.1: THEORETICAL FRAMEWORK OF THE STUDY

Several theories have been developed to fit all CAI requirements, but this study is theoretically underpinned by two carefully selected learning theories to form the framework, as follows:

- Constructivism learning theory (Dewey, 1933)
- Cognitive Information processing theory (Atkinson, 1968).

##### 2.1.1 Justification for a multi-theoretical approach in a study

For research to be open to scrutiny and discussion, according to Cobb (2007) the selected theoretical framework must be justified. Both the constructivism and cognitive information processing learning theories selected by the researcher are capable to assist and provide theoretical justification for the study. The theoretical and methodical implications for a multi-approach in a single study are:

First, a particular teaching and learning practice was investigated in the study, namely the effect of CAI on students' achievement and attitude in latitude and longitude, from constructivism and cognitive perspectives. Second, both constructivism and cognitive perspectives provide different approaches to investigate the practice of the CAI method within the teaching and learning paradigm (Greeno, 2003). However, combination of both constructivism and cognitive perspectives in this study were found to be logical and consistent in that it helps to understand how teaching and learning take place in the classroom and to evaluate the benefits of CAI strategies on both the students and teachers (Ertmer & Newby, 1993).

### **2.1.2 Constructivism learning theory**

John Dewey is often considered the philosophical founder of constructivism learning theory. He argued against the notion that schools should focus on repetitive, rote memorisation, and proposed that students should engage in real world, practical, and workshops that would enable them demonstrate their knowledge through creativity and collaboration (Dewey, 1933). Although many other philosophers (e. g Bruner, 1966; Piaget, 1972; Vygotsky, 1978) worked with these ideas, but the first major contemporary to develop a clear idea of constructivism was John Dewey. In constructivist approach, learning is active process in which the learner uses his sensory input and constructs meaning out of it (Bishaw& Egizibher, 2013).

To the constructivists, learning can point to different teaching practices. This indicates that the approach encourages students to use active techniques to create more knowledge reflect on it, talk about what they are doing, and how their understanding is changing (Bishaw&Egizibher, 2013). In reaction to didactic approaches such as behaviourism, Bruner, (1966) and Vygotsky,(1978) believed that learning is an active, contextualized process of constructing knowledge rather than acquiring it. The constructivists, did not completely dismiss the role of the teacher in the classroom, but argued that adult teachers only guide the students on how to perform a task. The process of students' engagement with their peers will enable them refine their thinking or their performances in a given task (Bruner, 1966; Vygotsky, 1978). This view corroborated that of Dewey (1933) who argued that the crucial action of constructing meaning is mental, and this occurs in the mind. He stressed further that physical actions and hand-on experience maybe necessary for learning, but this is not sufficient. Teacher may need to provide activities, which engage the mind of students as well as their hands.

### **2.1.3 Cognitive information processing (CIP) learning theory**

The cognitive information processing (CIP) theory of Atkinson (1968) sees teaching and learning as a system of activities deliberately and methodically created to induce students' learning of specific content. The theory is concerned with how individuals gain knowledge and how they use it to guide decisions and perform effective actions. CIP views the human mind as a system that processes information according to a set of logical rules and limitations similar to those with which a computer is programmed (Kalanda, 2012). It emphasizes that comprehension is aided as learners become actively involved in the learning process through

group interactions, active student participation, small steps, immediate feedback, and reinforcement of information (Atkinson, 1968; Tabassum, 2004).

The Key items in CIP are (i) the effect of stimuli on the organism's receptors (ii) the storage of information in short-term memory (working memory) (iii) the storage of information in long-term memory (iv) the process involved in encoding and decoding information, and (v) the retrieval of stored information, and analysing its ultimate effects on the behaviour of the organism (Alesi & Trollip, 2001; Maitland, 2010; Tabassum, 2004).

In similar vein, the CAI method of teaching provides a platform whereby students perform tasks that are tailored to their developmental level and are motivating. Piaget's theory opposed any teaching method that treats children as passive receptacles; instead, a teacher should provide children with learning opportunities that enable them to advance through each developmental stage (Lim & Hang, 2003; Lin, 2008; Piaget, 1966).

#### **2.14 Justification for the selected theoretical framework**

In the study, the selected theoretical framework (constructivism and Cognitive Information Processing) that facilitates the interpretation and explanation of students' computer assisted instruction performances is justified (see section 4.10). The simple idea of constructivism learning theories, that (1) learners construct new understandings by using what they already know, and (2) that learning is not passive but rather active (Dewey, 1933; Owusu, Monny, Appiah & Wilmot, 2010) was evident through the use of CAI in mathematics classroom as reported by many students. This implies that teaching was not viewed as the transmission of knowledge from enlightened to unenlightened. The Constructivist teacher only serves as a guide to students as more knowledgeable person who provides students with opportunities to test the adequacy of their current understanding, and apply this to the new situations. In the new situations, students were engaged to build their knowledge, and were encouraged on group interactions where the interplay among the participants helps individual student becomes explicit about their own understanding by comparing it to that of their peers.

Similarly, cognitive information processing theory focuses on what happens in the mind; how and the information that came in from the environment is processed by a sense of temporary sensory memory system and then fed into a limited capacity short term stores (Atkinson, 1968,). In the study the use of CAI was guided by the theory to modify the teaching and the learning environment to facilitate the of students' attention and perception of incoming information, make suggestions, and teach skills to stay active in working memories. CAI

classroom enabled students learn best when a concrete object or activity is used in the classroom. However, participants in the control schools were not given opportunity to actively construct their own mathematical knowledge but rather, worked independently as they depend on their teachers to direct them.

## **2.2: THEORIES OF LEARNING AND CAI**

Psychologists and philosophers have suggested various theories of learning and have sought to understand how it occurs (Greeno, Collins & Resnick, 2006). Traditionally, learning is viewed as something that occurs within an individual. Individuals may participate and learn in the groups, but it is the individual that learns (Matland, 2010). Theories of learning can advise teachers on the use of instructional resources including technologies, but the learning activities in which students actually engage (mental, physical, and social) determine what a student learns in the classroom (Brown, 2003).

### **2.2.1 Behaviourism Orientation**

Behaviourism as a learning theory originated from the research of psychologist such as Pavlov, (1927) and Skinner, (1938). This learning theory concentrates on the study of overt behaviours that can be observed and measured. According to these theorists, learning is a change in behaviour, which is an individual's response to events (stimuli), which is affected by introducing punishment or reinforcement after behaviour, is exhibited. The behaviourists viewed the mind as a "black box" in the sense that response to a stimulus can be observed qualitatively totally ignoring the possibility of thought processes occurring in the mind. The behaviourism paradigm is classified as follow:-

1. observable behaviour
2. behaviour by the environment, and
3. Reinforcement of the learning through contiguity.

They outlined four behavioural learning principles, namely (i) the actor or the learner who is supposed to act in a prescribed manner (ii) the behaviour itself (iii) the condition(s) under which that action would occur and (iv) the criteria to judge if the behaviour is applicable (Kalanda, 2012; Tabassum, 2004). Their emphasis is that behaviour can be conditioned by rewarding right stimulus-response patterns (Baroody, 1997). These psychologists regard learning as a change in behaviour, i.e. an individual's response to events (stimuli), which is affected by introducing punishment or reinforcement after behaviour, is



exhibited. They stress that behaviour can be conditioned by rewarding the right stimulus-response patterns. It is argued that new subject matter should be presented to learners in a graded sequence of controlled steps, called programmed instruction (PI). Emphasis is on four behavioural learning principles, namely (i) the actor or learner who is supposed to act according to pre-controlled steps (ii) the behaviour itself, (iii) the condition(s) under which that action would occur, and (iv) criteria to judge whether or not the behaviour is applicable (Kumar, 2010; Pavlov, 1927; Skinner, 1938).

### **2.2.2 Behaviourism learning theory and its application to CAI**

The type of learning environment that is based on Pavlov's classical conditioning can be involved in both the positive and negative experience of a learner in school. This happens when learners associate their learning experience with something that either makes them feel pleasure or discomfort in school (Onoshakpokaiye, 2011; Panaoura, 2006). They can equally associate the previous learning experience with the new concept is being introduced in class (Tabassum, 2004). For instance, students can associate the ideas they had on bearing in their senior secondary class one (SSC1) with the newly introduced topic on latitude and longitude in their second year, since they are closely related under the concept of mensuration.

The type of learning environment that is based on Skinner's operant conditioning is applicable based on a given reinforcement (reward) and punishment (Skinner, 1938). The idea behind drill software is to increase the frequency or correct answering in response to stimuli, which is one of the emphases of the behaviourism paradigm. Skinner's programmed instruction (PI) suggests that new subject matter should be presented to learners in a graded sequence of controlled steps.

According to the PI pattern, learners work through the programmed material by themselves at their own speed, and were latter tested on their level of comprehension by answering an examination question or completing a diagram. The correct answer appears immediately with additional information if required (Tabassum, 2004). This follows one of the emphases of the CAI package developed by the researcher to teach the concept of latitude and longitude by presenting a graded sequence of controlled steps to the learners in solving a given problem. This could be used to increase desirable behaviour or decrease undesirable behaviour in a learner (Kalanda, 2012).

### **2.2.3 Cognitivist orientation**

Psychologists such as Jean Piaget, (1886–1980) and Lev Vygotsky, (1896 –1934) influenced cognitive theory. The theory is interested in how people understand material and learning activities. Cognitive theory is an approach to psychology that attempts to explain human behaviour by understanding thought processes. It emphasizes how people comprehend and represent the outside world within them and how our ways of thinking about the world influence our behaviour (Denzin, 2006). The assumption is that in humans, thoughts are the primary determinants of emotions and behaviours. They considered that although changes do occur in learning, they are an indirect outcome of learning (Lim & Hang, 2003; Ozmen, 2008). The theorist argued further that students construct cognitive processes, higher-order thinking skills and mental representations when they are actively acquiring information. They maintain that attainment comes from the application of critical thinking skills and the understanding of essential concepts (Lim & Hang, 2003). The theorists stress that learning involves the transformation of information in the environment into knowledge that is stored in the mind. Learning occurs when new knowledge is acquired, or when existing knowledge is modified by experience (Denzin, 2006; Tabassum, 2004; Piaget, 1972; Vygotsky, 1978).

### **2.2.4 Cognitive learning theory and its application to CAI**

The underlying concept of cognitive theory involves how we think and gain knowledge. The theory attempts to understand how problem solving changes throughout childhood and how cultural differences affect the way we view our academic achievement and language development. Among Piaget's major contributions was that children pass through distinct stages of mental and emotional development. Piaget theorized four stages of cognitive development that represent differences in the qualitative thinking abilities (Shaki & Gevers, 2011). These stages are sensory-motor, pre-operational, concrete and formal operational.

The theory suggests that teachers should carefully assess the current stage of a child's cognitive development and assign tasks for which the child is prepared. Piaget believed that education merely refines the child's cognitive skills that have already emerged. Hence, the teacher acts only as facilitator to guide children to explore their world and discover knowledge (Saulnier, Bruce, Landry, Jeffrey & Wagner, 2008; Shaki & Gevers, 2011). The CAI classroom allows a teacher to maintain a proper balance between critically guiding the child and allowing opportunities for them to explore things on their own to learn through discovery (Adedamola, 2015; Liao, 2007). The teacher acts as facilitator rather than as a dispenser of

repository knowledge. Students are given opportunities to explore the world around them and make meaningful contributions to learning thereby making learning learner centred (Fatade, 2012).

Piaget's concept of reflective abstraction describes the construction of logical-mathematical structure by an individual during the course of cognitive development. The idea involves the CAI classroom where students freely interact with one another and the learning material is presented to foster the development of problem-solving skills and reduce abstract thinking. Learners are encouraged to learn from each other and hear the views of others to break down egocentrism. Piaget's cognitive theory suggests that a teacher should be concerned with the process of learning rather than the end-product. He suggested that the curriculum should be adapted to individual needs and developmental levels (Sprandlin, 2009). This view is one of the tenets of CAI whereby students interact with the objects in the environment through a variety of techniques such as quizzes, simulations, explorations, study at their own rate, check their own answers and advance after answering correctly with the aid of their computers.

The educational implication from Piaget's work and its use in the CAI classroom is that students learn best when a concrete object or activity is used in the classroom. If this approach is implemented to teach mathematics in Nigerian schools, it will significantly alter the role of the teacher and nature of the learning environment (Adedamola, 2015; Akanmu, 2015; Ogunleye, 2007). The teacher will become more of facilitator than expositor and this will promote learning rather than teaching everything directly (Ajaja&Erawoke, 2010). Another educational implication of Piaget's view in the CAI classroom according to Chen& Liu, (2007) is that students learn best by making discoveries, reflecting on them and discussing them with their peers rather than by imitating their teachers or memorizing mathematical rules.

### **2.2.5 Constructivism Orientation**

The constructivism theory of learning posits that learning is an active, constructive process (Dewey, 1933). The theory states that a learner is an information constructor. It emphasizes the fact that knowledge is constructed based on personal experience and hypotheses of the environment and that learners continuously test these hypotheses through social negotiations. Vygotsky, (1978) a constructivist, emphasizes how meanings and understandings grow out of social encounters. He argues that learning is passed down from generation to generation and

that it is the result of guided social interaction in which children work with their peers and a mentor to solve problems. He stresses further that cognitive development is understood only if one takes cultural and social contexts into account (Dewey, 1933; Van de Walle, 2007; Vygotsky, 1978).

### **2.2.6 Constructivism learning theory and its application to CAI**

According to constructivists, appropriate teaching may include a number of components such as genuine discussion, cooperative group work, project work and problem solving for engagement, mastery of an autonomous project, exploration and investigative work (Sprandlin, 2009). Learning as a social process occurs when people are engaged in social activities (Ochoyi, Ukwumunu, 2008; Millar, 2010; Silverman&Casazza, 2000; Sprandlin, 2009). To constructivists, motivation both extrinsic and intrinsic; it is a reaction to positive and negative reinforcements. Students learn faster when CAI software is used to present new topics or teach perceived difficult topics, and when students are actively involved in the learning process through group interactions, quizzes, simulations, explorations and other varieties of CAI techniques(Alesi &Trollip, 2001). For instance, in the constructivist classroom, when teaching a theorem stating that “The sum of the degree measures of the three interior angles of a triangle is 180 degrees”, a teacher would present the idea of moving the three angles together to calculate the sum and would then have students discuss it or share their ideas about moving angles. Students would be allowed to tear the triangle apart and experiment with different ways of making three angles come together again (Lin, 2009). With this manipulation, according to Lin, students would find that many of their ideas about moving angles would produce three angles forming a straight line indicating an angle of 180°.The teacher in this case acts only as a coordinator after planting a powerful mathematical idea in a personally meaningful context for students to investigate (Lin, 2009).This corroborates a technology principle:

Technology is essential in the teaching and learning of mathematics; it influences the concepts taught and enhances students’ learning. Computers, when used effectively, can support fundamental characteristics of learning by active engagement, participation in groups, frequent interaction and feedback, and connections to real-world contexts (Roschelle, Pea, Hoadley, Gordin&Means, 2000, p. 36).

The theories highlight the role of engagement and social interaction in the students' own construction of knowledge (Bruner, 1966; Piaget, 1963; Vygotsky, 1978). The teacher engages learners in activities in which they interact with information, make observations, formulate and articulate ideas that lead them towards discovery, conceptual construction or invention. The theories emphasize that what and how students learn are influenced by many environmental factors, such as how an instructor teaches and how actively engaged the students are in the learning process. The approach has the potential benefit of guiding the learner through a unit of study at his/her own rate and measures the progress made.

### **2.3: RELEVANCE OF THE THEORIES**

As agreed by most theorists, certain conditions are essential for learning to occur. Among these are contiguity, reinforcement, and repetition (practice) as emphasized by the behaviourism paradigm. The basis for behaviouristic theory is that a stimulus (S) that elicited a response (R) that was immediately followed by positive reinforcement would result in increasing the probability that the response would occur upon further presentation of the stimulus. This point of view by Skinner, a behaviourist, is directly applicable to drill and practice as well as the tutorial form of CAI (Kalanda, 2012; Alesi&Trollip, 2001).

As society and the world are rapidly changing, a close look at each of the learning theories shows their relevance and appropriateness as foundation of certain technologies such as e-Learning and computer-assisted instructions. For instance, various educational games, including educational websites and computer games that focused on stimulating a young child's senses while engaging the child in various cognitive tasks falls within the purview of cognitivist paradigm theory (Brown, 2008). According to Branigan, (2002) and Hohlfield, Ritzhaupt, Barron, (2010) the use of ICT to teach mathematics is grounded on constructivism learning theory. Constructivist learning theory in an interactive relationship will add value, and strengthen the junction of learning mathematics in Nigerian schools (Awofala&Fatade, 2013). Kriek and Stols, (2013) pointed out that the idea embedded in constructivism to guide instructional design strengthens the students to produce particular behaviour to learn more. They suggest the need for a flexible and enabling environment that accommodates the use of technology and other forms of ICT tools such as CAI tutorials, hypermedia tools and web-based communication. The onus therefore lied on the teachers to employ a suitable ICT tools that will enhance the teaching and learning of mathematics in their schools (Chen&Liu, 2007).

## **2.4: CRITICS OF THE THEORIES**

There are various critics of the three theories of learning. For instance, the behaviourism theory of learning is criticized for not given attention to memory. In addition, the theory did not attach any importance to transfer of learning and motivation (Alesi & Trollip, 2001; Kalanda, 2012).

The cognitivist theory is criticized for not promoting the principle of active learning in a classroom setting. It is argued that the theory emphasised more on reading, watching, demonstration and listening rather than activity based learning (Alesi & Trollip, 2001). The constructivism learning theory is faulted on the inappropriate use of some instructional methodologies to teach some subjects in the classrooms (Alesi & Trollip, 2001).

Although various literatures have reported on the appropriateness of the theories in many countries (e.g England and USA) to have yielded positive results on students' achievements however, some other researchers (e.g Baker, Chen, & Zimmerman, 2007; Gersten & Lee 2002; Yusuf, 2004) have argued against their effectiveness in the CAI classroom.

This, notwithstanding, the researcher opined that if constructivism, and the cognitive information processing (CIP) theories of learning paradigm are effectively adopted in Nigerian elementary and secondary schools through various uses of instructional strategies and ICT tools, students' performance and their learning attitude will be enhanced (Branigan, 2002; Hohlfield, et al. 2010).

## **2.5: BACKGROUND OF LONGITUDE AND LATITUDE**

The history of longitude and latitude is a record of efforts of navigators and scientists over several centuries to discover a means of determining longitude. Historically, the most important practical application of this was to provide safe ocean navigation, which required knowledge of both latitude and longitude (Wong, 2001).

Eratosthenes, in the 3<sup>rd</sup> century BC, proposed the first system of longitude and latitude for a map of the world. Thereafter, Hipparchus proposed a system of determining longitude by comparing the local time of a place with an absolute time and used such a system to uniquely specify places on the earth. This seems to be the first recognition that longitude can be determined by an accurate knowledge of time (William, 1996).

Literature reveal that sailors had been sailing to places far and near for hundreds of years without really knowing where they were; they could measure their location north or south of the equator, but could not measure their location east or west of their homeport(Dava, 1995;William, 1996; Wong, 2001). Although latitude could be measured from the altitude of the sun at noon (i.e. at its highest point) with the aid of a table giving the sun's declination for the day, to determine longitude at sea was not easy for navigators. In order to avoid problems from not knowing one's position accurately, navigators have, where possible, relied on taking advantage of their knowledge of latitude; sail to the latitude of their destination, follow a line of constant latitude and also rely on dead reckoning, which, according to Dava, (1995), was inaccurate on long voyages out of sight of land. These methods have resulted in shipwreck with many lives lost worldwide due to errors; in navigation.

A number of maritime disasters attributed to serious errors in reckoning position at sea prompted the British government to establish the Board of Longitude in 1714 with a longitude prize for such a person or persons that should discover how to measure longitude (William, 1996). These prizes motivated many navigators and scientists in most European countries to be involved in finding a solution to the problem of how to devise a clock that could keep accurate time while at sea, unaltered by rough water or weather conditions. With such a timekeeper, sailors would be able to know the time back at their homeport and calculate their longitude. Although there was no natural starting position for longitude, unlike latitude, which has the equator as a natural starting position, the choice of the Greenwich meridian in London as reference meridian was adopted in 1884 at the International Meridian Conference, as the universal prime meridian or zero point of longitude by British cartographers (Evans, Sassselov&Short, 2002).

Amerigo Vespucci was perhaps the first European to deduce longitude, in comparatively crude terms, in August 1499, by comparing the positions of the moon and Mars with their anticipated positions after devoting a great deal of time and energy studying the problem. He remarks:

As to longitude, I declare that I found so much difficulty in determining it that I was put to great pains to ascertain the east-west distance I had covered. The result of my labours was that I found nothing better to do than to watch for and take observations at night of the conjunction of one planet with another, and especially of the conjunction of the moon with the other planets, because the moon is swifter in her course than any other planet. I compared my observations with an almanac. After I had made experiments

many nights, one night, the twenty-third of August 1499, there was a conjunction of the moon with Mars, which according to the almanac was to occur at midnight or a half hour before. I found that...at midnight, Mars's position was three and a half degrees to the east (Fredrick, 1945, p. 76–90).

However, many other navigators criticized his findings based on several limitations, such as the occurrence of a specific astronomical event like the moon and a stable viewing platform. In 1612, Galileo proposed that with sufficient accurate knowledge of the orbits of the moons of Jupiter, one could use their positions as a universal clock and this would make possible the determination of longitude. This method was found to be impracticable for navigators on ships. In 1773, John Harrison invented the marine chronometer, a key piece in solving the problem of accurately establishing longitude at sea, thus revolutionizing and extending the possibility of safe long distance sea travel. Finally, the combination of the availability of marine chronometers and wireless telegraph time signals put an end to the use of lunar in the 20<sup>th</sup> century (William, 1996; Wong, 2001).

### **2.5.1 Definitions of longitude**

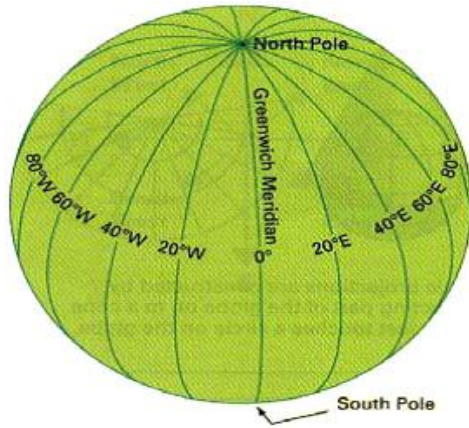
Harwood, (2011) describes longitude as angular distance measured east and west of the prime meridian (Greenwich meridian). The prime meridian is 0° longitude. As one travels east from the prime meridian, longitude increases to 180° and as one travels west from the prime meridian, longitude increases to 180°. The 0° longitude designation is an arbitrary, international convention. It dates back to the days of British sea superiority, which established the 0° line of longitude (prime meridian) as the great circle that passes through the Royal National Observatory in Greenwich, England (William, 1996). As the earth is not perfectly spherical and homogeneous, then longitude at a point would not just be the angle between a vertical north-south plane through that point and the plane of the Greenwich meridian. The earth is not homogeneous, and has mountains, which have gravity that can shift the vertical plane away from the earth's axis. Notwithstanding this, the vertical north-south plane still intersects the plane of the Greenwich meridian at some angle; that is, the longitude that one can calculate from star observations (Evans et. al., 2002; Wong, 2001).

#### ***Lines of longitude***

The linear distance between lines of longitude vary and is a function of latitude. The linear distance between lines of longitude is at its maximum at the equator and decreases to zero at the poles. There are 360 degrees of longitude, divided into 180° east and 180° west of the prime meridian. The line of longitude measuring 180° west is the same line of longitude



measuring 180° east of the prime meridian and serves as the International Date Line. Because earth completes one rotation in slightly less than 24 hours, the angular velocity of rotation is approximately 15° of longitude per hour. This rate of rotation forms the basis for time zone differentiation (Evans et. al., 2002).



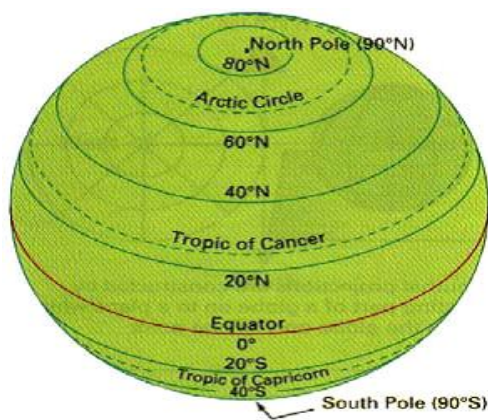
**Figure 2.1: Lines of longitude on the world globe**

### **2.5.2 Definitions of latitude**

Latitude, which is defined with respect to an equatorial reference plane, is a parallel mark and distance measured north or south from the equator (William, 1996). A geographic coordinate specifies the north-south position of a point on the earth's surface. If the earth is cut perpendicular to the polar axis, the circles formed on its surface are called lines of latitude (Macrae et al., 2009). The earth's equator (i.e. the great circle or middle circumference) is designated 0° latitude, while the north and south geographic poles respectively measure 90° north (N) and 90° south (S) from the equator. The angle of latitude is determined as the angle between a transverse plane cutting through earth's equator and the right angle (90°) of the polar axis. As one travels north of the equator, the latitude increases up to 90° at the North Pole. Similarly, as one travels south of the equator, the latitude increases up to 90° at the South Pole. In the northern hemisphere, the latitude is always given in degrees north and in the southern hemisphere it is given in degrees south (Harwood, 2011).

### *Lines of latitude*

If the earth is cut perpendicular to the polar axis, the circles formed on its surface are called lines of latitude. The most important line of latitude is the equator ( $0^\circ$ ). The North Pole is  $90^\circ$  North ( $90^\circ$  N) and the South Pole is  $90^\circ$  South ( $90^\circ$  S). All other lines of latitude have a number between  $0^\circ$  and  $90^\circ$ , either north or south of the equator. Some other important lines of latitude are the Tropic of Cancer ( $23.5^\circ$  N), Tropic of Capricorn ( $23.5^\circ$  S), Arctic Circle ( $66.5^\circ$  N) and Antarctic Circle ( $66.5^\circ$  S). The distance between lines of latitude remains constant. One degree of latitude equals 60 nautical miles (approximately 69 statute miles, or 111 km (World of Earth Science, 2003).



**Figure 2.2: Lines of latitude on the world globe**

### **2.5.3 Meridian**

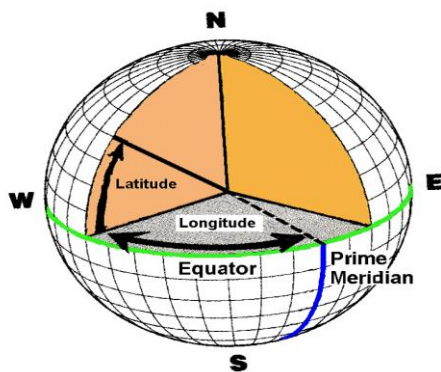
A **meridian** is defined as a great circle of the earth passing through the geographical poles at any given point on the earth's surface. The **upper branch** of a meridian is the half of the great circle from pole to pole through a given position; the **lower branch** is the opposite half (Macrae et al., 2009).

### **2.5.4: Equator**

The equator is the only great circle whose plane is perpendicular to the polar axis. An equator is the intersection of a sphere's surface with the plane perpendicular to the sphere's axis of rotation midway between the poles. It is the only parallel of latitude that is a great circle and is usually referred to as the earth's equator, which is an imaginary line on the earth's surface equidistant from the North Pole and South Pole dividing the earth into the northern hemisphere and southern hemisphere. The earth's equator is about 40,075 km (24,901 miles) long; 78.7% is across water and 21.3% is over land (Wong, 2001; Harwood, 2011).

### 2.5.5 Great circles

Great circles are defined as "any circle on the surface of a sphere, especially when the sphere represents the earth, formed by the intersection of the surface with a plane passing through the centre of the sphere. In other words, any circle on the surface of a sphere whose plane passes through the centre of the sphere is called a **great circle** and any path, which follows a great circle on the surface of the earth, will be the shortest possible distance between two points. Thus, a great circle is a circle with the greatest possible diameter on the surface of a sphere. Any circle on the surface of a sphere whose plane does not pass through the centre of the sphere is a small circle (Dava, 1995; World of Earth Science, 2003).



**Figure 2.3: Prime meridian and equator on the globe**

### 2.6: MATHEMATICS OF LONGITUDE AND LATITUDE

Knowledge of the mathematics of latitude and longitude gives clear understanding on the use of maps and solving related questions on the earth globe. For instance, longitude measurements often combine with measurements of latitude to pinpoint a location. It expresses a location in the number of degrees east or west of the prime meridian. To determine the longitude at a point on a globe, we may calculate the time difference between the location and the Universal Time Coordinated (UTC). Since there are 24 hours in a day and 360 degrees in a circle, the movement of the sun across the sky is at the rate of 15 degrees per hour ( $360^\circ/24 \text{ hours} = 15^\circ \text{ per hour}$ ). Therefore, if the time zone for an individual person is three hours ahead of UTC then he is near  $45^\circ$  longitude (i.e.  $3 \text{ hours} \times 15^\circ \text{ per hour} = 45^\circ$ ). Because the point might not be at the centre of the time zone, which is defined politically, it is pertinent to use the word near. Hence, their centres and boundaries often do not lie on meridians at multiples of  $15^\circ$ . To adequately perform this calculation, a

chronometer (watch) set to UTC time is required and needed to determine local time by solar or astronomical observation (World of Earth Science, 2003; Harwood, 2011).

Furthermore, to give a precise position on the earth's surface, a specific longitude is combined with specific latitude (usually positive in the northern hemisphere). This is done by replacing the west/east suffix by a negative sign in the western hemisphere while the eastern hemisphere is positively consistent with the right-handed Cartesian coordinate system, with the North Pole up. With longitude specified in sexagesimal (base 60) notation such as  $27^{\circ} 39' 10''$  E, whereby each degree is sub-divided into 60 minutes and later divided into 60 seconds, the angular measure may be converted to radians. Thus, longitude may be express as a signed fraction of  $\pi$  (pi) or an unsigned fraction of  $2\pi$  (World of Earth Science, 2003; Wong, 2001).

### **2.6.1 Objectives of latitude and longitude in WAEC mathematics syllabus**

The mathematics curriculum for senior secondary schools and the WAEC syllabus specifies that students be taught the following content in latitude and longitude:

- Distinguish between great circle and small circle on the surface of the earth.
- Define the lines of longitude (including the meridian) and latitude (including the equator) on the surface of the earth.
- Determine and sketch the position of a point on the earth's surface in terms of its latitude and longitude (e.g.  $14^{\circ}$  N,  $26^{\circ}$  E and  $37^{\circ}$  S,  $106^{\circ}$  W).
- Calculate the distance between two points on the great circle (meridian) or the equator.
- Calculate the distance between two points on a parallel of latitude.
- Calculate the shortest distance between two points.
- Compare great circle and small circle route on the surface of the earth (Macrae, Kalejaiye, Chima, Garba, Ademosu, Cannon & McLeish Smith, 2009, p.53).

### **2.6.2 Latitude and longitude-related questions in WASSCE mathematics paper 2**

Latitude and longitude-related questions are frequent in the West African Senior School Certificate Examination mathematics paper (2) (WASSCE, 2011–2015). For example, in 2015, questions 6, 8 and 12 were on bearing, latitude and longitude. Candidates were to calculate the distance between two points on a parallel of latitude and to determine the position of a point on the surface of the earth. In 2014, candidates were asked in questions 3, 10, 13 to calculate the speed, distance between two points on a great Circle and time taken for the movement. The candidates were expected in questions 6, 7 and 9 to calculate the speed, and the distance between two points on a great Circle in 2013. In 2012, questions 5, 7 and 11

focused on latitude and longitude, bearing and other aspects of solid shapes, while the shortest distance between points along the equator were questions 5 and 9 for the candidates in 2011(WASSCE, 2011–2015). This indicates the central position of latitude and longitude concepts in the West African Senior School Certificate Examination mathematics paper (2). Despite the importance of these aspect of mathematics in the curriculum, many candidates lacked the skills and techniques required to solve latitude and longitude problems.

### Typical examples of WASSCE questions on Latitude and Longitude

#### Question 1

*A Plane flies due East from A, (Lat. $53^{\circ}$ N, Long.  $85^{\circ}$ E) to a point (Lat. $53^{\circ}$ N, Long. $85^{\circ}$ E) at an average Speed of 400Km/hr. The plane flies south from B to a point C 2000 km away. Calculate, correct to the nearest whole number. (Take  $\pi=22/7$ ;  $R=6400$ km)*

- (i) *The distance between A. and B:*
- (ii) *The time the plane takes to reach point B*
- (iii) *The latitude of C.*

#### Solutions to Question (1)

##### Step1

(i) Sketch the diagram

##### Step2

(ii) Identify the line of latitude and longitude on the globe

##### Step3

Find the difference between point A and point B =  $85-25(60^{\circ})$

Speed = Distance /Time

Distance =  $400 \times 0.5$

= 200Km

Speed= distance /time

$400\text{km/hr} = 200\text{km}/x$

$X = 200/400$

Answer = 0.5hr

#### Question2

*An aircraft flies due South from an airfield on latitude  $36^{\circ}$ N, longitude  $138^{\circ}$ E to an airfield on latitude  $36^{\circ}$ S, longitude  $138^{\circ}$ E.*

- (i) *Calculate the distance travelled, correct to three significant figures.*
- (ii) *If the speed of the aircraft is 800km per hour, calculate the time taken, correct to the nearest hour. (Take  $\pi=22/7$ ;  $R=6400$ km)*

## Solutions to Question (2)

### Step1

(i) Sketch the diagram

### Step2

(ii) Identify the line of latitude and longitude on the globe

### Step3

Find the difference in latitude =  $36+36$

$$=72^{\circ}$$

$$r= R\cos\theta$$

$$=6400 \times \cos 72^{\circ}$$

$$=1977.6$$

$$\text{Distance} = \frac{\theta}{360} \times 2\pi R$$

$$2490(3\text{sf})$$

### Concern:

- (i) Many of the candidates could not read and carry out the instructions needed to solve problems.
- (ii) The candidates sometimes misread the questions and thus failed to understand what they were required to find.
- (iii) They lacked the skills and techniques of presenting their answers coherently.
- (iv) Many of them failed to find the latitude of a point.
- (v) They have difficulties on how to form the equation such as

$$D = \frac{\theta}{360} \times 2\pi R$$

### 2.6.3 Implication of latitude and longitude on Nigerian secondary school mathematics

With the discovery of the time standard for celestial navigation (Wong, 2001) which is Greenwich Mean Time (GMT), and the Greenwich Hour Angle (GHA) of the mean sun (an imaginary sun which moves at a constant speed), it is easy to distinguish between great circle and small circle on the surface of the earth. Also, lines of latitude and longitude (including the meridian and equator) on the surface of the earth are easily identified. One can determine the position of a point on the earth surface in terms of its latitude and longitude (e.g.  $140^{\circ}$  N,  $260^{\circ}$  E and  $370^{\circ}$  S,  $106^{\circ}$  W) by using the GMT formula:

Thus,  $GMT[h] = \underline{GHAMeanSun [^\circ]} + 12.$

15

GMT is the angle, expressed in hours, between the lower branch of the Greenwich meridian and the hour circle through the mean sun (the GHA of the mean sun increases by exactly 15° per hour, completing a 360° cycle in 24 hours (Dava, 1995).

According to Wong (2001), three planes passing through the surface of a sphere and through the sphere's centre form a spherical triangle. In other words, a spherical triangle is part of the surface of a sphere, and the sides are not straight lines but arcs of great circles as indicated in figure 2.4.

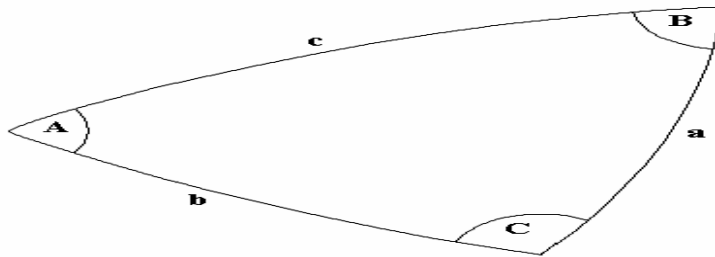


Figure 2.4: Spherical triangle of sine and cosine laws

**Law of sine:**

$$\frac{a}{\sin(A)} = \frac{b}{\sin(B)} = \frac{c}{\sin(C)}$$

**Law of cosine for sides:**

$$\cos(a) = \cos(b) \cos(c) + \sin(b) \sin(c) \cos(A)$$

$$\cos(b) = \cos(a) \cos(c) + \sin(a) \sin(c) \cos(B)$$

$$\cos(c) = \cos(a) \cos(b) + \sin(a) \sin(b) \cos(C)$$

**Law of cosines for angles**

$$\cos(A) = -\cos(B) \cos(C) + \sin(B) \sin(C) \cos(a)$$

$$\cos(B) = -\cos(A) \cos(C) + \sin(A) \sin(C) \cos(b)$$

$$\cos(C) = -\cos(A) \cos(B) + \sin(A) \sin(B) \cos(c)$$

These formulas allow us to calculate any quantity (angles or sides) of a spherical triangle if the other quantities are given. In particular, the laws of cosine for sides are of interest for navigational purposes. Furthermore, the formulae are very important when calculating the bearing and the position of a point on the surface of the earth, in terms of its latitude and longitude and useful when the distance between two points on the great circle (meridian) or the equator are to be determined.

As reported by Abakpa and Iji (2011) as well as Akinsola and Igwe (2011) students that are equipped with mathematical knowledge and skills in latitude and longitude are those capable to become active players in technology and vocational courses such as Aeronautic engineers, Geographers, Pilots and Mechanical engineers. Moreover, students that are equipped with the knowledge of mathematics of latitude and longitude will give clear understanding on the use of maps and solving related questions on the earth globe.

## **2.7: COMPUTER ASSISTED INSTRUCTION**

There are various terminologies used for the computer as learning medium and no universally agreed-upon definitions. Among the commonly encountered terminologies are the following:

- CAI, where the computer serves as tutor for teaching new skills and concepts through the use of common software often referred to as drill and practice, and tutorials;
- Computer-based learning (CBL), otherwise called computer assisted learning (CAL), that includes categories such as simulations and modelling, instructional games and problem-solving information handling;
- Computer-based education (CBE) that includes educational games which have been defined as an enjoyable social activity with goals, rules and educational objectives;
- Computer-based training (CBT), which allows students to direct their own progress (Clarke, Breed & Fraser 2004; Kalanda, 2012; Singh, 2010).

Of interest to the researcher is CAI, where the computer could act as tutor for teaching the concepts of latitude and longitude in the mathematics classroom. Wong and Lu (2011) describe CAI, as an interactive instructional technique whereby a computer is used to present instructional material and monitor the learning that takes place. In broader terms, CAI means the use of a computer to provide course content in the form of drill and practice tutorials and simulations (Aydin, 2005). CAI, according to Liao (2007), is the use of the computer as a tool to facilitate and improve instruction. He stressed further that the CAI program uses tutorials, drill and practice, simulation and problem-solving approaches to present topics, and test the students' understanding. These programs let students' progress at their own pace, assisting them in learning basic mathematical facts as well as more complex concepts in mathematics.



### 2.7.1 Usefulness of CAI

Educationists and researchers have come to see technology as a major force affecting every aspect of our lives. Khan, Bhatti and Khan (2011) posit that technology can be used to find, develop, analyse and present information, as well as to model situations and solve problems. Akanmu (2015) observed that technology and its products have great influence on what goes on in the classroom if effectively applied to education. He suggested that technology can prepare students to live, learn and work in the digital age if abstract concepts in mathematics and other science subjects are adequately handled with good illustrative material provided by teachers.

Of all the technological devices influencing education in recent times, technology in the form of the computer and its applications has become a major focus of educational policy and reforms (FME, 2010). The potential of the computer and its related infrastructure have cut across all fields of human development. Research studies (e.g. Adedoyin et al., 2008; Kulik & Kulik, 1987; Li & Edmonds, 2005; Wender & Muelboeck, 2003) established the role of the computer and its utilization in achieving quality education at all levels of the school system as key tools in acquiring, processing and disseminating knowledge. Through the computer, modern society has been described as the information age whereby people are provided with foundations for building up and applying knowledge globally (Liao, 2008).

Several studies (Chen & Liu, 2007; Light & Pierson, 2011; Lin, 2009; Liu & Liu, 2006; Rivert, 2001; Tabassum, 2004) have evaluated the impact of CAI on students' achievements and concluded that, supported by holistic approaches that include appropriate policies, infrastructure, professional development and curricula; it can help produce positive outcomes. Ozmen, (2008) outlined the numerous unique features of CAI that make it an exciting field. These include the fact that the computer as medium of instruction in mathematics classrooms has the ability to record and store all the students' responses. In addition, it can use this information to decide the next information needed by students. It has the ability to branch out not just in terms of one answer but also in terms of a whole series of previous answers. The use of CAI in the mathematics class affords students the opportunity to record the time taken to answer a question and the degree of correctness to determine which branch to take. Hence, the computer can be used to help a student in all areas of the curriculum.

### **2.7.2 Characteristics of CAI**

The way a computer is programmed, with linear or branching programs, provides a platform for it to act like a super teaching machine that caters for the needs of a number of students at the same time (Tabassum, 2004). It provides a flexible presentation of material to learners and equally keeps track of the progress of the number of learners at the same time (Aydin, 2005). Students may question the computer by means of a typewriter keyboard, and the computer will respond to the questions. Answers will be selected by the computer, which then assigns the learner to the next program, records progress and possibly prints reports.

CAI is therefore, not merely a sophisticated type of programmed instruction but it also uses electronic data processing, data communication concepts of audio-visual and media theory, system theory and learning theory (Pramila & Harsha, 2012). The unique features of CAI are numerous. Students are provided with one to-one interaction as well as an instantaneous response to the answers elicited. The student is asked a question by the computer; the student types in an answer and then gets an immediate response to the answer. If the answer is correct, the student is routed to more challenging problems; if the answer is incorrect, various computer messages will indicate the flaw in procedure, and the program will bypass more complicated questions until the student shows mastery in that area (Tabassum, 2004). Alessi and Trollip (2001) assert that the computer may either function to provide the entire learning experience or function to facilitate instruction within the blueprint of four phases of learning namely: (1) present information (2) guide the learner (3) practice and (4) assessment.

### **2.8: PAST STUDIES ON CAI**

There are diverse findings of studies on the effectiveness of CAI to narrow the achievement gap in mathematics and other subjects. In the past decades, various researchers (e.g Aluko, 2004; Baker, Gersten, & Lee, 2002; Barad, 2010; Kulik & Kulik, 1997; Liao, 2007; Li & Edmonds, 2005; Iskander & Curtis, 2005; Miller, Martineau, Clark, 2000; Millar, 2010; Wender & Muelboeck, 2003) have reported that computer-assisted instruction provided a better learning environment in mathematics achievement and other subjects. Conscious of this fact in England, the National Curriculum for England (2008) encouraged teaching mathematics by using information and communication technology. Similarly in USA, the use of computer as an essential tool for teaching, learning and doing mathematics was encouraged (Liao, 2007; Li & Edmonds, 2005).

Numerous meta-analysis findings and individual studies indicate that CAI has a positive impact on students' learning. Spradlin (2009) reported the meta-analyses findings of James Kulik and his associates at the University of Michigan where the achievement level of students using CAI was compared with that of students who had received the traditional method of instruction. In a study of 123 colleges and universities, the use of the computer as a tutor to supplement traditional instruction was associated with more learning in less time, slightly higher grades on the post-test and improved students' attitude towards learning (Kulik&Kulik, 1995).

Li and Ma (2010) examined the impact of computer technology on mathematics education in K12 classroom through a systemic review of existing literatures. A meta-analysis of 85 independent effect sizes extracted from 46 primary studies involving a total of 36,793 learners indicated statistically significant positive effect of computer technology on mathematics achievement. Christmann and Badgett's (2000) meta-analysis showed that college students who received traditional instruction coupled with computer-based instruction had higher achievement gains than those receiving traditional instruction alone in mathematics. The report is consistent with that of Bebell and Kay (2010) who found that in a computer-based classroom a student acquires basic knowledge and comprehension of assigned learning materials prior to the lesson and applies this newly acquired approach to collaborative, problem-solving, project-based learning.

Several efforts have been made to explore alternative ways of teaching mathematics by creating curricula and didactic material incorporating new tools, pedagogical approaches, and models to engage learners in a more pleasant mathematical learning process (Huang, Liu&Chang, 2012). Researchers such as Devi, Chinnaiyan and Dhevakrishnan (2012) have studied the effectiveness of CAI in the teaching of mensuration in mathematics at secondary school level and reported that students who were taught by using the CAI method achieved better than their counterparts who were taught with the traditional method of teaching. Manmood, (2012) examined the effectiveness of CAI in the Urdu language for secondary school students' achievement in science. Results of his study showed that CAI was an effective mode for knowledge, comprehension and the application domains of learning, as well as for learning in all content areas of general science, i.e. biology, chemistry and physics.

Kumar(2010) tested the effectiveness of CAI for teaching general science at secondary school level and found positive results in favour of CAI as compared with conventional or traditional method. Yusuf and Afolabi (2010) found CAI to be an effective mode of instruction for teaching biology to secondary school students in Nigeria both in individualized and cooperative settings. Mamnood (2006) examined students' performance in developmental mathematics when CAI was combined with traditional strategies. He found that CAI greatly enhanced the performance of low-performing students in learning mathematics. Singh (2010) demonstrated that the simulation mode is more effective than tutorial, drill and practice modes for teaching science to 9<sup>th</sup> grade students. Barad (2010) found science teaching through CAI more effective for high IQ students than low IQ students in the 9<sup>th</sup> grade. Hsu (2003) examined the effectiveness of CAI in teaching introductory statistics classes and found a moderate positive effect of CAI on students' learning..

Singh (2010) demonstrated that the simulation mode is more effective than tutorial, drill and practice modes for teaching science to 9<sup>th</sup> grade students. Barad(2010) found science teaching through CAI more effective for high IQ students than low IQ students in the 9<sup>th</sup> grade. Hancer and Tuzemen (2008) found CAI more effective as compared to the traditional method for teaching science at primary school level. Aluko (2004) and Fajola (2000) reported that high-ability students do perform better than those of low ability with the use of the CAI method of teaching. Raninga (2010) reported that CAI is an effective method for teaching mathematics to 7<sup>th</sup> grade students as compared with traditional methods. The research of Huang and Chang (2012) on learning achievement in solving word-based mathematical questions through a computer-assisted learning system indicates that the computer-assisted mathematical problem-solving system can serve effectively as a tool for improving the performances of the low achieving students in mathematics.

Furthermore, research studies of Chen and Liu (2007) and Liao (2007) on K-12 students to examine the effectiveness of CAI on their achievement and attitude using drill and practice revealed that CAI is more effective than the traditional method of teaching mathematics and positively enhanced the students' attitude to learning. Fuchs et al. (2006) reported that the use of CAI in the mathematics classroom improves students' learning, because the program allows for immediate feedback, and informs students whether their answers are correct or not. Iskander and Curtis (2005) investigated the effectiveness of CAI simulations on students' achievement in mathematics as compared to the traditional teaching method. They found that

the CAI approach to teaching captured students' attention more than the teacher-centred method, because the programs are interactive and learner centred. Their claims are consistent with the reported finding (Schorr&Gnoldin, 2008) on the positive effect of CAI on students learning of mathematics. They reported that the CAI teaching approach focuses on the learners rather than the teacher, and on learners' active mastery of material through interactive learning and teaching.

The literature shows evidence at various grade levels that CAI is an alternative ways of teaching mathematics to students in schools. Ragasa (2008) reported the positive effect of CAI on students' achievement in basic statistics as compared to the traditional method and found a significant improvement in students' post-test achievements. Lin (2009) compared web-based instruction and traditional instruction on pre-service teachers' knowledge of fractions. His findings showed a statistically significant difference between the experimental and the control groups' post-test mean scores in favour of the experimental group, an indication that the instruction had a positive impact on students' knowledge of fractions. Rivert(2001) studied students' achievement in fractions through using CAI versus the traditional method of instruction. The study revealed a significant improvement in CAI classrooms in comparison with traditional classrooms. Suh and Moyer (2011) examined the influence of virtual manipulative of different achievement groups during a teaching experiment in the fourth and fifth-grade. The results of the study indicated a statically significant overall gain following the treatment.

Findings on the impact of CAI on students' learning, according to Light and Pierson (2011) are organized around following major areas. They include Collaboration among students; students' engagement and motivation; Mathematics classroom discourse; teaching and administration; family and home; social and community, and economic development.

### **2.8.1 Collaboration among students**

Collaborative learning, according to Raborife and Phasha (2010) is a way of coming together to solve problems and complete projects that tends to deepen students' learning and builds collaborative skills. The learner not only learns to build collaborative skills but also learns how to design activities to develop these skills. This view is supported by Davis (2012) namely, that collaborative learning encourages students to reach out to each other to solve problems and share knowledge and not only build collaborative skills; it leads to deeper learning and understanding. The use of CAI to teach mathematics has opened the door for

classroom collaboration among students. They learn to be more proactive and interact with their peers to deepen their understanding of the topic. Block (2014) used this strategy to teach at college preparatory schools in Oakland, California and recorded positive outcomes. He reported that collaboration among students has the power and potential of collaborative project and peer feedback.

### **2.8.2 Student engagement and motivation**

Students' engagement with mathematics, according to Christmann and Badgett (2000) occurs when they are procedurally engaged within the classroom, participating in the tasks and doing the mathematics, hold the view that the subject is worthwhile valuable and useful in and beyond the classroom. According to Anderson, Reder and Simon (2002) engagement is a multifaceted construct that operates at three levels: cognitive, affective and behavioural. With the use of CAI in the mathematics classroom, students demonstrated these three identified levels. They were able to recognize the value of learning through their active participation and involvement in academic and social activities. An argument is thus presented that the use of CAI in the classroom allows both learners and their teachers' unlimited access to technology.

### **2.8.3 Mathematics classroom discourse**

Mathematics classroom discourse is the language that teachers and students use to communicate with each other in the classroom (Aydin, 2005). It is about whole-class discussions, in which students talk about mathematics in such a way that they reveal their understanding of concepts. Students learn to engage in mathematical reasoning and debates, ask strategic questions on how to solve a problem and why a particular method was chosen. As they engage in discourse, they acquire ways of talking and thinking that characterize the particular area of the curriculum. This approach is supported by the theories of Vygotsky who argued that higher mental processes are acquired through the internalization of the structures of social discourse.

### **2.8.4 Excitement**

The use of CAI to teach mathematics, according to Ogbonnaya and Mji(2013)promotes active learning as students show great enthusiasm. Using CAI strategies in mathematics classrooms tends to excite students to answer mathematical questions and also motivated them to learn more (Awofala, 2012).

### **2.8.5 Teaching and administration**

Several researchers (Light&Pierson, 2011; Project tomorrow, 2010) revealed that the use of the CAI strategy to teach in the classroom empowers teachers to teach better, increase lesson planning and preparation productivity, gain a more positive attitude towards their work and improve efficiency of management and administrative tasks. The strategy also has a powerful impact on students' knowledge (Geaves et al., 2010). Choy, Wong and Goa (2009) reported that teachers' intentions and actions in integrating technology into their teaching provide them with greater pedagogical knowledge for implementation into their future teaching. Their findings revealed that teachers showed a positive response to computer-based classroom tuition for student-centred learning, and that these teachers are ready to play a leadership role in integrating ICT into the school curriculum.

### **2.8.6 Family and the home influence**

Although the involvement of parents and the home influence are secondary to the goals of ICT deployment, the use of this technology does seem to produce a positive effect in the home. Bebell and Kay (2010) contend that the use of a computer at home affords a student the opportunity of acquiring basic knowledge and comprehension of assigned learning materials before even entering the classroom. Furthermore, access to a computer at home helps the student to study or work on class assignments after school hours.

### **2.8.7 Social, economic and community effect**

Findings have shown that economically disadvantaged students reached proficiency levels matching the skills of advantaged control students with the use of ICT tools (Ozumen, 2008). It is argued that better educational outcomes can be a strong predictor of both economic and social growth. In the long run, an improved education would reduce criminal activity and reliance on welfare and other social programmes, increase charitable and volunteer activity and improve the health of both the individual and his or her family (Adebule&Aborisade, 2013). The use of ICT tools is therefore considered an important means to promote greater social equity and, if effectively used, would improve the quality of teaching and learning of mathematics in particular.

However, consistent critics on the use of ICT in schools indicate that ineffective implementation undermines students' learning opportunities and the academic impact. According to Shapley et al. (2010), giving attention to the importance of measuring implementation efforts before assessing outcomes has provided insight into the nature of

implementation strategies, school change processes and their influence on the whole school that might include changes to the curriculum and delivery of instruction. In addition, research conducted by Baker, Gersten and Lee (2002) on the influence of CAI on the mathematical achievement of low-achieving students revealed that low achievers did not perform significantly better. Yusuf (2004) that examined the effect of cooperative and competitive computer instructional strategies on junior secondary school students' performance in social studies and found that achievement levels have no influence on the academic performance of low-achieving learners/students. According to Chapman (2000) the use of computers to teach in the classroom drains financial resources from other aspects of education, such as the employment of highly qualified teachers or the availability of elective courses. He stressed that the fears of students developing short attention spans and the devaluation of books, have imposed boundaries on inquiry. Some factors, according to Ng and Lai (2012) could limit successful implementation of CAI in a mathematics classroom. Among these factors are institutional forces outside the classroom, and other contextual influences on the classroom curriculum. Similarly, the type of questions set in examinations and tests, management of the learning process, may influence the approach to teaching and learning of mathematics in the classrooms (Hamtni, 2000; Iskander & Curtis, 2005; Schorr & Gnoldin, 2008).

This, notwithstanding, the Professional Standard for teaching Mathematics had advocated for modern methods of teaching mathematics whose focus is student centred (Van de walle, 2007). The NCTM (2000) emphasized the need to help students learn the value of mathematics and develop self- confidence in doing mathematics. This view is supported by Davis (2012) that a CAI strategy encourages collaborative learning among students to reach out to each other to solve problems and share knowledge; not only build collaborative skills; it leads to deeper learning and understanding. The use of CAI to teach mathematics as argued by Block (2014) opens the door for classroom discourse among students. They learn to be more proactive and interact with their peers to deepen their understanding of the topic. The CAI strategy enables students learn how to engage in mathematical reasoning and debates, acquire ways of talking and thinking that characterize the particular area of the curriculum, ask strategic questions on how to solve a problem and why a particular method was chosen.



In this study, I decided to use the CAI strategy to teach the concept of latitude and longitude to 2<sup>nd</sup> year secondary school mathematics students to equip them with mathematical knowledge and skills that are basic requirements for technological development and transformation of any country.

## **2.9: CHALLENGES TO CAI IMPLEMENTATION IN NIGERIAN SCHOOLS**

There are several drawbacks to the implementation of computer instruction in Nigerian schools (Adeyemi, 2012; Adedoyin et al. 2012; Aluko, 2004; Nbani, 2012). Among these is the cost to the system of the purchase, maintenance and updating of equipment. There is also the fear that the use of the computer in education could decrease the amount of human interaction. Availability of software or computer programs is another most difficult aspect of the instructional computer. Although some courseware can be bought from a company, the program provided might not be adequate or suitable to the particular needs of the individual class or curriculum. When a courseware template, which provides a general format for test and drill instruction for the teacher or the school, is used, it tends to be boring and repetitive. The test and the questions follow the same pattern for every course.

When software is developed in-house, or teachers make provision for software that is tailored to their own needs, the claim is made that it is expensive and time consuming and will jeopardize their functionality. Many teachers of mathematics are confused on how to teach mathematics with the use of computer. Their attitude towards computer varies depending on their age and years of service. In Nigerian schools, according to Manoah, Indoshi and Othuon (2011) an attitude of complete ignorance on computers still continues, though its magnitude is weaker compared to past years. In the main, teachers who trained before the start of the computer age share this attitude; they have the most negative attitudes towards its pedagogical use and insist on using traditional modes of teaching. The second major attitude is that of those teachers who are not able to abandon their traditional habits completely but who do foresee the computer as potential for the future of education. The attitude most prevalent and continually widening is the realization and acceptance of the importance of computers for education (Manoah, et al. 2011; Nyaumwe & Ngoepe, 2010).

Research study (Rohaani, Taconis&Jochems, 2010) on teachers' knowledge reports that most teachers are inexperienced in the use of the new approach and overwhelmed by classroom challenges such as lack of classroom management, subject matter knowledge and the diverse needs of students. Most teachers in this research did not have sufficient pedagogical skills and knowledge in planning to integrate technology into their lessons(Akintade, et al. 2013;Manoah, et al. 2011). Moreover, teachers were not prepared to change from their conventional method of teaching, arguing that the strategy would not work in a developing country like Nigeria where the problem of electricity is a common phenomenon. Administrators, who are expected to assume the responsibility of empowering schools with technology, face numerous challenges, in particular funding issues associated with acquiring, implementing and maintaining the technological infrastructure.

According to Hadjianthoma and Karagiorgi (2009) many factors account for the successful implementation and integration of CAI into the schools' curriculum. As a policy decision, it usually requires a considerable investment in technology on the assumption that both teachers and students will achieve specific outcomes. Miller, Martineau and Clark (2009) have argued that it is difficult to establish whether a venture has been successful without an initial statement of clear goals or objectives and expected outcomes. The following criteria are outlined for the successful integration and implementation of CAI in the curriculum. They include the following:

### **2.9.1 Relevance of instructional material**

Before the integration and implementation of any computer technology and applications in the curriculum, its relevance and potential values to the teaching and learning experience should be considered(Hohlfied, Rizhaupt&Barron, 2010; Hadjithoma,&Karagiorgi, 2009). This argument is consistent with those of Johnson and Aragon (2003) that the selection of appropriate materials for teaching would produce positive results in both students' achievement and their attitude when the following criteria are considered:

- Is the computer applications/ICT appropriate to the topic?
- Does the technology add value to the specific topic?
- How would the use of the application support the instructional process?

### **2.9.2 Students' participation**

The choice of appropriate activities by the teacher enhances students' learning ability. Teachers who lack knowledge about real-world ICT or CAI practice are less able to develop meaningful and practical learning activities, which could benefit students and promote active participation in classroom activities.

### **2.9.3 Attitude and skills of educators**

Although many factors affect students' learning and achievement, teachers' personal attitude towards mathematics and the teaching and learning of the subject have a powerful impact on the way in which mathematics is approached in the classroom (Fatade, 2012). Other factors, such as the relevance of the instructional material, knowledge, attitude, goals and skills of educators, as well as the influence of the environment affect the successful integration and implementation of any computer application in schools (Manoah, Indoshi & Othuon, 2011). It is then the collective efforts of both teachers and students to work together in ensuring that the learning process is more student-centred than teacher-centred, since the driving force behind the use of any ICT or computer application should be the goal of learning.

Various studies on educational effectiveness have been concerned with what happens in the classroom with respect to cognitive and non-cognitive outcomes (Johnson & Aragon, 2003). However, factors such as the quality of teaching, time on task, content covered, effective learning time, classroom management, climate and relationship within the classroom have often been excluded, despite their importance as an explanatory variable in model learning and educational effectiveness. In line with NCTM principles and standards on reform, educational researchers like Sungur and Tekkaya (2006) and Hallam and Iresion (2005) seem to agree with the idea that, among other factors, the teacher's teaching style has some impact on students' learning and attitude.

## **2.10: CONCLUSION AND SUMMARY OF THE CHAPTER**

This study looked at computer assisted instruction as a holistic support strategy which considered constructivism and cognitive information processing (CIP) theories as those that fit all CAI requirements to form the framework. These theories of learning interlinked that none of them is sufficient on its own to effectively build a dynamic computer assisted instructional strategy programme. However, constructivist that incorporate the concept of

classroom collaboration seemed to make more sense in helping to achieve the goals and requirements of computer assisted instruction in the mathematics classroom.

In addition, the background of latitude and longitude, its' relevant, barriers and criteria for successful implementation of CAI in Nigerian schools were discussed in the chapter.

Furthermore, I discussed the diverse findings of studies on the effectiveness of CAI to narrow the achievement gap in mathematics and other subjects (Crook, 1994; Iskader&Curtis, 2005; Li&Ma, 2010; Suh&Moyer, 2011). Literatures have indicated that the use of CAI to teach mathematics and other subjects in many countries (e.g England and USA) have yielded positive results on students' achievements. Although, some researchers (e.g Baker, Chen, & Zimmerman, 2007; Gersten&Lee 2002; Yusuf, 2004) have argued against the effectiveness of CAI in the classroom, but if CAI is effectively implemented in Nigerian schools, students' performance in mathematics may be enhanced.

## CHAPTER THREE

### RESEARCH METHODOLOGY

This chapter presents the research design of the study. The following were considered when planning for this current research study. (i) The research design and methods of research for the study (ii) the population and participation sample for the study (iii) choice of appropriate instrument for the study (iv) validity, and reliability of the instruments chosen for the study (v) data collection and data analysis (vi) trustworthiness (vii) ethical consideration. In addition, this chapter discusses the procedure adopted for data collection, the statistical tools used for data analysis and why a mixed method design approach (Creswell, 2010; Creswell, 2013) was considered appropriate for the study. The chapter concludes with a summary.

#### 3.1 RESEARCH DESIGN

The study followed a pre-test, post-test non-equivalent quasi-experimental group design (Creswell, 2013). The choice of this design method allows investigation of intact groups in real-life classroom settings since it was not easy to randomly assemble students for any intervention during school hours so as to avoid any artificial conditions. The design is typically easier to set up than true experimental designs but lacks randomization of the subjects (Creswell, 2013; Shadish, Cook & Campbell, 2002).

The design is appropriate for this study because it reduces the interactive effect of treatment and increases the external validity of the findings (Creswell & Plano, 2011). The choice of a quasi-experimental quantitative research design for the study also allowed the researcher to assign participants randomly, to either the experimental or the control group in order to control extraneous variables that might influence the relationship. Participants did not have any control over which of the groups they should belong or not belong in receiving the treatment. The quasi-independent variable-instructional strategy was manipulated at two levels (CAI and TM) to provide answers to the research questions raised for the study in order to assess the extent to which the CAI and TM have influenced students' achievement and attitude to the concept of latitude and longitude in both the control and experimental groups as stated in research objectives 1, 2, 3 and 4 of the study (see section 1.9 & section 1.10).

The research design is symbolically presented below:

N<sub>1</sub>: O<sub>1</sub> X<sub>1</sub> O<sub>2</sub> Experimental Group I (CAI)

N<sub>2</sub>: O<sub>1</sub> O<sub>2</sub> Control Group II (traditional method)

The first row represents the experimental group. The second is the control group. O<sub>1</sub>, O<sub>2</sub>, represent pre-test and post-test; X<sub>1</sub> represents the treatment and O<sub>1</sub> and O<sub>2</sub>, were tested for statistical significance, using the analysis of covariance (ANCOVA).

In addition, a qualitative research design that allows the researcher to observe, converse, and interview participants to gather information, words and pictures for analysis and constructs a holistic representation of the whole situation was adopted (Plano & Creswell, 2010). The qualitative method is subjective and reveals the opinion and feelings of the participants as stated in research objective 5 of the study (See Section 1.9 & Section 1.10). A central phenomenon in qualitative research study is the key concept, idea, or process (Creswell, 2013). Qualitative data was collected from the participants through the following sources: semi-structured interviews with students and selected teachers, classroom observations and spontaneous conversations. These contain general questions that participants were expected to answer (see Appendix 4 & Appendix 5).

In the first place, the choice of the qualitative method to answer research question five (5) in the study, using semi-structured interviews with students and selected teachers was to provide a platform to record and documentation of events under study (Merriam, 1997). Second, the qualitative method of enquiry provides a comprehensive description of phenomenon of the CAI intervention that is being studied and gives insight into hidden factors that interplay within the content of the study (see Section 4.5 & section 4.6). The choice of the qualitative method is considered appropriate for the study because the pattern of the design was tailored to the needs of the study. For instance, the semi structured interview protocol serves the purpose of reminding the researcher of the questions, and provides a means for recording notes (Creswell, 2013). It contains instructions for the process of the interview; questions to be asked and the space to take note of the responses from the interview (see Appendix 4 & 5).

The use of both quantitative and qualitative methods in combination for this study is to provide a better understanding of the research problem and question than either method by itself (Creswell, 2013). A mixed-methods research approach is a procedure for collecting,

analysing, and “mixing” both quantitative and qualitative methods in a single study or a series of studies to understand a research problem (Creswell, Plano Clerk, 2011). The phase one of this study was the quantitative study and included independent variables (test1) pre-test scores, and the dependent variable intervention (test 2). Phase two was the qualitative study and involved semi-structured interviews for selected students and teachers, as well as classroom observations.

Several reasons have been advanced for using the mixed-methods research design in a study (Creswell, 2013; Miles & Huberman, 1994). First, mixed-methods research is an appropriate design to use if one seeks to build on the strengths of both quantitative and qualitative data. Second, the use of both quantitative and qualitative data together provides a better understanding of the research problem than either type by itself.

Third, the combination of both quantitative and qualitative data produces a very powerful mix (Creswell, 2011). Quantitative data, such as scores on an instrument, yields specific numbers that can be statistically analysed and produces results in assessing and describing the frequency and magnitude of trends about a large number of people. Whereas, qualitative data, such as semi-structured interviews and classroom observations, produces the actual words people offer from different perspectives on the topic; this combination provides a complex picture of the situation (Creswell, Plano Clerk, 2011). Furthermore, the use of a mixed-methods research design is useful when one type of research (quantitative or qualitative) is inadequate to address the research problems or to answer the research questions stated for a study. The decision to adopt the mixed-methods design supported the claims of other researchers (e.g. De Villiers, 2005b; Dhlamini, 2012; Kalanda, 2012) that the integration of the quantitative and qualitative approach in a study is not mutually exclusive but rather effective and complementary.

In this research work, threats to internal validity such as history, maturation, statistical regression, and experimental mortality, interaction with selection, instrumentation and design contamination were controlled by the researcher (Shadish, Cook & Campbell, 2002; Wimmer & Dominic, 2000). Internal validity refers to the validity of inferences drawn about the cause and effect relationship between the independent variable, while external validity refers to the validity of the cause and effect relationship as generalized to other persons, setting, treatment variables and measures. Threat to internal validity poses problems in drawing correct inferences about whether the variation (i.e. the variation in one variable

contributes to the variation in the other variable) between the presumed treatment variable and the outcome reflects a causal relationship (Creswell, 2013; Creswell&Plano, 2011; Plano&Creswell, 2010; Shadish, Cook&Campbell, 2002; Merriam, 1997).The following were ensured in controlling possible threats to internal validity in the research work.

First, the topic used as an intervention in the study (latitude and longitude) was in line with the WASCE mathematics curriculum. In addition, there was no urgent need for a review of the curriculum that could have brought about any change in the dependent variable of achievement in longitude and latitude (ATLL) and students' attitude to the concept. Furthermore, there was no immediate external examination that could distract students from full participation in the study. Both groups experienced a stable environment throughout the treatment period, hence controlling the possible effect of history in the study. Second, students in both the control and experimental groups were mature. They had all grown up within the same society, and passed through similar social, cultural and physiological stages of development that could have affected the dependent variable thus controlling any possible effect of maturation in the study. Besides this, they had gained the confidence required to participate in the study having been taught some aspects of plane and solid geometry in their first year at senior secondary school.

In the third place, students' pre-test scores in both experimental and control groups revealed that they had not received any instruction on the topic before this time either through vacation or lesson classes that could have led to the advantage of any student in any of the groups (see Tables 4.10 &4.11). In the fourth instance, in both the experimental and control schools, students were allowed to participate willingly considering the similarities of their characteristics in terms of age, class, exposure to the mathematics curriculum, language, criteria for selection and placement. Participants were randomly assigned to either of the groups without having control on where they wanted to belong or receive instruction that could have brought a change in the dependent variable thus controlling the possible effect of interaction with selection in the study.

The fifth consideration was that throughout the period of the study, students' attendance in both experimental and control group showed that no student dropped out, which ruled out the possibility of the effect of experimental mortality. In the sixth place, to control the probable effect of instrumentation in the study, the researcher did not change the instrumentation used for measuring students' achievement test on the concept of latitude and longitude (ATLL),



and questionnaire on students' attitude towards latitude and longitude (QSALL) in either the control or experimental group. Both supplied their information on the same instruments. The effect of testing in the study was ruled out with a two-month interval between the pre-test and post-test. The researcher reshuffled the test items before administering the post-treatment to prevent any form of familiarity and possible recognition effect between the pre-treatment instrument and post-treatment instrument in the study. This was done to reduce the effect as it cannot be eliminated unless a new test is used.

Finally, the selected schools for both experimental and control groups were separated and far apart from each other. Neither the teachers nor the students in either the experimental or control schools had any information on the schools used for the study, which prevented both the students and the teachers from any interaction with others in either of the groups. Thus, the effect of design contamination may be completely ruled out in the study.

Threats to external validity include the interaction of selection and treatment, interaction of history and treatments, interaction of setting and treatment, and effect of testing (Wimmer&Dominic, 2000). In the study, the effect of selection and treatment was controlled by using a homogenous sample. Students in both the control and experimental groups were similar in terms of their age. The average age of students in the control group was 15.5 years while the average age in the experimental group was 16 years. This indicates that those students in both groups fell within the same age bracket. Students at this stage are able to think logically and abstractly and can converse easily. The two groups were exposed to the same mathematics curriculum on latitude and longitude and displayed similar cognitive abilities as revealed in their pre-test scores, which serve as the baseline for the study (see Section 4.2 &Table 4.10).

The researcher was able to control the interaction of history and treatment by pre-testing the students in both the control and the experimental group on the same day and within the same period. Similarly, post-tests were performed on the same day and within the same period on the last day of the intervention. The interaction of setting and treatment was easy to control by the researcher because the research work was within Ogun State in Nigeria and, more importantly, the selected schools were within the Egba/Odeda axis in the state. Finally, to control the effect of testing in the study, there was a two month (8weeks) interval period between the pre-treatment and post-treatment of the instrument in both the experimental and

control groups. The researcher only reshuffled the pre-test instruments in order to reduce familiarity when students took the post-test.

### **3.2 POPULATION FOR THE STUDY**

The population for the study was all 2<sup>nd</sup> year senior secondary school (SSS) mathematics students in Ogun State, Nigeria. In the whole nation, Ogun State has the largest number of public primary and secondary schools administered by the government excluding those administered by either missionaries or individuals (Fatade, 2012). This is because Ogun State is the base for those missionaries who brought Christianity, along with western education to Nigeria in the 1840s. For this research study, public coeducational senior secondary schools were selected, since neither missionary schools nor private schools allow any interference with their administration (see Tables 3.1& 3.2).

Upon consideration of the criteria discussed in section 3.5 below, only schools that are in Abeokuta North and Odeda local government areas were considered for the study from among all the other schools in the Egba/Odeda axis of the state for these reasons: (i) accessibility to information (ii) proximity and (iii) familiarity with the axis. The selection of schools within these local government areas afforded the researcher the opportunity to liaise with the Ministry of Education in the Zone (Zonal Education Authority) to collect the information needed for the study. The researcher is very familiar with the geographical terrain of the axis since he works within this environment. Besides, the proximity of those schools to his base affords him opportunities to coordinate the study effectively.

### **3.3 SAMPLE AND SAMPLING PROCEDURE**

The sample in the study consisted of 320 2<sup>nd</sup> year senior secondary schools students. From eight (8) senior secondary schools contacted for the research study, only six (6) schools met the criteria stated below. Simple random technique was used in selecting schools for either the pilot or the main study, from among the six schools. The researcher writes the initials of each of the schools on a piece of paper and each was squeezed into a bolus on the floor. The first two boluses were tagged as pilot schools1 and pilot school 2 (P1, P2) whereas the remaining four boluses were considered for the main study schools. The four schools selected to participate in the main study were coded: experimental school 1 and experimental school 2 (E1, E2); control school 1 and control school 2 (C1, C2) (Egba/Odeda axis) in the state. The breakdown of 80 students selected for the pilot study, and the 320 students from the four schools selected for the main study appear in tables 3.1 and 3.2 respectively.



**Table 3.1: Breakdown of pilot students' selection and their groups**

Group Type	School Status	School Code	Number of students /Subject Area	Gender
<b>Experimental</b>	Public	E(P1)	Arts (16)	Male(7);Female(9)
			Comm. (14)	Male(7); Female(7)
			Science (10)	Male( 6); Female(4)
			<b>n= 40</b>	
<b>Control</b>	Public	C(P2)	Arts (16)	Male(7); Female(9)
			Comm .(14)	Male(7); Female(7)
			Science(10)	Male( 6); Female(4)
			<b>n= 40</b>	

The breakdown of 80 students (Experimental and Control groups) selected for the pilot study was gender and subject area balanced to an extent. Some schools had more girls in arts classes than other subject combinations, hence this accounts for the variation in their numbers. The researcher carried out a pilot study for two weeks to enable him to compare his findings with those of the main study and that they are verified by respondents other than those originally involved (see Section 4.1). In addition, the pilot study reduces the number of treatment errors, because unanticipated problems revealed would be overcome in the subsequent main study (Creswell, 2011).

**Table 3.2: Breakdown of students' selection and their groups for main study**

Group Type	School Status	School Code	Number of students /Subject Area	Gender
<b>Experimental</b>	Public	E1	Arts (38)	Male(20);Female(18)
			Comm.( 28)	Male(14); Female(14)
				Science(15)
	Public	E2	Arts (38)	Male(20); Female(18)
			Comm.(27)	Male(14); Female(13)
			Science(16)	Male( 10); Female(6)
			<b>n= 162</b>	
<b>Control</b>	Public	C1	Arts (38)	Male(20); Female(18)
			Comm.(27)	Male(14); Female(13)
				Science(16)
	Public	C2	Arts (38)	Male(20); Female(18)
			Comm.(24)	Male(14); Female(10)
			Science(15)	Male(10); Female(5)
			<b>n = 158</b>	

The selection of 158 students to the control and 162 to the experimental groups was gender and subject area balanced to an extent. There are variations in the number of Senior Secondary school mathematics class across the schools. Some schools had more girls in arts classes than the boys whereas, some schools have more girls in commercial classes than arts classes. For instance, school C1 had more girls in their Arts and commercial classes than the boys whereas; school C2 had more boys in science class than schools' E2. This accounts for the variations in the number of students selected as appears in table 3.2 according to their subjects combinations and gender. Section 4.2 gives detailed reports of the main study conducted.

The participants for the study were purposively selected based on the following criteria:

1. There is no impending or immediate external examination that could distract students or staff from full participation in the study.
2. The students are mature and have gained the confidence required to participate in the study having been taught some aspects of plane and solid geometry in their first year at senior secondary school.
3. The topic used as an intervention in the study (latitude and longitude) is in line with the WASCE mathematics curriculum (WAEC, 2008).
4. The 2<sup>nd</sup> year senior secondary school students (SSS) have not received instruction on the topics before.

Schools that participated in the study were purposively selected upon consideration of these criteria:

1. Each school has a computer laboratory.
2. The mathematics teachers are willing to participate in the study.
3. The school is a public coeducational senior secondary school.

The researcher randomly assigned two schools to the experimental group and the remaining two schools to the control group in the main study. The same trend was followed during the pilot study by randomly assigning one school to the experimental group and the other school to the control group. Further to the selection of experimental and control schools for the study, the researcher visited the selected schools and met the principals, senior school mathematics teachers and students to solicit their cooperation for the smooth conduct of the study.

### 3.4 RESEARCH INSTRUMENTS

For the collection of data needed in this study, the following instruments were designed and used:

1. Achievement test on conceptual knowledge and calculation skills of latitude and longitude (ATLL)
2. Questionnaire on student's attitude towards the learning of latitude and longitude (QSALL).
3. Semi-Structured interview for selected students and teachers.
4. Classroom Observations

Discussed in section 3.4.1 to section 3.4.5 are the adequacy and relevance of these instruments.

#### 3.4.1. Achievement test on latitude and longitude (ATLL)

The achievement test on latitude and longitude (ATLL) developed by the researcher was used in the study (see Appendix 1). The questions were an essay-type cognitive test that required students' higher-order cognitive skills of Bloom's taxonomy (analysis, synthesis and evaluation) and objectives of latitude and longitude, as contained in the mathematics curriculum for senior secondary (WAEC, 2008). The instrument was used for pre-test and post-test in both the control and experimental groups. The researcher requested the input of subject teachers because of their wealth of experience in the field; moreover, some of them are seasoned external examiners for both the WASCE and National Examination Council (NECO). Initially, 10 questions were drawn from WASCE past questions based on the syllabus and objectives of latitude and longitude in mathematics (WASSCE, 2010; WASSCE, 2012). After validation of the instrument, five questions eventually emerged (see Table 3.3) for examination questions requirements.

**Table 3.3: Typical examination questions and requirements**

Content of latitude and longitude				Total
	Analysis	Synthesis	Evaluation	
(i) Distinguishing between great circle and small circle (ii) Definition of lines of longitude and latitude on the surface of the earth	-	-	-	1
(i) Determining and sketching the position of point in term of its latitude and longitude (e.g. 14° N, 26° E, 37° S, 106° W).	-	2	-	1
Calculation of distance between two points on the great circle (ii) Calculation of distance between two points on a parallel of latitude	-	3	-	1
Calculation of the shortest distance between two points (ii) comparing great and small circle route on the surface of the earth		-	4, 5	2
<b>TOTAL</b>	<b>20%</b>	<b>40%</b>	<b>40%</b>	<b>5 (100%)</b>

**Question 1** in the ATLL test items involves identification of relations, which fall into the **analysis** category. The use of action verbs such as distinguish, define, and sketch in the question indicates that students are to decompose learned material into components and understand the relationship between them (Pohl, 2000). Analysis is the simplest cognitive domain in the hierarchical structure of Bloom's taxonomy cognitive domain (Bloom et al., 1956). It also requires the application of learned knowledge because of the action verbs used.

**Question 2** in the test items falls under the second category of Bloom's taxonomy cognitive domain referred to as **synthesis**. This includes the ability to organize ideas, translate, interpret

information, extrapolate, and explain correctly. It is the ability to combine the elements of learned knowledge into new integrated wholes (Pohl, 2000). The questions expect students to simply recall knowledge of facts, terminologies, structures and/or algorithms.

**Question 3** in the test items also falls into the **synthesis** category because students are expected to have the ability to translate, interpret information, extrapolate, and explain correctly. They are to recall knowledge of facts and form abstracts from learned material to solve new task.

The structure of **Questions 4 and 5** requires students to show their ability to pass judgment based on internal and external evidence. This is what Bloom's taxonomy cognitive domain calls **evaluation**. Evaluation as the most complex domain (Pohl, 2000) in Bloom's taxonomy is a way of assessing how well students use their foundational knowledge to perform complex tasks.

The ATLL was considered suitable for data collection in the study because it addresses the objectives of the research work that principally aimed at examining the effect of CAI on students' achievement in longitude and latitude along the Bloom taxonomy cognitive domain. The essay-type ATLL instrument (see Appendix 1) is best to determine the basic information and cognitive skills a student needs to acquire in facing the challenge of high-level mathematical problem-solving tasks and create products. To check the suitability and relevance of the instrument, the researcher pilot studied it in two public, coeducational senior secondary schools different from those used for the main study. The schools for the pilot study are distantly located from each other and at a distance from the main schools in the study to prevent any possible interaction between the pilot-studied and main study students.

### **3.4.2 Computer assisted instruction package (CAIP)**

The purpose of this section is to explain how CAIP was developed and used to teach the concept of latitude and longitude to 2<sup>nd</sup> year senior secondary school students in Ogun State, Nigeria.

CAIP developed by the researcher was used to teach latitude and longitude to 2<sup>nd</sup> year mathematics secondary school students. The package is self-instructional interactive and consists of five lessons structured into three modules. The areas covered in the package are the introduction of latitude and longitude; identification of latitude and longitude on the globe and guided steps in solving related questions on latitude and longitude.



The researcher developed the package, with the assistance of a professional programmed developer using both Math lab and Java languages(See Appendix 6).

In the development of the package, four methodological phases were strictly followed: analysis, design, implementation and validation. In the analysis stage, the improvement of students' cognitive skills was considered as the baseline for the development of components of the software. At the design stage, storyboard scripts and the framework were defined. Mathematics and computer experts validated the CAIP software; inputs from the co-supervisor for the appearance, operation, spelling, logistic and many other aspects were considered before the final output. The end users' usability evaluation was conducted through a pilot study by the researcher on the same, similar to the final sample used in the study. Results obtained in the usability experience were used for the improvement of the package.

The CAIP was mainly used for students in the experimental group as an intervention. In the CAI lessons, introduction of latitude and longitude on the globe (video clip) that is the first phase was projected onto the screen for students to see with explanation from the researcher. The second phase is the recognition and identification of latitude and longitude on the globe following same pattern. The last stage is the guided steps in solving latitude and longitude problems (See Appendix 6)

### **3.4.3 Questionnaire on Students' Attitude (QSALL)**

The researcher measured students' attitude towards latitude and longitude by using the questionnaire on students' attitude in latitude and longitude (QSALL) adopted from other researchers (Mogane&Atagana, 2010; Shankar et al., 2005; Tapia&Marsh II, 2004). The 30 items Likert scale type instrument consists of two sections. The first section (Part A) is on students' demographic data: name of the school, gender, age and class. The second section (Part B) consists of 30 items with 5 points (strongly disagree, disagree, undecided, agree, and strongly agree). The (QSALL), purposely used as pre-test and post-test in the experimental group, is considered suitable for the study because it enabled the researcher to examine the impact of the CAI method on students' attitude towards the learning of latitude and longitude. The instrument is also most advantageous in providing an overview of students' commonly espoused general attitude based on statements summarizing the effectiveness of the new approach to the teaching and learning of the topic.

The Likert scale type instrument takes 15 minutes on average to complete. The QSALL is composed of five dimensions as outlined below.

1. Self-confidence in mathematics learning: This indicates perceived ease, or difficulty of learning latitude and longitude (e.g. plane geometry is an aspect of mathematics that I find very difficult to understand).
2. Feelings/liking of latitude and longitude: Feelings/liking denotes students' affective, emotional and behavioural reactions concerning liking or disliking the topic longitude and latitude (e.g. I do not like the latitude and longitude topic in mathematics).
3. Perceptions/opinions about the subject teacher: This indicates the belief that students hold about their subject teacher, and towards his or her teaching style (e.g. I dislike the way our teacher behaves during mathematics lessons).
4. Anxiety about mathematics/latitude and longitude: Anxiety denotes a deeper attitude or feelings of tension and mathematics phobia that interfere with the manipulation, computation and calculation of mathematics (e.g. I am always worried when I am asked to solve mathematics problems).
5. Usefulness of latitude and longitude in mathematics: Usefulness indicates a student's belief concerning the importance of mathematics to the nation, community or to him or herself (e.g. I do not need to pass mathematics because I am not a science student).

#### **3.4.4 Semi-Structured interviews**

Semi-structured interviews according to Creswell (2010), is a two-way conversation in which the interviewer asks the participant questions in order to collect data. Semi-structured interviews are generally favoured in research studies because they are flexible and can be used to follow up incomplete and unclear responses (Creswell, 2012; Harries&Brown 2010). The researcher conducted semi-structured interviews with students and selected teachers in order to collect data and to learn about the ideas, beliefs, views, opinions and behaviours of the participants' as indicated in the objective five (5) of the study(see section 1.9 & section1.10). The researcher probed some gestures and expressions that were observed in the classrooms during the interview sessions. There are five questions that allow participants maximum flexibility to respond.

### **3.4.5 Classroom Observations**

Classroom observation is a method of gathering information about how a programme or initiative operates in a naturalistic environment, generally as discreetly as possible (Creswell, 2010). Gay, Mills and Airasian (2006), opined that interactions between students and teachers, behaviour of students, and behaviour of the teachers can be best studied through naturalistic observation. In this present study, the researcher tried to maintain as much as objectivity as possible. His attention was focused on students-students interaction within their groups, and how they interact with the computer to solve mathematical problems.

### **3.5 VALIDITY OF RESEARCH INSTRUMENTS**

The general concept of validity was traditionally defined as the degree to which a test measures what it claims to be measuring. Content validity according to Kimberlin and Winterstein (2008), relates to how well the test succeeds in covering the field with which the test is concerned; whereas construct validity is a judgement based on the accumulation of evidence from numerous studies using a specific measuring instrument. The next section discusses the content validity of the ATLL and the construct validity of the QSALL.

#### **3.5.1 Content validity of ATLL**

Five mathematics experts to ascertain the coverage area of the selected topic validated the ATLL used in the study. The researcher requested the input of these mathematics experts that consisted of three principal lecturers from a tertiary institution, and two seasoned mathematics subject teachers because of their wealth of experience in the field. They were requested to subject the questions to face and content validity in terms of (i) language clarity to the target audience (ii) relevance to the aims of the study, and (iii) coverage of the topics chosen for the study. The five questions that were considered by the experts were further subjected to scrutiny by mathematics educationist who made some amendments to question two and finally approved the document.

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### **3.5.2 Construct validity of QSALL**

In this study, the 35 item-attitude surveys was used as a questionnaire because of its versatility and efficiency (McMillian, 2004).The survey had been widely used by previous studies (Mogane&Atagana, 2010; Shankar et al., 2005). To check the construct validity of QSALL, the initially constructed 35 Likert scale-type instrument was given to two seasoned mathematics subject teachers and three mathematics lecturers from a tertiary institution to check the adequacy, appropriateness and suitability of the instrument to the Nigerian sample (Likert, 1932). Thereafter, 30 items constituting the (QSALL) was given to mathematics educationist for comment. The suggestions made were used to revise the instrument before using it for data collection. The QSALL used as a questionnaire is considered appropriate for this study because of its versatility, efficiency and generalizability.

### **3.5.3 Validation of semi-structured interviews and classroom observational protocol**

Qualitative researchers gave various definitions of reliability and validity from different perspectives. Elder and Flingerson (2002) and Merriam (1998) relate qualitative reliability to a concept evaluating quality in a qualitative study with the purpose of generating understanding. To check the validity of both the interview and classroom lesson observation protocol in order to ensure that they are well-structured and well-planned, the researcher consulted experts to check the relevance and adequacy of the instruments with those instruments used in the quantitative method.(McMillian&Schumacher, 2006). According to Denzin & Lincoln (1998), paying attention to dimensions such as transferability, credibility, dependability and conformability will increase the trustworthiness in a qualitative research study. Merriam (1998) classified six categories of strategies to ensure the internal validity in qualitative research:

1. Crystallization: several investigators, sources and methods should be used to compare the findings with one another;
2. Member check: data and findings are verified by respondents other than those originally involved;

3. Long-term observation: data is gathered over an extended period in order to increase internal validity;
4. Peer examination: the researcher solicits the opinion of other colleagues and co-workers;
5. Collaborative research: participants are involved in the research process;
6. Clearing of research bias: there is clarification of the researcher's assumptions, views and theoretical orientation before starting the research study.

Before the commencement of the main study, the researcher pilot tested the interview questions. In addition the implementation of the observation scheduled was tested.

### **3.6 RELIABILITY OF RESEARCH INSTRUMENTS**

#### **3.6.1 Reliability of the ATLL**

The reliability of a test refers to consistency in measurement; the repeatability of findings and stability of measurement over time ( De Vos, 2000; Si-Mui & Raja, 2006). To obtain the reliability coefficient of the ATLL used for the study, results of the pilot study conducted in schools different from those selected for the main study were used by the researcher. For the post-test, the instrument's contents were re-ordered and administered to the same sample after two weeks to obviate the "hallo" effect (content bias) in the pre-test and post-test. The researcher calculated the discrimination index and item difficulty for two reasons: first, to evaluate the quality of the items and of the test; second, to revise and improve both items and the test as a whole (See Appendix 3).

The item discrimination index ( $D$ ), measures the difference between the percentage of students in the upper group ( $PU$ ), i.e., the top scorers, who obtained the correct response, and the percentage of those in the lower group ( $PL$ ), i.e., the bottom scorers, who obtained the correct response divided by the total number of students in the two groups ( $TNS$ ). Thus,  $D = \frac{PU - PL}{TNS}$ . The higher the discrimination index, the better the item can determine the difference, i.e., discriminate, between those students with high test scores and those with low ones (Si-Mui & Raja, 2006; Shadish, Cook & Campbell, 2002). The results were used to determine the difficulty and discrimination index of each ATLL item in the respective tests. In term of discrimination index, the rule of thumb specifies that 0.40 and greater are very good items; 0.30-0.39 need improvement; 0.20-0.29 need some revision while, below 0.29 are items considered poor and may need major revision or be eliminated (Ebel & Frisbie, 1986). Discrimination indices are very important in that poor discriminatory

items are a valuable signpost towards ambiguous wording, grey areas of opinion and perhaps, even wrong keys (Si-Mui&Raja 2006).

Item difficulties are simply the percentage of students taking the test who answer the items correctly. For the study, the item difficulty index (P) was calculated by using the formula  $P = R/T$ , where R is the number of correct responses and T is the total number of responses (i.e. correct + incorrect + blank responses). The researcher was motivated for item and test analysis in the study because an item difficulties and index assisted in determining what was wrong with individual items. It also provided empirical data about how individual items and whole test performed in real test situation. The test items yielded a discrimination power of more than 0.40 and a difficulty index of 0.40–0.60. This follows the rule of thumb, which specifies that above 0.75 and that 0.25–0.74 is difficult (Creswell, 2011; Plano&Creswell, 2010; Creswell, 2013). In this current study, the reliability of test items was determined through the application of the Spearman Brown formula with the sample of 158 participants. However, the Cronbach Alpha computed to determine the internal consistency and reliability of the test was  $r = 0.84$ . It can be concluded, therefore, that the five test items are reliable and moderate difficulty level (Hill& Lewicki, 2007).

### **3.6.2 Reliability of QSALL**

For the QSALL, the 30 items focused on five identified factors as reflected in the (QSALL) as listed below. The scores of the pilot study students in the control school were subjected to factor analysis using principal component Analysis with factor loading based on an Oblimin eight factor resolution (See Appendix 3). The following criteria were observed for determining the number of factors. First, a factor whose meaning was comprehensive was considered. Second, all components with eigenvalues under 2.0 were to be dropped. Third, variable explained criterion was observed, and four, the Scree test which suggested two factors was plotted. The X-axis components and the corresponding eigenvalues Y-axis components were plotted (Creswell, 2013; Shadish, Cook&Campbell, 2002). Initially, a seven factor solution was obtained but was considered not good enough because, the components had just three items. Thereafter, a six factor solution was computed but also discovered that one of the factors with only four items has low internal consistency reliability (0.21). Close examination of the Scree plot suggested a five factor solution which eventually was found meaningful, and non-overlapping interpretable structure (see Appendix 2b). These identified criterion shows that the total percentage of variation explained is 58.45%. This indicates that

the items did not load on more than one structure. The reliability Cronbach alpha was computed and a reliability coefficient of 0.85 was found, an indication that the items are adequate. Hence, the instrument is reliable for the purpose of the study (Ahmadian et al., 2010; Jackson, 2012).

### **3.6.3 Trustworthiness of semi-structured interviews and observational protocol**

In order to check the suitability of the interview and observational protocol used in the study, experts were consulted to check the relevance and adequacy of the instruments with those instruments used for data collection in the quantitative method. This follows the views of Gay, Mills and Airassian (2005) who explicated on judging validity and reliability within the realism paradigm which relies on multiple perceptions about a single reality. Constructivism as a qualitative research paradigm probes deeper understanding rather than examining surface features (Creswell & Plano Clark, 2011; Gay, Mills & Airassian, 2005; Stenbacka, 2001). Therefore, to acquire valid and reliable, multiple and diverse realities, multiple methods of searching or gathering data are considered appropriate. Maitland (2007) argued that using several kinds of methods or data, including using both quantitative and qualitative approaches, strengthens a study by combining methods. In order to determine the reliability of the instrument in this study, the observations results were consistently checked against the interview results. According to Bell (2005), researcher must conduct his interview with all honesty and respect for the participants.

## **3.7 DATA COLLECTION**

### **3.7.1 PILOT STUDY**

A pilot study is a preliminary trial of the research methods and the instruments intended for use during the main study (Creswell, 2012). In this current study, I pilot tested the instruments intended for two weeks, (September 9<sup>th</sup> -20<sup>th</sup> 2013) in schools different from those selected for the main study. This is to identify problem areas with the research design method or the instruments and make necessary amendments before the commencement of the main study. Pilot study improves the data collection mechanism to support recommendations for change, and informs on going developments or the next phase of the work (Kalanda, 2012). It enables the researcher to check the appropriateness of the methodologies adopted for the study, the techniques and suitability of the instruments. The piloting was informed by the need to further validate the instruments used for the main study and, more importantly, to serve as try-out session for the ATLL. Feedback from the pilot-tested participants is capable of

assisting in either making a change or refining the content as well as inappropriate terminology in the intended instruments for the study. Results from the pilot study will equip the researcher with additional information that can contribute to the overall success of the research findings.

During piloting, I sought to find if the use of (CAI) to teach the concept of longitude and latitude in the mathematics classroom could positively enhance participants' learning ability and their attitude as compared to the traditional method of instruction. On the other hand, subject teachers' perceptions on the use of the CAI package in teaching their students on the topic (latitude and longitude) was sought through semi-structured interviews by the researcher. The entire agenda for the study was to trial-test a small number of participants and schools to serve as guide for the main study. I did not attempt to re-organize the test items on the ATLL when admitted as post-test during piloting. This action, according to Pike (1999), might have introduced a cognitive bias or "hallo" effect on students' post-test scores. To reduce this effect and coupled with the hierarchical nature of Bloom's taxonomy as specified in table 3.2 above, I then reorganized the test-items of the ATLL when used in the main study. For instance, items 1, 4 and 5 were retained in their original position while items 2 and 3 were interchanged.

#### ***The CAI implementation in the pilot study***

Implementation of the CAI intervention lasted two weeks in the pilot study school. As specified in the school time table, 5 periods, which is equivalent to 5 hours of teaching time table per week was used. Hence, it was possible to implement the two weeks intervention without much problem.



**Table 3.4: A two weeks pilot study schedule**

<b>PILOT PROGRAMME</b>			
<b>Week</b>	<b>Day</b>	<b>Lesson Activity</b>	<b>Research activity</b>
<b>1</b>	<b>1, 2&amp; 3</b>	Researcher introduces himself to students; ATLL and QSALL pre-administer Researcher invigilated	Administratio n of Pre-test
<b>1</b>	<b>4,5</b>	Introduction of the concepts and objectives of latitude and longitude; arrangement of students in groups; identification of the concept on the globe;	<b>Intervention</b>
<b>2</b>	<b>6,7</b>  <b>8,9</b>  <b>10</b>	How to determine and sketch the position of a point on the Earth Surface in terms of its' Latitude and Longitude (e.g. 14 <sup>0</sup> N, 26 <sup>0</sup> E and 37 <sup>0</sup> S, 106 <sup>0</sup> W) was taught; Self explanations. Calculate the distance between two points on the Great Circle (Meridian) or the Equator; Revision and remedial with the use their computer. Participants write post –test; by Invigilation by the researcher.	<b>Observations</b>  <b>Observations</b>  <b>Administer Post-test</b>

### **3.7.1.2. Quantitative data for pilot study**

Quantitative data collected from the pre-test and the post-test were analysed using both descriptive and inferential statistics (See Section 4.1). Having observed the improvement in the students' performance, from the pre-test to the post-test performance, the researcher needed to ensure that this improvement was indeed due to the computer assisted instruction intervention. In order to determine the effectiveness of the CAI, the mean scores of the pre and the post-tests were compared using a t-test at 0.05 significance level. The results revealed a significant difference in the post-test achievement scores of the experimental and the control classes with respect to ATLL, in favour of the experimental class ( $P < 0.05$ ). This suggests the effectiveness of the CAI in improving students' achievement in latitude and longitude.

### ***3.7.1.3. Qualitative data for pilot study***

The qualitative data collected during the pilot study was thematically analysed; a method that involves comparing, contrasting and categorising data in order to draw meaning from the data (Dezenzin &Lincon, 2005; Gall, Gall&Borg, 2007; Merriam, 1998; Patton, 2002).As suggested by Barbie (2010), content analysis was used to develop the categories or the themes during the process of data analysis, with reference to the themes and categories specified for the study, namely, students' engagement, classroom mathematical discourse, and collaboration among students, excitement and teachers' perceptions on the use of CAI(see Table 3.5) .

These themes are in line with the research questions raised for the study.The interview protocol that initially consisted of eight questionsbut latter reduced to five questions, after the scrutiny by education experts, was used to gather information from participants in the focused group interview. The first open-ended questions serve the purpose of making the interviewee relax and motivated to talk. The approach was considered appropriate because of its central premise that the use of both quantitative and qualitative in combination provides a better understanding of research problems than either approach alone (Gall, Gall&Borg,2007).The qualitative results on the use of CAI shed more lights on the reasons why this method of teaching was successful as a supported intervention.

**Table 3.5: Example of a pilot study respondents' coded transcript**

Reflective Notes	Activity	Code	Theme
Effectiveness of CAI	<b>Interviewer:</b> <i>Do you think you learn mathematics better, with the use of CAI to teach it the classroom?</i>	The positive impact of the CAI on students' learning	Student Engagement
Note: Emotion	<b>L1:</b> Wow! This computer of a thing has really been fantastic. I was involved and participated.		
Emotional expressed	<b>Interviewer:</b> <i>Have you ever used computer to solve mathematics problems like this before in the class?</i>	Students were motivated to learn new thing	Students' excitement and self-confidence
Note that the CAI package need adjustment before use for main study	<b>L2:</b> Oh! Never...am I so excited with this new idea to teach us the topic. <b>Interviewer:</b> <i>In your opinion, do you think the use CAI to teach the topic in mathematics is better than other methods employed to teach in schools?</i>	Teachers admire and appreciate the use of CAI to teach mathematic	Teachers' opinion on the use CAI.
	<b>T1:</b> The package is good but, I would like you to work the interface used for drawing the diagram. Also include more examples for students Generally, it is okay.		

### **3.7.2 MAIN STUDY**

The collection of data for research study lasted for eight weeks, September 8<sup>th</sup> –October 31<sup>st</sup> 2014. Schools that are categorized into both experimental and control groups within the local governments in the state were visited and introductory meetings with the students, school heads, and the participating teachers (research assistants) were held before the administration of the pre-tests, the lesson presentations and the writing of the post-tests. In the study, quantitative data (scores from achievement test ATLL; scores from questionnaires QSALL), and qualitative data (semi-structured interview; classroom observation) form the strongest form of quantifications.

#### **3.7.2.1 Achievement Test**

The study began with the administration of a pre-test (an achievement test) to both groups (experimental and control). Students were assigned index numbers so as to ensure anonymity. The index numbers ranges from PRE-001 (for the first student) to PRE-320(the last student). The index number used for the pre-test was also adopted for the post-test with little modification on the code (POS). A student with pre-test code of PRE-004 used the code POS-004 for the post-test. A unique code and numbers were allocated to each student consecutively without any interruption in each school. For instance, the last student in schools E1and E2 was coded with pre-test code PRE-160 while the first student in school C3 was coded with pre-test code PRE-161, and POS-161 for the post-test.

The CAI intervention was administered by the researcher in the experimental schools while the participated teachers administered the test in the control schools. For the post-test, the researcher re-ordered the instrument's content and administered the same sample after six weeks. The purpose of the post-test was to evaluate the achievement level of the two groups after learning about latitude and longitude. The researcher worked with one school at a time to deal with the issue of biases and contamination since the two schools selected for the study are not in close proximity. The total marks obtainable by any student were 100% because each of the five ATLL items attracted a maximum score of 20 marks. The nine -points scales used in Nigerian schools for reporting purposes is indicated in table 3.7 below.

**Table 3.6: The nine -points scale used in Nigerian schools for reporting purposes**

Grades	Definition	Interpretation	Equivalent
A1	Excellent	80%- 100%	1
B2	Very Good	75%-79%	2
B3	Good	70%-74%	3
C4	Credit	65%-69%	4
C5	Credit	60%-64%	5
C6	Credit	50%-59%	6
D7	Pass	45%-49%	7
E8	Pass	40%-44%	8
F9	Fail	0%-39%	9

Source: WAEC (2007, P. 11 -27)

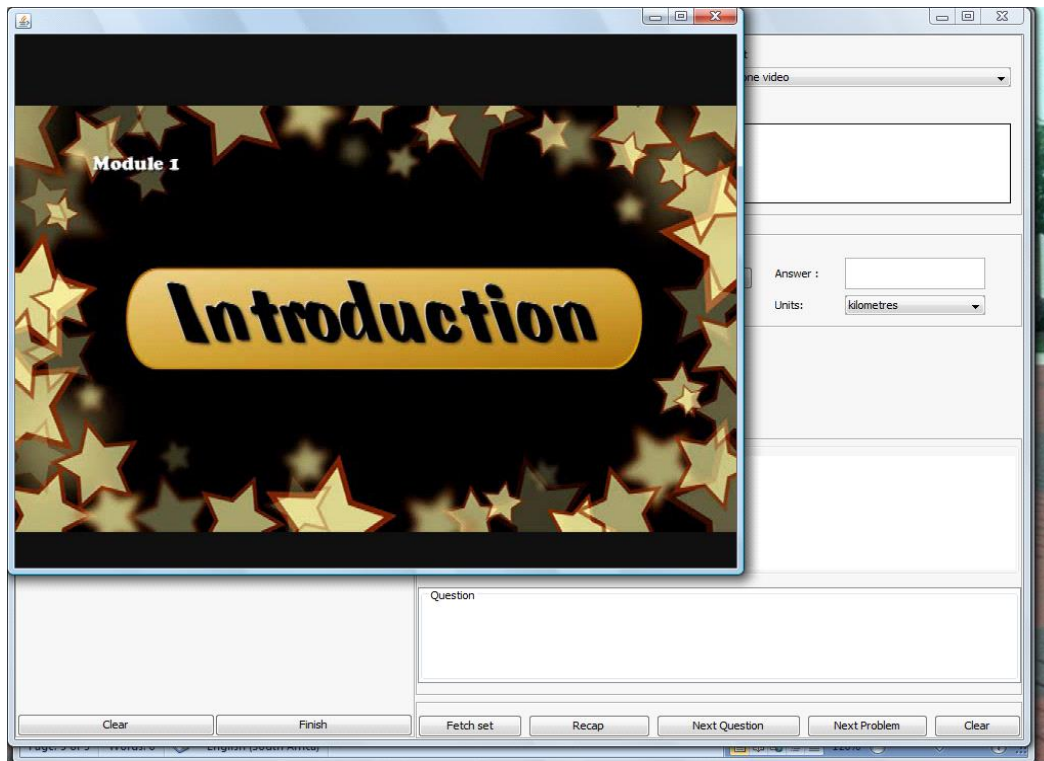
### 3.7.2.2. Instruction

#### *Experimental classes :( The Computer Assisted Lesson)*

The researcher himself used the Computer Assisted Instruction strategy to teach two experimental schools while teachers retained conventional traditional approach (TM) method in other two schools tagged the control groups. In addition, teachers' involvement in the implementation of CAI might have prolonged the study since they are not trained on the use of the intervention. The treatment for the experimental groups was carried out using a specially designed Instruction Guide for teaching latitude and longitude. The Instructional guide involved the following specific phases as listed below:

- Introduction, Identification of the topic, concept sub-topic, and objectives of latitude.
- Recognition and identification of latitude and longitude on the globe
- Presentation and implementation of the strategy –carrying out specific treatment
- Evaluation of the learning outcome and consolidation of knowledge gained through guided steps in solving latitude and longitude problems.

**Phase One: Introduction-** The lesson was introduced to the students through video clip as shown in figure 3.1 below. The researcher explained the objectives of latitude and longitude, and its' importance in the school syllabus. In addition, explanations on how to identify lines of longitude and latitude on the globe was displayed through video clip (see figure 3.2).



**Figure 3.1: Appearance of module one on screen**

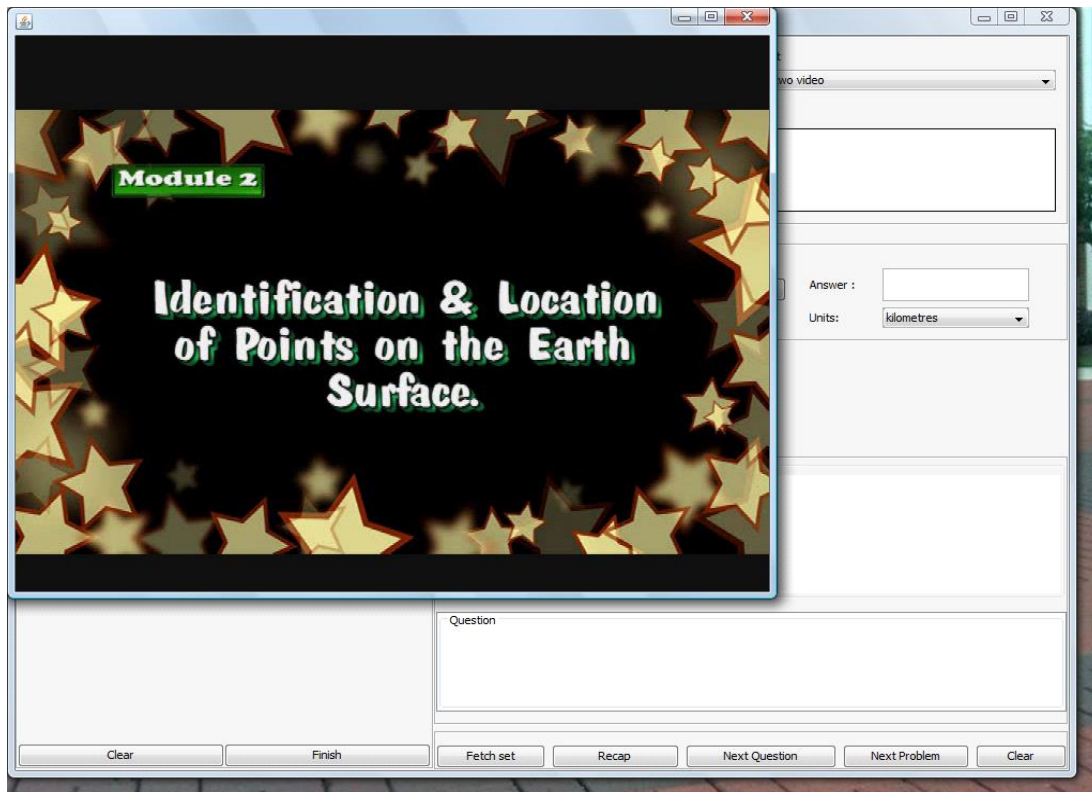
### **Phase two: Recognition and identification of latitude and longitude on the globe**

This is tagged module two of the computer instruction package (CAIP). To explore module two, follow the procedure as indicated below.

- Use the Stop and close to exit the video.
- Use the Pause button to pause the video.
- Use the Play button to resume a paused video.

Use the Play button to resume a paused video.

If you have clicked on the content list and selected the module two video, the appearance of the module will be displayed, as in figure 3.2 below.

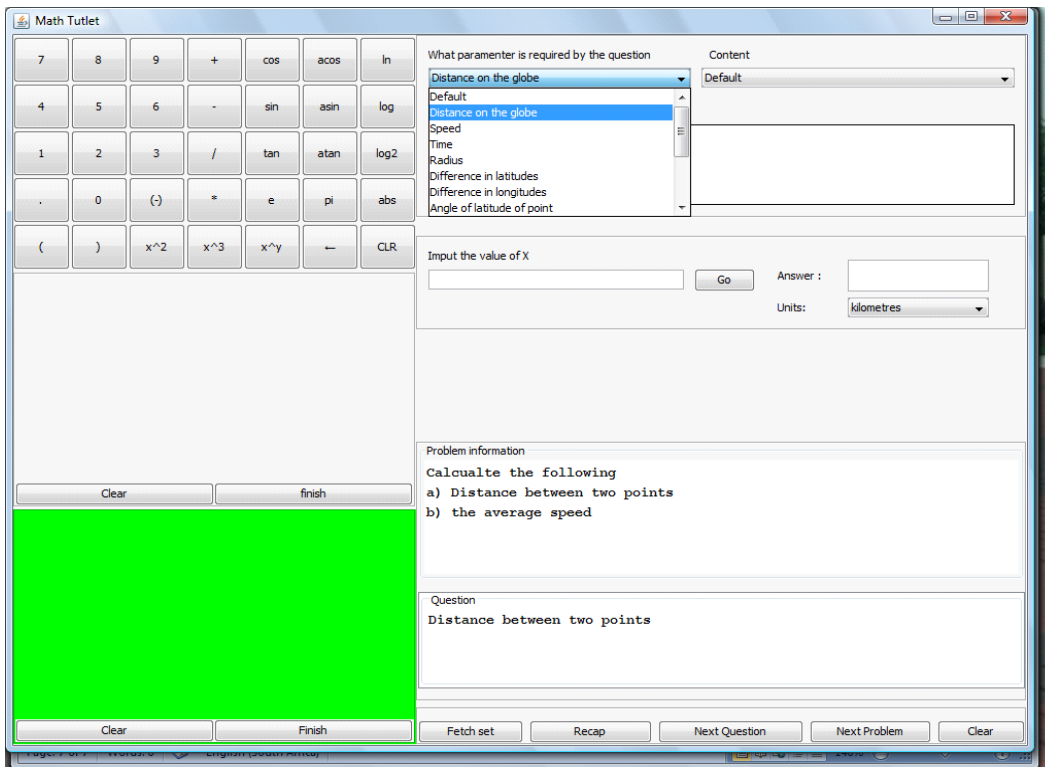


**Figure 3.2: Appearance of module two on screen**

### **Phase Three: Presentation and implementation of the strategy -carrying out specific task**

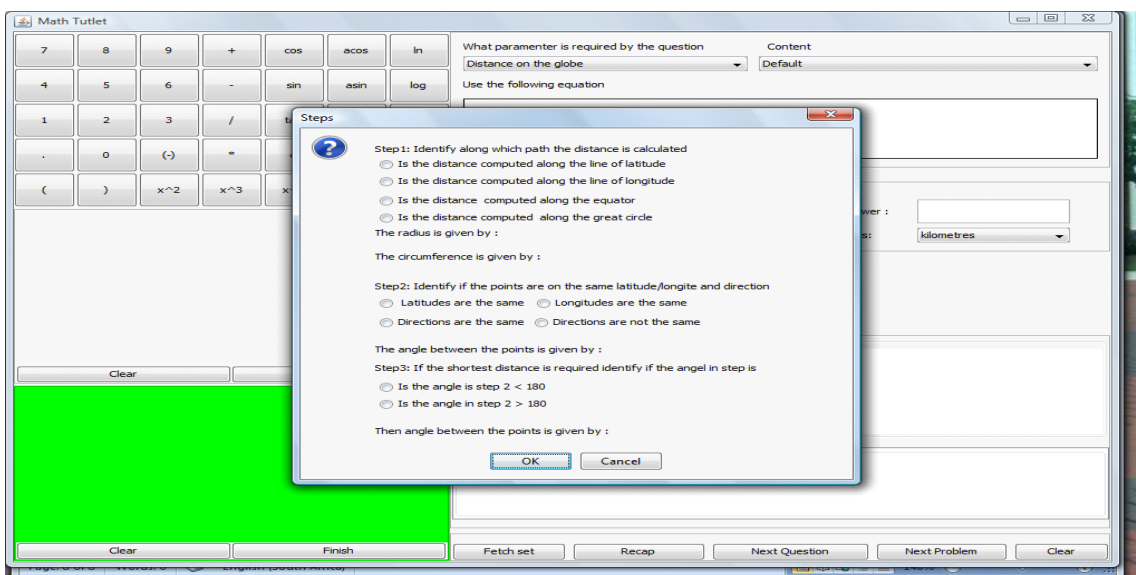
This phase explains the guided steps on how to solve questions related to latitude and longitude in mathematics through CAIP.

- Start by establishing the type of question by selecting the required parameter as shown in the figure below.
- If the question requires distance between two points on the globe, then
- Select the *Distance on the globe* as in Figure 3.3



**Figure 3.3: Guided steps to solving latitude and longitude problems**

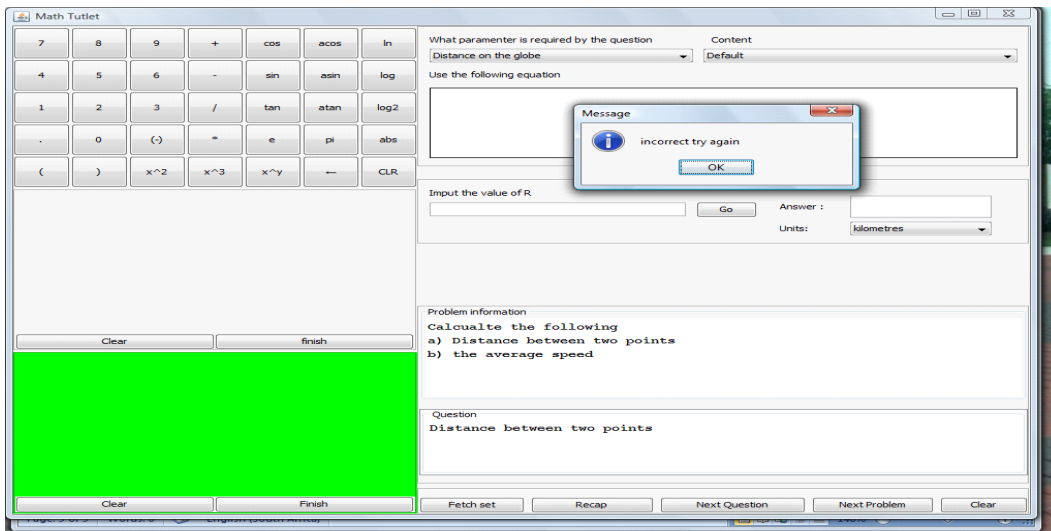
Follow the steps as they appear on the screen, select the appropriate response as requested and click OK as indicated in figure 3.4 below.



**Figure 3.4: Appearance of the pop-up message**

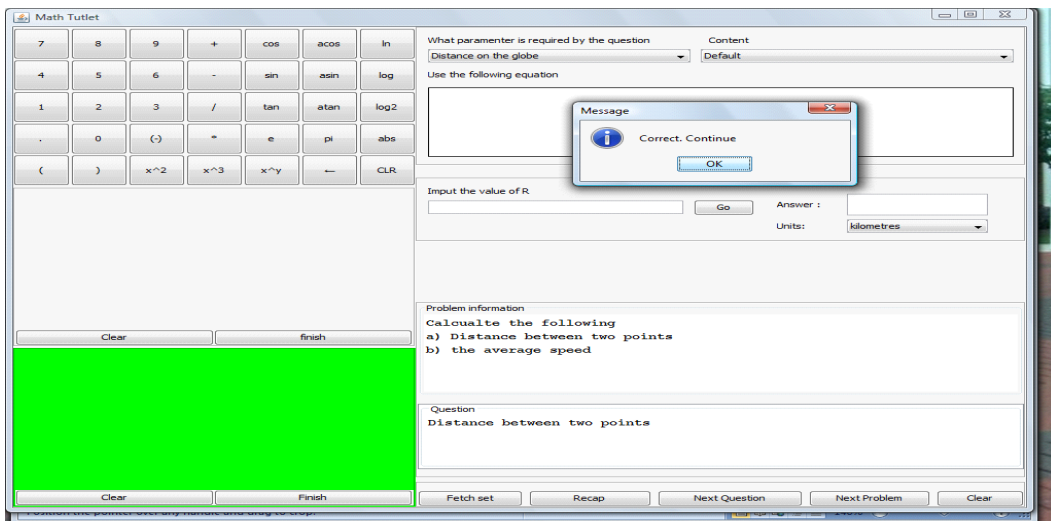


If all the steps are not completed in a satisfactory way **the incorrect and retry message** will pop up as shown on the screen in figure 3.5



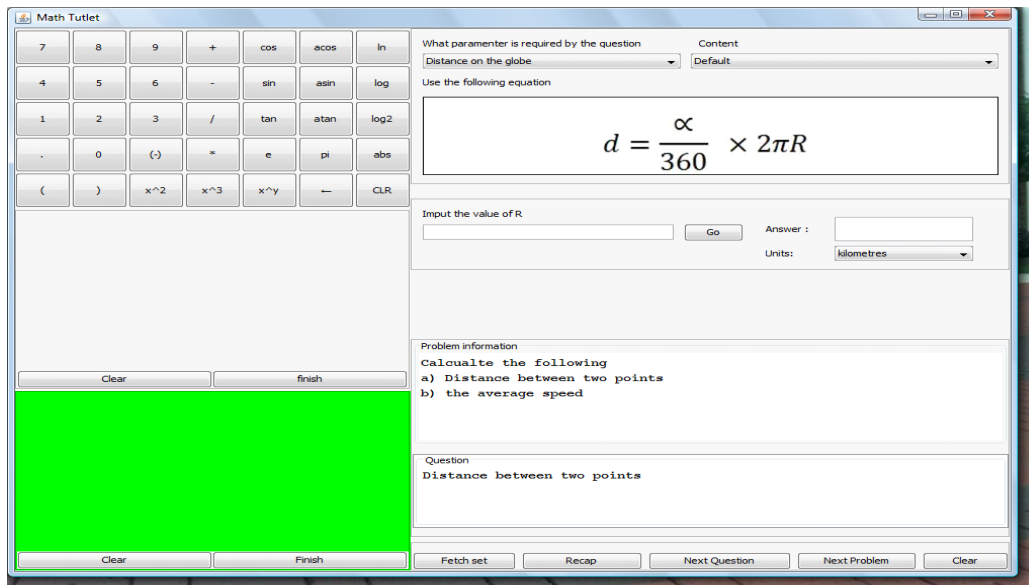
**Figure 3.5: Appearance of the incorrect and retry message**

However, if all the steps are completed satisfactorily, **the correct and continue message** will pop up on the screen as shown in figure 3.6 below.



**Figure 3.6: Appearance of correct OK message**

Upon clicking OK, the correct formula to use is displayed as shown **figure 3.7** depending on the given question.

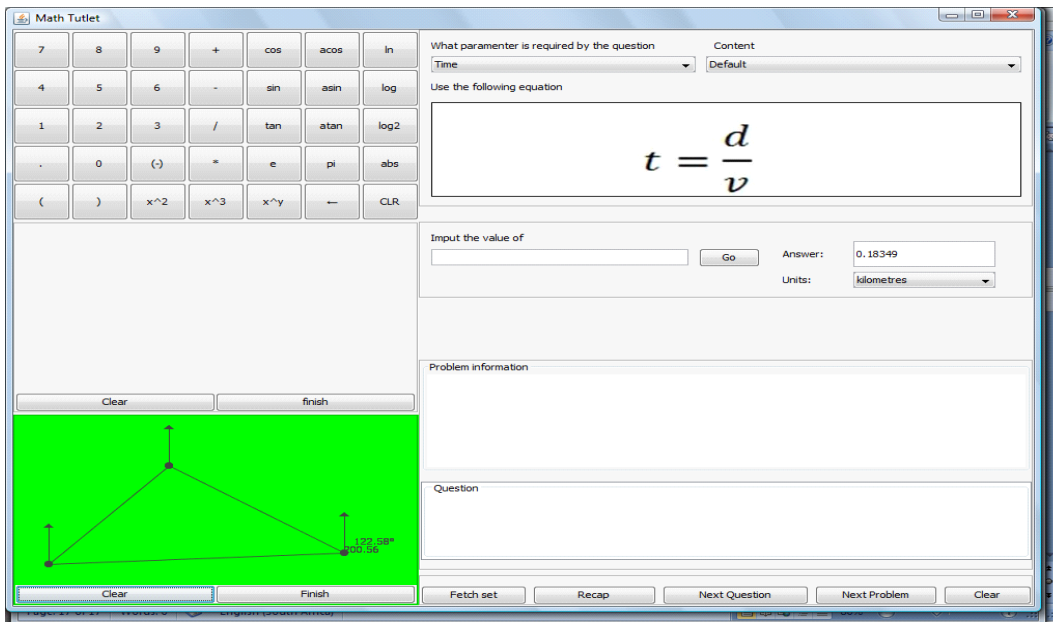


**Figure 3.7: Appearance of the correct formula**

For freehand sketching and plotting of lines; Move the mouse towards the next point using the angle displayed.

- Click to insert the second point.
- A normal line is plotted.
- The two points remain connected.

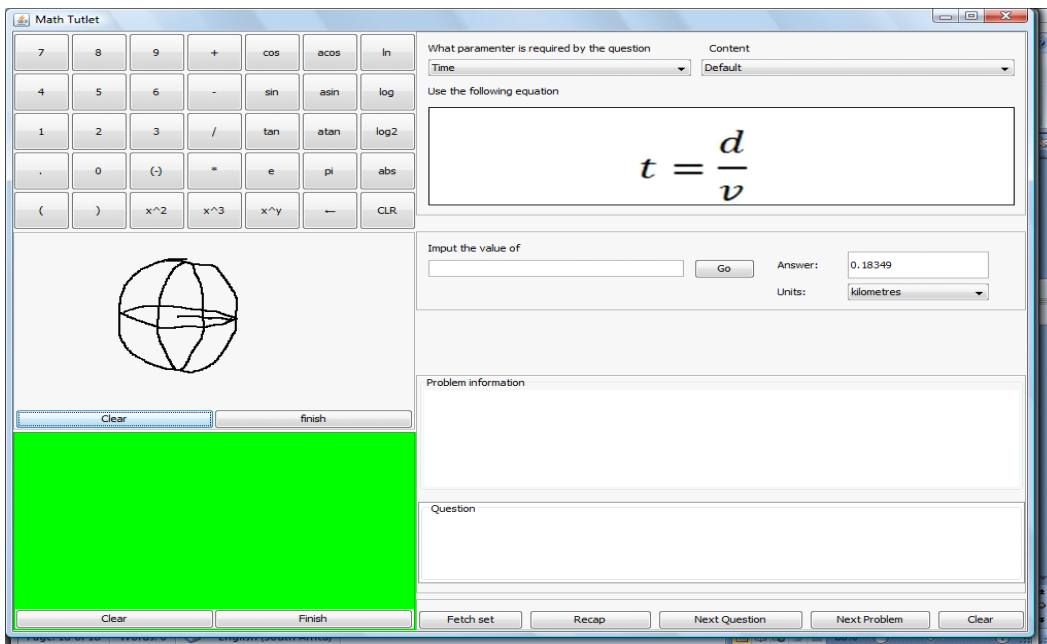
You may click clear button if unsatisfied with the type of sketch produced without any problem. A plotted diagram may be erased at your comfort and another could be drawn through the use of mouse.



**Figure: 3.8**Plotting of lines and angles

Use the mouse to perform a freehand sketch.

- Press and hold the mouse.
- While holding drag the mouse to draw the required sketch.



**Figure 3.9:** Sketching lines of latitude and longitude on the globe

During the activities, students were introduced to the lesson on the objectives and, identification of latitude and longitude on the world globe. Questions were asked to assess students' knowledge, and to establish the connections between the topic and the real-life situation (figure 3.1 & figure 3.2). Students were arranged in groups to carry out specific task given to them. In group setting, students have opportunity to share knowledge and discuss issues that enhances their learning performances. In order to facilitate students' learning, the researcher explained the guided steps that students needed to follow when working with the CAI package. The package was used by the researcher to solve related questions on latitude and longitude for each group to follow. To determine if students can demonstrate the learning skills acquired, each group of students was given different related questions to work with using CAI package with little or no guide by the researcher. However, I monitored how they use the package and I was amazed at their performances. My attention was focused on student-student interaction, students-students interaction within their groups, both inter- and intra-group discussion among them, how students interact with the computer to solve mathematical problems on latitude and longitude and the collaboration among them to solve common problems. Table 3.7 explains the summary of the planned computer assisted instruction lesson.

**Table 3.7: Summary of a planned computer Assisted Instruction Lesson**

<b>COMPUTER ASSISTED INSTRUCTION LESSON</b>	
<b>INTRODUCTION (20min)</b>	<ul style="list-style-type: none"> <li>• Introduction of the lesson by the researcher;</li> <li>• Explain the objectives of latitude and longitude.</li> <li>• Researcher asks questions to assess students' knowledge of the topic;</li> <li>• Establish the connection between the topic and the real-life situation.</li> </ul>
<b>BODY OF THE WORK (20min)</b>	<ul style="list-style-type: none"> <li>• Carry out specific treatment as student arranged in groups;</li> <li>• Researcher monitors the group as they discuss solution steps.</li> <li>• Allow self –explanation activity and probing</li> </ul>
<b>CONCLUSSION (20min)</b>	<ul style="list-style-type: none"> <li>• Reflection;</li> <li>• Problem solving activity (using computer to solve problems on latitude and longitude).</li> <li>• Evaluation of success rate;</li> <li>• Brain-Drill questions tackled;</li> <li>• Homework assignments given.</li> </ul>

In both the experimental and the control schools, the researcher followed their departmental guidelines that allowed five **hours** per week for mathematics lessons in the school timetable (see table 3.8).

**3.8: An instructional timetable used at school E1 during the intervention**

<b>DAY/ TIME</b>	8:00-9.00	9.00-10.00	10.00-11.00	11.00-1200	1.00- 2.00
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
MONDDAY	Mathematics				
TUESDAY			Mathematics		
WEDNESDAY		Mathematics			
THURSDAY	-----				
FRIDAY		Mathematics			

### **3.7.2.2.2: Control classes (Traditional Method Lesson)**

For the control group, the lessons were organized and taught by the selected teachers under the supervision of the researcher using the classroom teacher-centred method on the same topic of latitude and longitude, and following the already prepared instructional lesson plans. The instructional plan consists of introduction, objectives, content, presentation, evaluation and conclusion (Okpala, Onoja&Oyedeki, 1993).

### **3.7.2.3 Data collection from a questionnaire (QSALL)**

Questionnaire on students' attitude towards longitude and latitude (QSALL) purposely used as pre-test and post-test was administer to both groups (experimental and control). To ensure anonymity, students were told to use the same assigned index numbers for their pre and post-attitude questionnaire. The use of QSALL is considered suitable for the study because it enabled the researcher to examine the impact of CAI method on students' attitude towards the learning of latitude and longitude. Students' mean scores and the standard deviations in both groups were calculated and analysed using frequency and simple percentage.

**Table 3.9: Field work activities for the main study**

<b>Week</b>	<b>Activities</b>	<b>Action taken</b>
<b>One</b>	Visitation to schools categorized into experimental control within the axis	Select the schools, assess the facilities and solicit the cooperation of both teachers and students
Two	Students pre-tested in both groups	Administration of ATLL and QSALL in both experimental and control group before the intervention
Three, four five and six	Instructional lesson plan on the content of latitude and longitude implemented	Traditional method (TM) was used in control classes while CAI package was used in the experimental classes
Seven and Eight	Students post-tested in both groups; selected students interviewed	ATLL administered in both the control and the experimental classes; selected students interviewed while observation was a continuous process throughout the lessons

### 3.7.2.4 Semi- structure Interviews

A qualitative interview, according to Creswell (2010), is a two-way conversation in which the interviewer asks the participant questions in order to collect data and to learn about the ideas, beliefs, views, opinions and behaviours of the participant. Semi-structured interviews were used in this study to corroborate data emerging from other sources. The interviews lasted for 10 minutes and were audiotaped by the researcher. The protocol used was flexible and the researcher was not restricted from using any other probing questions during the interview. The protocol was used to gather information from participants in the focused group interview. Five questions allow participants maximum flexibility to respond. The first open-ended questions serve the purpose of making the interviewee relax and motivated to talk. The question was easy to understand and caused the participants to reflect on an experience that they could easily discuss. The core questions, 3, 4 and 5, address major research questions in

the study (see Appendix 4&Appendix 5). The sampling techniques for the interviewees' selections adopted from other researchers (Dhlamini, 2012; Silverman, 2005) were based on the following characteristics.

1. Learners' post-test scores (achievement scores test);
2. Learners' participation/involvement during the treatment of the computer assisted instruction tasks;
3. The initial status of learners' and teachers' literacy in computer (met by all students and teachers); and,
4. Teachers' views on the use of CAI to teach mathematics to their students.

### **3.7.2.5: Classroom Observations**

Observations of the participants in the main study lasted for two hours per school i.e. 4 hours of observation to authenticate and enhance information gathered through other methods (Silverman, 2005). During the regular mathematics classroom observation, I took field notes to document the observation. As much as possible I tried to maintain as objectivity in order not to influencing the outcome of the research study.

## **3.8 DATA ANALYSIS**

Quantitative data (achievement test) collected from the pre-test and post-test was used to answer the research questions and objectives 1, 2, 3&4 raised in the study. Whereas data from classroom observations and semi-structure interviews were analysed using qualitative method to address research question and objective 5 raised for the study.

### **3.8.1: Quantitative analysis**

In analysing the quantitative data collected for the study, the test 1 (pre-test) and test, 2 (post-test) scores of the control and the experimental groups were analysed using descriptive statistical tools, such as mean and standard deviation. In addition to the descriptive statistical tools, analysis of covariance (ANCOVA) was performed in order to adjust initial group differences in participants' pre-test scores related to performance on the dependent variable (Gay et al. 2011; Hill&Lewicki, 2007). The dependent variable was students' post-test achievement scores in latitude and longitude, while the covariate was students' pre-test scores in latitude and longitude. The researcher discussed the uses of ANCOVA techniques, its underlying assumptions, and the homogeneity of regression (slope) before ANCOVA test was performed (see chapter 4 of the study).



### **3.8 .1.1: Use of descriptive tools in data analysis**

The use of descriptive tools in data analysis made it possible to describe the distribution of test 1 (pre-test) and test 2 (post-test) of the two groups (Matland, 2010). The mean in the study measured the central location and centre of gravity of the observations while standard deviation is a reflection of distance in the individual mean scores. The tools enabled the researcher to compare students' performance in both groups and determine the effectiveness of the CAI intervention on students' achievement in latitude and longitude (Hill&Lewicki, 2007).

### **3.8 .1.2: Use of inferential tools in data analysis**

The use inferential statistical tool in a study allows one to test the stated hypotheses, to draw conclusions and make inferences from a study sample to the overall population (Gay etal. 2011; Hill, &Lewicki, 2007). Using an inferential statistical tool in study also allows for testing the relationship between the scores. An alpha level of 0. 05 were used for all statistical data in the study. To assess the effect of the intervention (X), the mean results of the two classes on the pre-test, post-test level of achievement were compared for a possible significant difference.

### **3.8.1.3: Testing research hypothesis**

The study investigated whether or not students who are taught using CAI strategy would demonstrate greater achievement in latitude and longitude than students' taught through the use of traditional instruction techniques.

**Null hypothesis (H<sub>0</sub>):** *There is no statistically significant difference between the students' achievement in latitude and longitude for the control and the experimental groups.*

**Alternative Hypothesis (H<sub>1</sub>):** *There is statistically significant difference between the students' achievement in latitude and longitude for the control and the experimental groups.*

To test for the null hypothesis, an ANCOVA test was performed by the researcher (See Section, 4.2.2). The post-test scores were entered as the dependent variable while the pre-test scores were entered as covariates to control for differences among the students before the treatment, on SPSS version 20. Alpha level was established at 0.05.

### **3.8.2 Qualitative data analysis**

The data collected was analysed qualitatively from transcriptions of the interview and classroom protocol (see Appendix 4&Appendix 5). The following themes are specified for the study namely: students' engagement, classroom mathematical discourse, and collaboration among students, excitement and teachers' perceptions on the use of CAI. These themes are in line with the research questions and the central phenomenon of the study (Barbie, 1998; Merriam, 1997). The researcher considered this method appropriate because of its central premise that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone.

#### ***3.8.2.1: Transcribing the qualitative data***

The transcription of students' verbal responses during the interview was done directly from the audio recordings, checked by listening to the recording and then reading through the transcribed words with the assistance of a teacher who did not have any association with any of the participants. This was rechecked a second time to ensure that the transcriptions correspond to what was recorded. Final collation of the data took place after the researcher was sure that the transcription was accurate. The data was coded and categorized into themes (Barbie, 1998; Merriam, 1997). Table 3.11 is a typical example of main study respondents' coded transcripts.

**Table 3.11: Example of a main study respondents' Coded Transcript**

Reflective Notes	Activity	Code	Theme
<p>Effectiveness of CAI</p> <p>Note: Emotion expressed by students</p> <p>Emotion expressed</p> <p>CAI is effective for future use by teachers</p>	<p><b>Interviewer:</b> <i>Do you think you learn mathematics better, with the use of CAI to teach it the classroom?</i></p> <p><b>L1:</b> I can't believe this! This computer programs is good for learning.</p> <p><b>Interviewer:</b> <i>Have you ever used computer to solve mathematics problems like this before in the class?</i></p> <p><b>L2:</b> For where? We have never used such a thing like this before.</p> <p><b>Interviewer:</b> <i>In your opinion, do you think the use CAI to teach the topic in mathematics is better than other methods employed to teach in schools?</i></p> <p><b>T1:</b> The package is good for teach other math topics. Should be considered by Ministry of education for use in schools.</p>	<p>The impact of the CAI</p> <p>CAI motivated students to learn</p> <p>Teachers admire and appreciate the use of CAI to teach mathematic</p>	<p>Student Engagement</p> <p>excitement and self-confidence</p> <p>opinion on the use CAI expressed</p>

### 3.9 ETHICAL CONSIDERATIONS

In accordance with the dictates of the University of South Africa (Unisa) and the fact that the study deals with human subjects therefore is subject to ethical considerations, there was a need for ethical clearance. Permission was sought from the local education authorities and school principals to use their schools and their pupils. Letters of consent were given to the researcher by the school principals to use both their schools and their subjects (see Appendix 6). None of the participants used for the study were forced to participate, and the identity of every participant was kept under strict confidentiality. Hence, participants were not asked to write their names but rather use the letters of the alphabet and the numbers assigned to them

and their schools. The researcher was honest in his dealing with all participants and was mindful of their personal cost such as an affront to dignity; embarrassment, lost of trust, and lowered self-esteem. The researcher kept research work visible and was opened to suggestions. In addition, the following precautions were taken. (1) the researcher did not abuse his position as someone in authority (2) the researcher ensure sensitivity to all people such as ethnicity, gender, culture, religion, personality etc. With all necessary documents attached, the researcher applied through his supervisor to the Unisa Research Ethical Committee before starting the field study.

### **3.10 SUMMARY OF THE CHAPTER**

The aim of this chapter was to provide a detailed description of the study approach adopted, including the research paradigm, research design, the population and sample for the study, and the composition of the instruments used in the study. It explains why the mixed method design approach was considered appropriate for the research study. The chapter has discussed the validity and reliability of the instruments resulting from the pilot study conducted. In accordance with the stated null hypothesis for the study, the statistical tools used for the analysis have been clearly discussed.

## CHAPTER FOUR

### FINDINGS

In this chapter, results obtained from the pilot and main study are presented, analysed and interpreted empirically. This has enabled the researcher to provide answers to the research questions raised for the study. According to Creswell and Clark (2007), data analysis in a mixed - method research study consists of analysing the quantitative data using quantitative methods, and the qualitative data using qualitative methods. Therefore, the raw data collected from the fieldwork for both experimental and control groups was analysed both quantitatively and qualitatively as discussed in the chapter. The chapter concludes with summary after the the integrated findings of both the quantitative and the qualitative data analysis.

#### 4.0 QUANTITATIVE FINDINGS

##### 4.1 PILOT STUDY RESULTS

One of the purposes of pilot study according to Gall, et al, (2007) is to try out the achievement tests. In order to determine the statistical significance of the mean difference, and to affirm the effectiveness of the CAI strategy, the pre-test and post-test scores for both the control and the experimental schools were compared using the t-test at 0.05 significant levels. The t-test is used to compare the means ( $\mu$ ) of two or more independent groups Gall, et al, 2007. A smaller p-value than the significant value ( $\alpha=0.05$ ) in the t-test results shows a mean difference from the hypotheses value. Whereas, if the p-value associated with the t-test is greater, i.e  $p>0.05$ , it can be concluded that the mean is not different from the hypothesised value. Then the null hypothesis is not rejected. The t-test pre-test results for the pilot study from the experimental and the control schools were analysed and presented in table 4.1.

**Table 4.1: Pilot study Pre –test result(n=40)**

Group	N	Mean	S.D	S.E	t-value	Level of significant
Experimental	40	11.42	2.97	2.20	1.56	Not significant
Control	40	10.37	2.62	1.62		

Table 4.1 showed that pre-test Mean Scores ( $M$ ), and the Standard Deviation ( $SD$ ), of both the Experimental and the Control groups are ( $M=11.42$ ,  $SD=2.97$ ), and ( $M=10.37$ ,  $SD=2.62$ ) respectively. The t-value is 1.56 which is not statistically significant at 0.05 levels. It could then be concluded that there is no statistically significant difference between the experimental

and the control group in the pre-test. This confirms the equivalence of the two groups. Therefore, it was evident that before the treatment, the two groups were at the same level in the topic.

After the intervention, the post-test scores for the two groups (experimental and control group) were analysed and the t-test results were presented in table 4.2

**Table 4.2: Pilot study post –test result(n=40)**

Group	N	Mean	S.D	S.E	t-value	P	Level of significant
Experimental	40	55.35	2.74	1.98	7.42	0.0351	Sign. at 0.05 level
Control	40	40.21	2.16	1.46			

The post-test mean scores of the experimental and control groups are  $M=55.35$ ,  $SD=2.74$ , and ( $M=40.21$ ,  $SD=2.16$ ) respectively. From the table, the probability of error is less than 0.05 ( $P=0.0351 < 0.05$ ). Therefore, the null hypothesis is rejected. It is concluded that the difference between the mean scores of the post-test is statistically significant. From the findings, it is evident and was clearly indicated that the treatment was statistically significant on students' achievement.

Table 4.3 presents the descriptive statistics of students' pre-test achievement means scores and the standard deviation for both males and females in the two groups as analysed.

**Table 4.3: Pilot study pre –test scores based on gender (n=40)**

Group	Male				Female			
	N	Mean	S.D	S.E	N	Mean	S.D	S.E
Experimental	20	11.89	2.76	2.21	20	11.41	1.99	1.33
Control	20	10.01	2.65	2.04	20	10.04	1.85	1.53

The male students' pre-achievement mean scores and the standard deviation Male: ( $M=11.89$ ,  $SD=2.76$ ) and Female :( $M =11.41$ ,  $SD=1.99$ ) was not significantly different in the experimental group. Similarly, in the control group, pre-achievement mean scores and the standard deviation Male: ( $M=10.01$ ,  $SD=2.65$ ) and Female :( $M=10.04$ ,  $SD=1.85$ ) was not significantly different. The results reveal that neither males nor their females' counterparts have received any knowledge on latitude and longitude topic before the treatment.

Table 4.4 shows students' pre achievement t-test results for both males and females in the two groups. The researcher compared their pre-test scores in the groups using the t-test at 0.05 significant levels.

**Table 4.4: Pilot study pre-test results based on gender (n=40)**

Grp	Male						Female					
	N	X	S.D	t-	P	Sig	N	X	S.D	t-	p	Sig
Exp.	20	11.21	2.66	value 4.27	3.64	NS	20	11.26	1.94	value 4.54	2.35	NS
Con	20	11.15	2.74				20	10.89	1.86			

In the Table, the probability of error is greater than 0.05 ( $P= 3.64 > 0.05$ ) for the males and ( $P= 2.35 > 0.05$ ) for the females. The non-significance of the results reveals that neither males nor their females' counterparts have received any knowledge on latitude and longitude topic before the treatment. Therefore, the null hypothesis is not rejected but accepted.

Table 4.5 presents the descriptive statistics of students' post-test achievement means scores and the standard deviation for both males and females in the two groups as analysed.

**Table 4.5: Pilot study post –test scores based on gender (40)**

Group	Male				Female			
	N	Mean	S.D	S.E	N	Mean	S.D	S.E
Experimental	20	54.47	2.95	1.89	20	55.89	1.83	1.06
Control	20	41.26	2.09	2.71	20	40.15	1.90	1.24

From the table 4.5, the achievement means scores of female students are slightly higher than the achievement mean scores of their male counterparts in the post-tests whereas, in the pre-achievement scores, male students have slightly higher achievement scores than their female counterparts (see Table 4.3). The difference in the achievements' scores (pre and post-tests) for both males and the females are not significant; this indicates that gender might not be a factor for better performance towards the learning of latitude and longitude by students.

After the intervention, the post t- test results for the two groups (experimental and control group) for both male and the female students were analysed and presented in table 4.6

**Table 4.6: Pilot study post t-test results based on gender (n=40)**

Grp	Male						Female					
	N	X	S.D	t-value	p	Sig	N	X	S.D	t-value	P	Sig
Exp.	20	55.41	2.96	4.77	3.85	NS	20	54.96	1.67	4.64	3.74	NS
Con	20	42.15	2.34				20	41.89	1.97			

From the table, the probability of error is greater than 0.05 ( $P= 3.85 > 0.05$ ) for the males, and ( $P = 3.74 > 0.05$ ) for the females. The results reveal that both males and their females' counterparts in the two groups were not significantly different. This indicates that the treatment was statistically not significant on either males or their females' counterparts for better performance towards the learning of latitude and longitude. Therefore, the null hypothesis is not rejected but accepted.

#### 4.1.1.1: Analysis of students' attitude results

Students' learning attitude in latitude and longitude questionnaire tagged as QSALL was used to measure students' attitude towards the concept of latitude and longitude before and after the intervention in the two groups (experimental; and control) during the pilot study.

From the table 4.7, a minimal difference of 0.02 is observed between the groups in the pre-test mean scores of the students from the groups. Mean scores of students from experimental group in the pre-test were ( $M=3.46, S.D=0.94$ ) while pre-test mean scores of students for the control group were ( $M=3.44, S.D= 0.89$ ). Thus, both experimental group and the control group had similar responses to the questionnaire before the intervention (see also, Table 4.8).



**Table 4.7: Pilot study pre and post samples attitudescores**

Test	STRATEGY	N	MEAN	SD
Pre-Treatment Attitude	CAI	40	3.46	0.94
	TM	40	3.44	0.89
Post-Treatment. Attitude	CAI	40	3.78	0.87
	TM	40	3.21	0.92

In table 4.7 the mean score for experimental group in the post-test were ( $M=3.78$ ,  $S.D= 0.87$ ) while mean scores of students for the control group were ( $M=3.21$ ,  $S.D= 0.92$ ). This indicates that students in the experimental group that were taught using computer assisted instruction had higher post-test mean scores than their counterparts in the control group. Students in the control groups complained that the class were boring, and that, they only copy down what was written on the blackboard by their teachers.

**Table: 4.8 :Summary of pilot study pre- treatment mean scores**

PRE-ATTITUDE QUESTIONS		MEAN		SD	
		E	C	E	C
<b>Theme one: Self-confidence about learning/solving latitude and longitude mathematics problems</b>					
1	Mathematics is difficult for me especially bearing which is fundamental to the learning of latitude and longitude.	3.44	3.47	0.86	0.54
2	Latitude and longitude is not a difficult aspect of mathematics for me	4.21	3.26	0.97	0.85
3	The calculation of distance between two points and length between parallels of latitude are always confusing when solving questions on the topic	3.37	3.16	0.79	0.95
4	I always enjoy the mathematics class when problems that involve application of formulas are being solved in class.	3.58	3.46	0.69	0.65
5	I find it difficult to apply some of the formulas given when I am to solve problems with 3-dimensional solidgeometry.	4.03	2.17	0.79	0.95
6	I can still improve in mathematics if I give more attention to solving mathematical problems	4.12	3.26	0.98	0.88
<b>Theme two: Students' interest in latitude and longitude and mathematics generally</b>					
7	Communicating with other students helps me have a better attitude towards mathematics that involves lines and angles.	3.82	3.33	0.87	1.17
8	The concept of latitude and longitude is not clear to me in mathematics	3.73	3.85	0.75	0.79
9	I prefer topics that are difficult in mathematics to be taught with the aid of instructional materials so as to assist the low achievers to catch up quickly especially latitude and longitude.	3.85	3.57	0.78	0.98
10	I always find it interesting when solving problems on solid geometry especially latitude and longitude.	3.87	3.76	0.83	0.89
11	My foundation in mathematics at the junior class is poor and this contributed to my low performance in the senior class	3.62	2.41	0.95	0.68
12	Mathematics is one of my favourite subjects and I often practice it.	4.11	3.85	0.85	1.19
<b>Theme three: Students' perceptions/opinions of the subject teacher</b>					
13	Detail explanations given by my teacher on latitude and longitude with the use of instructional materials give me better understanding of the topic.	3.83	3.38	0.87	0.96
14	My teachers encouraged me to like mathematics hence they gave me adequate materials and attention whenever I asked them.	4.17	4.04	0.97	1.06
15	If mathematics could be taught with the use of computer	3.65	4.07	0.73	1.06

	by our subject teacher, many students will learn it faster				
16	Our mathematics teacher is not always regular in the class to teach us	3.65	3.72	0.65	1.13
17	We have not been having a mathematics teacher for the past one session	2,85	2.09	1.76	0.68
18	Latitude and longitude can be the most enjoyable topic if our teacher explains it clearly in the class	3.62	4.06	0.85	0.89
<b>Theme four : Students' anxiety about mathematics/latitude and longitude</b>					
19	Mathematics that involves lines and angles always scares me and I generally hate those topics	3.95	3.78	0.88	0.76
20	I am scared about calculation of difference between angle of latitude and longitude of two points on the earth globe.	2.45	3.01	0.83	1.43
21	My parents told me that too much practice of mathematics can have a negative effect on me, hence I hate the subject	3.55	3.34	0.62	0.48
22	Computer assisted instruction will make students become lazy in using their brain to solve mathematical problems.	3.64	3.61	0,94	0.36
23	Adequate power supply in our schools may hinder the proper use of computer systems in most secondary schools for the teaching of mathematics.	4.01	3.56	0.73	0.85
24	Because I am in art class mathematics is not compulsory for me. Hence I attend the class whenever I like.	3.97	3.01	0.83	0.78
<b>Theme five: Usefulness of mathematics and latitude and longitude</b>					
25	Mathematics is needed in designing practically everything in life.	3,74	3.82	0.75	0.79
26	Mathematics could be made more interesting for students if new topics are introduced through the use of computer packages, with a guided approach to real life.	3.67	3.79	0.76	1.19
27	Mathematics could be made more interesting for students if new topics are introduced through the use of computer packages, with a guided approach to real life.	3.73	3.57	0.96	0.77
28	Mathematics helps me to think fast whenever I help my parents at their marketplace after school hours.	3.71	3.67	0.78	0.92
29	The use of computer assisted instruction will expose students to modern technology in solving mathematical problems.	3.91	3.88	0.84	0.96
30	Mathematics is the only subject that promotes science and technology.	3.85	3.78	0.95	0.92
<b>OVERAL TOTAL</b>		<b>3.46</b>	<b>3.44</b>	<b>0.94</b>	<b>0.89</b>

In table 4.7, the summary of students' post- attitude treatment scores in the experimental group were ( $M=3.78$ ,  $S.D= 0.87$ ) while post- treatment attitude mean scores of students for the control group were ( $M=3.21$ ,  $S.D= 0.92$ ). It obvious that students in the experimental group that were expose to CAI strategy attained higher post-test mean scores than their counterparts in the control group.

**Table 4.9: Summary of pilot study post-treatment mean scores**

POST-ATTITUDE QUESTIONS		MEAN		SD	
		E	C	E	C
<b>Theme one: Self-confidence about learning/solving latitude and longitude mathematics problems</b>					
1	Mathematics is difficult for me especially bearing which is fundamental to the learning of latitude and longitude.	3.62	3.73	0.76	0.45
2	Latitude and longitude is not a difficult aspect of mathematics for me	3.54	3.71	0.93	0.78
3	The calculation of distance between two points and length between parallels of latitude are always confusing when solving questions on the topic	4.24	3.33	0.94	0.72
4	I always enjoy the mathematics class when problems that involve application of formulas are being solved in class.	3.48	3.55	0.96	0.87
5	I find it difficult to apply some of the formulas given when I am to solve problems with 3-dimensional solid geometry.	4.29	2.32	0.83	0.68
6	I can still improve in mathematics if I give more attention to solving mathematical problems	4.46	3.58	0.94	0.87
<b>Theme two: Students' interest in latitude and longitude and mathematics generally</b>					
7	Communicating with other students helps me have a better attitude towards mathematics that involves lines and angles.	3.69	3.48	0.67	0.74
8	The concept of latitude and longitude is not clear to me in mathematics	3.83	3.58	0.77	0.69
9	I prefer topics that are difficult in mathematics to be taught with the aid of instructional materials so as to assist the low achievers to catch up quickly especially latitude and longitude.	3.60	3.59	0.69	0.79
10	I always find it interesting when solving problems on solid geometry especially latitude and longitude.	3.69	3.97	0.69	0.77
11	My foundation in mathematics at the junior class is poor and this contributed to my low performance in the senior class	3.65	3.41	0.87	0.98
12	Mathematics is one of my favourite subjects and I often practice it.	3.54	3.68	0.79	0.76
<b>Theme three: Students' perceptions/opinions of the subject teacher</b>					
13	Detail explanations given by my teacher on latitude and longitude with the use of instructional materials give me better understanding of the topic.	3.78	3.88	0.97	0.86
14	My teachers encouraged me to like mathematics hence they gave me adequate materials and attention whenever I asked them.	3.37	3.79	0.98	0.87
15	If mathematics could be taught with the use of computer by our subject teacher, many students will learn it faster	4.78	3.18	0.90	0.88
16	Our mathematics teacher is not always regular in the class to teach us	3.79	3.83	0.72	0.79

17	We have not been having a mathematics teacher for the past one session	2.69	3.78	0.79	0.69
18	Latitude and longitude can be the most enjoyable topic if our teacher explains it clearly in the class	3.98	3.94	0.85	0.88
<b>Theme four : Students' anxiety about mathematics/latitude and longitude</b>					
19	Mathematics that involves lines and angles always scares me and I generally hate those topics	3.96	3.88	0.58	0.86
20	I am scared about calculation of difference between angle of latitude and longitude of two points on the earth globe.	3.45	3.81	0.93	0.93
21	My parents told me that too much practice of mathematics can have a negative effect on me, hence I hate the subject	3.85	4.34	0.82	0.98
22	Computer assisted instruction will make students become lazy in using their brain to solve mathematical problems.	3.74	4.67	0.84	0.96
23	Adequate power supply in our schools may hinder the proper use of computer systems in most secondary schools for the teaching of mathematics.	3.11	4.76	0.83	0.95
24	Because I am in art class mathematics is not compulsory for me. Hence I attend the class whenever I like.	3.87	3.91	0.93	0.88
<b>Theme five: Usefulness of mathematics and latitude and longitude</b>					
25	Mathematics is needed in designing practically everything in life.	4.75	3.92	0.95	0.89
26	Mathematics could be made more interesting for students if new topics are introduced through the use of computer packages, with a guided approach to real life.	3.97	3.79	0.78	0.87
27	Mathematics could be made more interesting for students if new topics are introduced through the use of computer packages, with a guided approach to real life.	3.83	3.87	0.96	0.98
28	Mathematics helps me to think fast whenever I help my parents at their marketplace after school hours.	3.81	3.87	0.88	0.96
29	The use of computer assisted instruction will expose students to modern technology in solving mathematical problems.	3.91	3.88	0.84	0.94
30	Mathematics is the only subject that promotes science and technology.	4.75	3.77	0.85	0.97
<b>OVERAL TOTAL</b>		<b>3.78</b>	<b>3.21</b>	<b>0.87</b>	<b>0.92</b>

To further affirm the effectiveness of CAI strategy on students learning attitude, the researcher compared their pre-test and post-test scores using the t-test at 0.05 significant levels in the experimental group. The t-test results for pre-and-post-treatment attitude scores were analysed and presented in table 4.10

**Table 4.10 :Pilot study post- attitude scores (n=40)**

Group	N	Mean	S.D	S.E	t-value	P	Level of significance
Pre-Treat. Attitude	40	17.45	3.42	0.27	2.12	0 .0563	Sign. at 0.05 level
Post-Treat Attitude	40	26.86	3.68	0.94			

In the Table, the probability of error is less than 0.05 ( $P= 0 .0563 <0.05$ ). Therefore, the null hypothesis is not accepted but rejected. We can conclude that the difference between the mean scores of the pre and the post-attitude test is statistically significant. Hence, it is interpreted that students who were taught by CAI in the Experimental group had higher post-Attitude treatments mean scores

## 4.2: MAIN STUDY

### 4.2.1 DESCRIPTIVE STATISTICS

Descriptive statistics are used to summarise and describe the basic feature of the data in a study (Ragasa, 2008). For the study the researcher computed the mean, standard deviation and the ranges of students' scores for the control and the experimental groups. Each of the five ATLL items attracted a maximum score of 20 marks. Hence, the total marks obtainable by any student were 100. The raw scores for both control and experimental classes were analysed and interpreted using descriptive tools.

From the total number of 320 participants, only 316 (98.75%) participated fully in the study. These 316 participants attended all the CAI lessons in the experimental schools; they participated in the computer instructional package (CAIP) laboratory exercises and wrote the pre and post achievement tests. Attendance was taken in both the control and the experimental schools for record purposes. Records showed that two (2) students were absent in either one or both session of the achievement in the control schools. Likewise in the experimental schools, two (2) students did not write one or both of the achievement tests (see table 4.11). Evidently, 4(1.25%) were absent for the study.

**Table 4.11: Breakdown of students' participation in achievement test**

Schools	Number of students /Subject Area		No of Students absent and did not write either 1 <sup>st</sup> or both tests	No of male students that wrote tests 1&2	No of female students who that wrote tests 1&2
<b>E1</b>	Arts	38	<b>01</b>	43	38
	Comm.	28			
	Science	16			
<b>E2</b>	Arts	38	<b>01</b>	44	37
	Comm.	28			
	Science	16			
<b>C3</b>	Arts	38	01	42	36
	Comm.	26			
	Science	16			
<b>C4</b>	Arts	38	01	43	33
	Comm.	24			
	Science	16			
<b>TOTAL</b>	<b>320(100%)</b>		<b>4(1.25%)</b>	<b>72(53.75%)</b>	<b>144(45.0%)</b>
	<b>Total (M+F) = 316(98.75%)</b>				

**4.2.1.1: Analysis of students' pre and post-test for the two groups**

In order to determine the baseline knowledge and equivalence of the two groups, the researcher pre-tested students in both the control and the experimental groups.

From table 4.12 the pre-test mean scores of students from the experimental group were ( $M=11.74$ ,  $S.D= 7.92$ ) while mean scores of students for the control group were ( $M=9.96$ ,  $S.D=8.25$ ). The results of the two groups revealed students' baseline knowledge in latitude and longitude, and the equivalence of the two groups. This indicates that none of the groups have gained any knowledge of the topic before now; hence the two groups were comparable in terms of their knowledge of the topic.

**Table 4.12: Summary of main study pre-test scores for the two groups**

<i>Groups</i>	<i>N</i>	<i>Mean</i>	<i>S.D</i>	<i>S.E</i>
Experimental	160	11.74	7.92	0.67
Control	156	9.96	8.25	0.65

A comparison of the experimental group post-test mean scores (55.67) and the control group post-test mean scores (40.83) as illustrated in the Table 4.13 shows that the CAI intervention improved students' performance in the experimental group. Experimental group students



were taught with the CAI method of instruction before they were post-tested whereas, students in the control group were taught with the traditional method of instruction. The difference in the post-test means score for the two groups showed the impact of the CAI intervention in favour of the experimental group.

**Table 4.13: Summary of main study post-test scores for the two groups**

<i>Groups</i>	<i>N</i>	<i>Mean</i>	<i>S.D</i>	<i>S.E</i>
Experimental	160	55.67	6.35	0.64
Control	156	40.83	6.75	0.53

The summary of students' improvement in their post-test mean scores in the control group was presented in Table 4.14. The pre-test mean scores were 9.96 while the post-test mean scores were 40.83 with 31% mean improvement score. Although no intervention was used in the group, an improvement occurred in student performance. This indicates that learning took place with the use of traditional method to teach the topic but the students may have performed better if the CAI intervention had taken place to teach the concept of latitude and longitude in the classroom.

**Table 4.14: Summary of students' Improvement scores in the control group**

<b>Statistics</b>	<b>Pre-test</b>	<b>Post-test</b>	<b>Improvement score</b>
Mean	9.96	40.84	30.88
Standard deviation	8.25	6.76	7.44
Range	40.00	42.00	39.00
Minimum	0.00	26.00	10.00
Maximum	40.00	68.00	49.00

After the intervention as illustrated in Table 4.15, students' performance reveals a good improvement in their post-test scores. This might be due to the intervention given to the group, but not due to chance. Before the intervention, the mean scores were 11.74. After the intervention, the same set of students was post-tested, and the mean score was 55.67, which indicate a good improvement in students' performance in the topic. The results show that the use of the CAI mode of instruction produced a significant difference on the post-test performance of the students. This indicates that the CAI package enhanced students' learning of the concept of latitude and longitude.

**Table 4.15: Summary of students' Improvement scores in the experimental group**

Statistics	Pre- test	Post-test	Improvement score
Mean	11.74	55.67	43.93
Standard deviation	7.92	6.35	7.43
Range	40.00	34.00	34.00
Minimum	0.00	40.00	27.00
Maximum	40.00	74.00	61.00

Table 4.16, discusses students' pre and post-test achievement descriptive scores based on gender. The male students' pre-achievement mean scores and the standard deviation ( $M=10.84$ ,  $S.D =8.21$ ) compared to the female students' pre-achievement mean scores ( $M = 10.73$ ;  $S.D 8.04$ ) was not significantly different in the experimental group. Similarly, the post-test achievement mean scores, and the standard deviation for male students ( $Mean = 54.04$ ;  $S.D=9.66$ ) compared to the post-test achievement mean scores, and the standard deviation for female students ( $M = 53.98$ ;  $S.D = 9.66$ ) were not significantly different after the intervention as illustrated in the Table. This indicates that female students attain almost the same achievement scores as their male counterparts when taught the concept of latitude and longitude through the use of the CAI mode of instruction in the mathematics classroom.

**Table 4.16: Pre and Post- achievement descriptive scores based on gender**

Control Group						Experimental group				
	Gender	N	X	SD	SE	Gender	N	X	SD	SE
Pre-Test	Male	87	9.65	8.42	.643	Male	86	10.84	8.21	.647
	Female	69	10.33	8.43	.672	Female	74	10.73	8.04	.642
Post-Test	Male	87	40.87	9.25	.756	Male	86	54.04	9.66	.761
	Female	69	40.85	9.41	.761	Female	74	53.98	9.52	.760

Table 4.17 shows students' pre achievementt-test results for both males and females in the two groups. The students' pre-test scores in the groups were compared using the t-test at 0.05 significant levels.

**Table 4.17: Pre t-test resultsbasedon gender**

Grp	Male						Female					
	N	X	S.D	t- value	P	Sig	N	X	S.D	t- value	p	Sig
Exp.	87	10.56	7.96	4.47	3.66	NS	69	10.26	8.94	4.42	3.75	NS
Con	86	10.17	7.84				74	10.88	8.86			

In the Table, the probability of error is greater than 0.05 ( $P = 3.66 > 0.05$ ) for the males and ( $P = 3.75 > 0.05$ ) for the females. The non-significance of the results reveals that neither males nor their females' counterparts have been taught on latitude and longitude topic before the treatment. Hence, the null hypothesis is not rejected but accepted.

After the intervention, the post- t-test results for the two groups (experimental and control group) for both male and the female students were analysed and presented in table 4.18

**Table 4.18: post t-test resultsbasedon gender**

Grp	Male						Female					
	N	X	S.D	t- value	P	Sig	N	X	S.D	t- value	P	Sig
Exp.	87	54.41	9.46	4.57	3.65	NS	69	53.98	9.47	4.54	3.71	NS
Con	86	40.15	9.43				74	4.87	9.53			

From the table, the probability of error is greater than 0.05 ( $P = 3.65 > 0.05$ ) for the males, and ( $P = 3.71 > 0.05$ ) for the females. The results reveal that both males and their females' counterparts in the two groups were not significantly different. This indicates that the treatment was statistically not significant on either males or their females' counterparts for better performance towards the learning of latitude and longitude. Therefore, the null hypothesis is not rejected but accepted.



**Table 4.19: Pre and post achievement scores in the science, commercial and art classes**

	Gender	Subject area	No of Student	Mean	S.D.	S.E
Pre-test	Male	Science	16	11.49	9.314	.673
		Art	28	10.33	8.070	.587
		Commercial	28	9.65	6.597	.766
	Female	Science	15	10.78	7.921	.686
		Art	28	11.33	8.063	.591
		Commercial	37	10.05	8.470	.688
Post-test	Male	Science	16	54.23	9.653	.613
		Art	28	55.04	8.861	.546
		Commercial	28	54.32	8.502	.617
	Female	Science	15	55.64	9.313	.682
		Art	28	54.78	8.746	.633
		Commercial	37	55.45	9.334	.638

The male (science; Arts, and commercial) students' pre-achievement mean scores ( $M = 11.49; 10.33; 9.65; S.D = 9, 3; 8.07; 6.59$ ) compared to the female (science; Arts, and commercial) students' pre-achievement mean scores ( $M = 10.78; 11.33; 10.05; S.D = 7.9; 8.06; 8.47$ ) was not different in the experimental group. Similarly, the male (science; Arts, and commercial) students' post-test achievement mean scores ( $M = 54.23; 55.04; 54.32; S.D = 9.65; 8.86; 8.50$ ) compared to the female (science; Arts, and commercial) students' post achievement mean scores ( $M = 55.64; 54.32; 55.45; S.D = 9.31; 8.74; 9.33$ ) were not significantly different after the intervention. The results show that the use of the CAI strategy did not produce a significant difference on the post-test performance of both the female and male students.

#### 4.2.2: THE USE OF ANCOVA ANALYSIS

The use of ANCOVA for the study was considered appropriate as it eliminates unmeasured variables that confound the results, i.e. variables that vary systematically with the experimental manipulation (Gay et al. 2011; Hill, & Lewicki, 2007. ANCOVA as a general linear model allows for an experimental, non-equivalent research approach that suited the approach adopted for the study (Okpala, Onoja&Oyedeki, 1993).

#### 4.2.2.1 Assumption of linearity of data distribution

To test the stated null hypotheses for the study, the Analysis of Covariance (ANCOVA) was employed by the researcher using SPSS version 20. ANCOVA was used to examine whether a statistical significant difference existed between the post-test scores for the control and the experimental groups when the pre-test scores were held constant. This can be shown through the regression line of the two groups by evaluating whether the regression line for the intervention group was significantly elevated over the regression line of the control group (see Figure 4.1). ANCOVA assumes that the slopes of the regression lines are equivalent (same for the two groups) and should be homogenous (parallel). The researcher tested this assumption before doing ANCOVA. The choice of this statistical tool relied on its capability to remove the bias of those variables that may influence the dependent variable being measured. The tool reduces the within-group error variance in term of covariates and reduces the error variance by allowing the effect of the experimental manipulation to be more accurately assessed. Homogeneity of regression slopes is one of the assumptions to be made before the use of ANCOVA in a study. This is to show that the overall relationship between outcomes fits the regression line to the entire data set ignoring to which group it belongs.

#### 4.2.2.2: Levene's test for equality of variance

The Levene's test tests the assumption that each dependent variable has similar variances for the two groups (Ragasa, 2008). In the study, Levene's test was performed by the researcher to examine whether there was a difference between the error variance of the dependent variables between the participants in the control and the experimental groups. Error variance according to Jackson, (2012) is whatever sources of variability on which an attention is not focused. It is generally considered that if the Levene's statistics is significant at the 0.05 level or better, then the null hypothesis that the group have equal variances is rejected (Ragasa, 2008). To perform the Levene's test in the study, a null Hypothesis ( $H_0$ ) was formulated stating that the population variance are equal while the corresponding alternative Hypothesis ( $H_1$ ) stated that the population variances are not equal.

Thus:

***$H_0$ : Error variance of the dependent variable is equal across the groups;***

***$H_1$ : Error variance is not equal across the groups.***

The results of Levene's test is presented in table 4.20

**Table 4.20: Levene's test results**

	F	df1	df2	Sig.
Achievement's post-test	0.030	1	316	.583

Table 4.20 revealed that P value is greater than 0.05. Thus  $P = 0.583 > 0.05 = \alpha$ , an indication that the results are statistically non-significant. The results suggest that  $H_0$  is upheld since the dependent variable (post-test) scores is equal across the groups. The homogeneity assumption is therefore satisfied. Hence more inferential statistical tools can now be used.

#### 4.2.2.3: Homogeneity of regression slopes

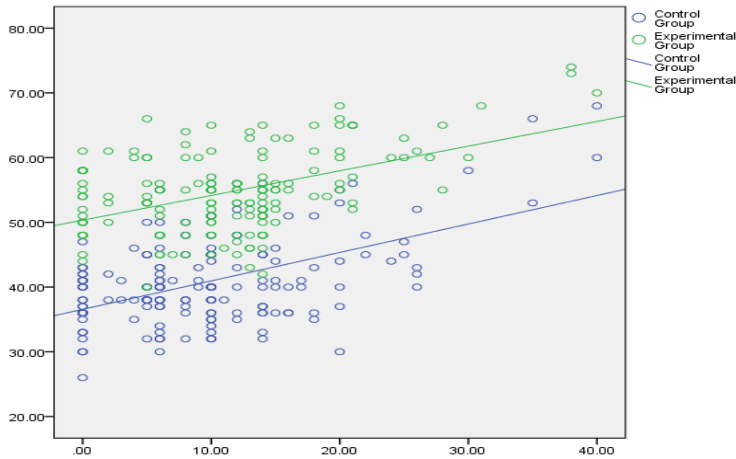
In this study, the researcher tested to see if there exist any relationship between the pre-test (covariate) scores and the instruction (independent variable) in determining students' performance in latitude longitude (see table 4.21). The following hypotheses were tested;

$H_0: \beta_1^{\text{Control}} = \beta_1^{\text{Experimental}}$ , and  $H_1: \beta_1^{\text{Control}} \neq \beta_1^{\text{Experimental}}$ .

As revealed from the table 4.21 the homogeneity of regression slopes were homogenous. Hence  $H_0: \beta_1^{\text{Control}} = \beta_1^{\text{Experimental}}$  was upheld while  $H_1: \beta_1^{\text{Control}} \neq \beta_1^{\text{Experimental}}$  was rejected. It was rejected because  $F < F_{0.05, 1, 314}$ . This indicates that the overall relationship between outcomes fits the regression line to the entire data set (see figure. 4.1) illustrates the scatter plot for both the control and the intervention groups and the corresponding regression slopes.

**Table 4.21: Homogeneity of regression slopes test**

Source	SS	DF	MS	F	p-value
Heterogeneity of Slopes	16.641	1	16.641	0.511	0.547
Individual Residuals( $res_i$ )	10222.414	314	32.555		
Within Residual( $res_w$ )	10239.055	315			
	CRITICAL VALUES		$F_{0.05, 1, 314}$	3.86510799	
	CRITICAL VALUES		$F_{0.01, 1, 314}$	6.6994680	
$H_0: \beta_1^{\text{Control}} = \beta_1^{\text{Experimental}}$					
$H_1: \beta_1^{\text{Control}} \neq \beta_1^{\text{Experimental}}$					
Reject $H_1$ because $F < F_{0.05, 1, 314}$					



**Figure 4.1: Scatter plot for control and intervention groups**

Equation of best fit:

Control group  $Y = 0.438x + 36.589$   $R = 0.53$

Experimental group  $Y = 0.381x + 50.35$   $R = 0.476$

Given these assumptions, the researcher can now statistically report on the main effect of computer-assisted instruction on students' performance, identify the significant effect of CAI and argue its' superiority over the traditional teaching method. It will also enable the researcher to advocate for the use of CAI in the mathematics classroom in order to overcome the challenges of perceived difficult topics such as latitude and longitude in mathematics. The researcher believed that it should now be possible to isolate the effect of computer-assisted instructions when the effect of the pre-test (covariate) is controlled in the study

#### 4.2.2.4: Performing ANCOVA analysis

##### 4.2.2.4.1: Hypothesis One

*Null hypothesis (H<sub>0</sub>): There is no statistically significant difference between the students' achievement in latitude and longitude for the control and the experimental groups.*

*Alternative Hypothesis (H<sub>1</sub>): There is statistically significant difference between the students' achievement in latitude and longitude for the control and the experimental groups.*

The output of the test is presents in the table 4.22



**Table 4.22: The test of Between –Subject Effects**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Pre-test	45.723	1	46.810	2.405	.643
Group	15982.730	1	15982.730	539.596	.00

From Table 4.22, the result confirms the classification of pre-test scores as a covariate, and therefore, the use of ANCOVA analysis is established. In addition, the main effect of the computer assisted instruction is observed after controlling for the pre-test scores. Thus, after the removal of the effect of pre-test, the effect of the computer assisted instruction becomes obvious and significant as confirmed by  $F(1,311) = 539.596, p < 0.05$ . The significant result at level  $P < 0.05$  indicates a less than 5% chance that the result is due to randomness. The flip side of this result indicates a 95% chance that the difference in the post-test achievement scores between the two groups is real difference and not simply due to chance. The null hypothesis ( $H_0$ ) is therefore rejected. This indicates that the use of computer assisted instruction to teach latitude and longitude is superior to the traditional method of teaching. The CAI teaching approach accelerates students' learning of latitude and longitude than the conventional teaching approach often employed by their teachers to teach the topic.

Thus,  $H_1: \mu_{\text{Computer Assisted Instruction}} > \mu_{\text{Traditional instruction}}$

#### **4.2.2.4.2: Hypothesis Two**

**Null hypothesis ( $H_{02}$ ):** *There is no significant difference between students' achievement in latitude and longitude for both the control and the experimental groups based on gender.*

**Alternative Hypothesis : ( $H_2$ )** *There is significant difference between students' achievement in latitude and longitude for both the control and the experimental groups based on gender.*

Hypothesis two ( $H_{02}$ ) was tested to further establish the claims made from table 4.14, that there is no significant difference in students' post-test achievement mean scores for males and females in the experimental group.

**Table 4.23: Summary of ANCOVA on students' achievement based on gender**

Source	Type III Sum of squares	Df	Mean square	F	Sig.	Eta Square
Corrected model	18463.312 <sup>a</sup>	12	1538.609	45.732	.000	.648
Intercept	205562.709	1	205562.709	6.110E3	.000	.953
Covariates(pre-test)	3466.746	1	3466.746	103.043	.000	.257
Treatment	12153.382	1	12153.382	361.238	.001	.548
Main effect Gender	134.375	1	134.37	.008	.987**	.000
Class Subject	3.962	2	1.981	.059	.943**	.000
Total	738520.000	311				
Corrected total	28489.132	310				

a.R Squared =.648 (Adjusted R Squared =.285) \*\*Denotes not significant at 0.05 alpha level.

As observed from the table ( $F(1, 310) = 0.008$ ,  $p=0.987$ ,  $n^2p=0.001$ ) the effect of gender is not significant. The result shows that male students' performance does not differ significantly from that of their female counterparts when they are taught latitude and longitude with the use of CAI and the covariate (pre-test) is statistically controlled. The result reveals that the significance of  $F = 0.987$  is greater than 0.05 alpha levels. This indicates that the use of CAI to teach both male and female student does not produce any significant difference in their post-test performances. Thus, we uphold null hypothesis two that there is no significant difference between students' achievement in latitude and longitude for the two groups based on gender when exposed to the CAI method of instruction.

#### 4.2.2.4.3: Hypothesis Three

**Null hypothesis (H<sub>03</sub>):** *There is no significant difference between the science students' achievement in latitude and longitude and their counterparts in the commercial and art classes for the experimental group.*

**Alternative Hypothesis :( H<sub>3</sub>)** *There is a significant difference between the sciences students' achievement in latitude and longitude and their counterparts in the commercial and art classes for the experimental group.*

From table 4.23, the result reveals that  $F_{(2, 310)} = 0.59$ ,  $p = \mathbf{0.943}$ ,  $n^2p = 0.001$ , hence the effect of students' class subject area is not significant. The result shows that the significance of  $F = 0.943$  is greater than 0.05 alpha levels. This is an indication that the use of CAI to teach both the science students and their counterparts in the commercial and arts classes does not produce any significant difference on their post-test performances in latitude and longitude. Consequently, we uphold null hypothesis three, that no significant difference exists between the science, commercial and arts classes in latitude and longitude for the two groups when exposed to the CAI method of instruction. This further supports the claim made (see table 4.19) that a non-significant difference exists between science students and their counterparts in the commercial and arts classes.

#### 4.2.2.4.4: Hypothesis Four

**Null hypothesis (H<sub>04</sub>):** *There is no significant difference in students' learning attitude in latitude and longitude for the control and the experimental groups.*

**Alternative Hypothesis :( H<sub>4</sub>)** *There is no significant difference in students' learning attitude in latitude and longitude for the control and the experimental groups.*

To further substantiate the claims that a significant difference exists in students' post-treatment attitude mean scores in the experimental group, hypothesis four was tested (see table 4.24). The students' post-intervention attitudes scores in the experimental and control groups using ANCOVA indicate that the difference in means between the two groups is statistically significant:  $F_{(1,299)} = 23.405$ ,  $p = .000^*$ ,  $n^2p = .073$ ). As observed in the table, the two-tailed p-value was 0.000, meaning that random sampling from identical populations would lead to a difference smaller than was observed in 100% of experiments and larger than was observed in 0% of experiments. Thus, the null hypothesis four is rejected and we uphold that there is a significant main effect from intervention on students' attitudes towards latitude and longitude.

**Table 4.24: Summary of ANCOVA on students' attitude (Gender and Class Subject)**

Source	Type III sum of squares	Df	Mean square	F	Sig.	Eta square
Corrected model	16638.016 <sup>a</sup>	12	1386.501	46.810	.000*	.653
Intercept	5211.767	1	5211.767	175.955	.000*	.370
Pre-attitude total	15982.730	1	15982.730	539.596	.000*	.643
Treatment	693.241	1	693.241	23.405	.000*	.073
Gender(G)	4.915	1	4.915	.166	.684**	.001
Subject area	12.065	2	6.032	.204	.816**	.001
Error	8856.330	299	29.620			
Total	3489276.000	312				
Corrected total	25494.346	311				

a. R Squared = .653 (Adjusted R Squared = .639) \* Sign \*\* Not Sign

#### 4.2.3: ANALYSIS OF STUDENTS' PRE AND POST ATTITUDE QUESTIONNAIRE

To measure students' attitude towards learning the concept of latitude and longitude before and after the intervention, a questionnaire tagged as QSALL was administered in the two groups to gather information from the participants.

Table 4.25 shows pre, post-test mean and standard deviation of students' attitude towards the teaching strategies employed to teach during main study in the two groups.

**Table 4.25: Main study pre and post samples attitude scores**

Test	Strategy	N	MEAN	SD
Pre-Treatment Attitude	CAI	156	3.57	0.92
	TM	160	3.51	0.90
Post-Treatment. Attitude	CAI	156	4.87	0.93
	TM	160	3.66	0.95

From the table, pre- treatment attitude mean scores for the experimental group students were ( $M=3.57$ ,  $S.D= 0.92$ ) while students' *post-* treatment attitude mean scores for the group were ( $M=4.87$ ,  $S.D= 0.93$ ). A difference of **1. 30** between the students' pre- treatment attitude mean scores and their post treatment-attitude means scores was observed. This indicates a positive change in students' learning attitude after the intervention. Table 4.26 summarises the participants' pre- treatment attitude scores.

**Table: 4.26 Summary of main study pre- treatment scores**

PRE-ATTITUDE QUESTIONS		MEAN		SD	
		E	C	E	C
<b>Theme one: Self-confidence about learning latitude and longitude problems</b>					
1	Mathematics is difficult for me especially bearing which is fundamental to the learning of latitude and longitude.	3.48	3.77	0.76	0.94
2	Latitude and longitude is not a difficult aspect of mathematics for me	4.81	3.46	0.87	0.75
3	The calculation of distance between two points and length between parallels of latitude are always confusing when solving questions on the topic	3.77	3.86	0.69	0.85
4	I always enjoy the mathematics class when problems that involve application of formulas are being solved in class.	4.58	3.46	0.67	0.69
5	I find it difficult to apply some of the formulas given when I am to solve problems with 3-dimensional solid geometry.	4.50	2.84	0.89	0.85
6	I can still improve in mathematics if I give more attention to solving mathematical problems	4.92	3.96	0.78	0.98
<b>SUB- TOTAL</b>		<b>3.84</b>	<b>3.67</b>	<b>0.67</b>	<b>0.78</b>
<b>Theme two: Students' interest in latitude and longitude and mathematics generally</b>					
7	Communicating with other students helps me have a better attitude towards mathematics that involves lines and angles.	4.82	3.63	0.97	1.97
8	The concept of latitude and longitude is not clear to me in mathematics	3.83	3.85	0.95	0.89
9	I prefer topics that are difficult in mathematics to be taught with the aid of instructional materials so as to assist the low achievers to catch up quickly especially latitude and longitude.	3.85	3.97	0.88	0.78
10	I always find it interesting when solving problems on solid geometry especially latitude and longitude.	3.67	3.96	0.93	0.79
11	My foundation in mathematics at the junior class is poor and this contributed to my low performance in the senior class	3.82	2.91	0.45	0.88
12	Mathematics is one of my favourite subjects and I often practice it.	4.71	3.95	0.75	1.89
<b>SUB-TOTAL</b>		<b>3.76</b>	<b>3.78</b>	<b>0.71</b>	<b>0.86</b>
<b>Theme three: Students' perceptions/opinions of the subject teacher</b>					
13	Detail explanations given by my teacher on latitude and longitude with the use of instructional materials give me better understanding of the topic.	3.83	3.78	0.97	0.86
14	My teachers encouraged me to like mathematics hence they gave me adequate materials and attention	4.97	4.44	1.87	0.96

	whenever I asked them.				
15	If mathematics could be taught with the use of computer by our subject teacher, many students will learn it faster	3.95	4.37	0.83	0.86
16	Our mathematics teacher is not always regular in the class to teach us	3.65	3.72	0.65	0.13
17	We have not been having a mathematics teacher for the past one session	2.89	2.89	1.96	0.78
18	Latitude and longitude can be the most enjoyable topic if our teacher explains it clearly in the class	3.68	4.03	0.88	0.86
<b>SUB-TOTAL</b>		<b>3.65</b>	<b>3.76</b>	<b>0.83</b>	<b>0.78</b>
<b>Theme four : Students' anxiety about mathematics/latitude and longitude</b>					
19	Mathematics that involves lines and angles always scares me and I generally hate those topics	3.85	3.78	0.88	0.76
20	I am scared about calculation of difference between angle of latitude and longitude of two points on the earth globe.	2.45	3.81	0.83	1.93
21	My parents told me that too much practice of mathematics can have a negative effect on me, hence I hate the subject	3.55	3.34	0.62	0.48
22	Computer assisted instruction will make students become lazy in using their brain to solve mathematical problems.	3.94	3.71	0.94	0.36
23	Adequate power supply in our schools may hinder the proper use of computer systems in most secondary schools for the teaching of mathematics.	4.01	3.56	0.93	0.85
24	Because I am in art class mathematics is not compulsory for me. Hence I attend the class whenever I like.	4.97	3.01	0.83	0.78
<b>SUB TOTAL</b>		<b>3.54</b>	<b>3.56</b>	<b>0.76</b>	<b>0.67</b>
<b>Theme five: Usefulness of mathematics and latitude and longitude</b>					
25	Mathematics is needed in designing practically everything in life.	3.74	3.82	0.75	0.79
26	Mathematics could be made more interesting for students if new topics are introduced through the use of computer packages, with a guided approach to real life.	3.67	3.99	0.86	0.89
27	Mathematics could be made more interesting for students if new topics are introduced through the use of computer packages, with a guided approach to real life.	4.73	3.17	0.96	0.77
28	Mathematics helps me to think fast whenever I help my parents at their marketplace after school hours.	3.71	3.67	0.78	0.92
29	The use of computer-assisted instruction will expose students to modern technology in solving mathematical problems.	3.91	3.88	0.84	0.96

30	Mathematics is the only subject that promotes science and technology.	3.15	3.88	0.85	0.82
	<b>SUB TOTAL</b>	<b>3.48</b>	<b>3.67</b>	<b>0.84</b>	<b>0.89</b>
	<b>OVERAL TOTAL</b>	<b>3.57</b>	<b>3.51</b>	<b>0.92</b>	<b>0.90</b>

Table 4.27 is the summary of students' means attitude post- test scores for the main study. From the table, it is observed that the experimental group students that were taught using computer-assisted instruction had higher post-treatment attitude mean scores when compared to their pre-attitude treatment scores. This indicates the impact of the CAI intervention on students' learning attitude in latitude and longitude topic. Further explanations on the five themes from the tests items are discuss in the next section.



**Table 4.27: Summary of main study post-treatment scores**

ATTITUDE POST-TEST QUESTIONS		MEAN		SD	
		E	C	E	C
<b>Theme one: Self-confidence about learning/solving latitude and longitude mathematics problems</b>					
1	Mathematics is difficult for me especially bearing which is fundamental to the learning of latitude and longitude.	4.52	3.93	0.96	0.85
2	Latitude and longitude is not a difficult aspect of mathematics for me	3.64	3.89	0.85	0.87
3	The calculation of distance between two points and length between parallels of latitude are always confusing when solving questions on the topic	4.85	3.69	0.92	0.86
4	I always enjoy the mathematics class when problems that involve application of formulas are being solved in class.	4.84	3.51	0.86	0.97
5	I find it difficult to apply some of the formulas given when I am to solve problems with 3-dimensional solid geometry.	4.45	2.89	0.78	0.67
6	I can still improve in mathematics if I give more attention to solving mathematical problems	4.39	3.95	0.79	0.97
SUB-TOTAL		3.87	3.76	0.86	0.84
<b>Theme two: Students' interest in latitude and longitude and mathematics generally</b>					
7	Communicating with other students helps me have a better attitude towards mathematics that involves lines and angles.	3.67	3.47	0.68	0.78
8	The concept of latitude and longitude is not clear to me in mathematics	3.88	3.57	0.77	0.89
9	I prefer topics that are difficult in mathematics to be taught with the aid of instructional materials to assist the low achievers to catch up quickly especially latitude and longitude.	3.67	3.87	0.69	0.69
10	I always find it interesting when solving problems on solid geometry especially latitude and longitude.	4.67	3.92	0.67	0.78
11	My foundation in mathematics at the junior class is poor and this contributed to my low performance in the senior class	3.85	3.81	0.77	0.88
12	Mathematics is one of my favourite subjects and I often practice it.	3.94	3.88	0.59	0.66
<b>Theme three: Students' perceptions/opinions of the subject teacher</b>					
13	Detail explanations given by my teacher on latitude and longitude with the use of instructional materials give me better understanding of the topic.	4.78	3.78	0.87	0.89
14	My teachers encouraged me to like mathematics hence they gave me adequate materials and attention whenever I asked them.	3.97	3.89	0.88	0.87
15	If mathematics could be taught with the use of computer by our subject teacher, many students will	4.88	3.88	0.91	0.98

	learn it faster				
16	Our mathematics teacher is not always regular in the class to teach us	3.79	3.86	0.82	0.89
17	We have not been having a mathematics teacher for the past one session	2.89	3.78	0.69	0.68
18	Latitude and longitude can be the most enjoyable topic if our teacher explains it clearly in the class	3.78	3.84	0.75	0.88
<b>SUB-TOTAL</b>		<b>3.78</b>	<b>3.87</b>	<b>0.83</b>	<b>0.81</b>
<b>Theme four : Students' anxiety about mathematics/latitude and longitude</b>					
19	Mathematics that involves lines and angles always scares me and I generally hate those topics	3.76	3.88	0.58	0.86
20	I am scared about calculation of difference between angle of latitude and longitude of two points on the earth globe.	3.85	3.81	0.93	0.93
21	My parents told me that too much practice of mathematics can have a negative effect on me, hence I hate the subject	3.95	4.94	0.62	0.78
22	Computer assisted instruction will make students become lazy in using their brain to solve mathematical problems.	3.84	4.67	0.86	0.92
23	Adequate power supply in our schools may hinder the proper use of computer systems in most secondary schools for the teaching of mathematics.	3.91	4.56	0.73	0.85
24	Because I am in art class mathematics is not compulsory for me. Hence I attend the class whenever I like.	3.97	3.81	0.73	0.88
<b>SUB-TOTAL</b>		<b>3.86</b>	<b>3.87</b>	<b>0.87</b>	<b>0.86</b>
<b>Theme five: Usefulness of mathematics and latitude and longitude</b>					
25	Mathematics is needed in designing practically everything in life.	4.95	3.72	0.85	0.79
26	Mathematics could be made more interesting for students if new topics are introduced through the use of computer packages, with a guided approach to real life.	4.97	3.69	0.88	0.97
27	Mathematics could be made more interesting for students if new topics are introduced through the use of computer packages, with a guided approach to real life.	3.93	3.87	0.96	0.88
28	Mathematics helps me to think fast whenever I help my parents at their marketplace after school hours.	3.1	4.87	0.78	0.86
29	The use of computer assisted instruction will expose students to modern technology in solving mathematical problems.	3.97	3.87	0.85	0.91
30	Mathematics is the only subject that promotes science and technology.	4.78	3.87	0.75	0.87
<b>OVERAL TOTAL</b>		<b>4.87</b>	<b>3.66</b>	<b>0.93</b>	<b>0.95</b>

#### 4.2.3.1. Students' learning attitude before the intervention

In this section, the emerged themes (see tables 4.26) were analysed using frequency and percentage. For the purpose of this analysis, the affirmatives 'strongly agree' and 'Agree' were collapsed to 'Agree' while the non-affirmatives 'strongly disagree' and 'Disagree' were collapsed to 'Disagree' as often used in educational research studies (e.g. Mogane & Atagana, 2010).

#### Theme1:Self-confidence in solving latitude and longitude/mathematics problems

Of the participants, 64.8% of the total agreed that they have difficulties with learning and solving questions related to the concept of latitude and longitude while 25.2% of disagreed with the statement, and the remaining few were undecided. This is an indication that they are frustrated and lack self-confidence in solving latitude and longitude mathematics problems.

**Table 4.28: Self-confidence in solving latitude and longitude/mathematics problems**

Likert Scale	Frequency ( $\Sigma F$ )	Cum. Freq. ( $\Sigma FX$ )	%
Agreed	204	1020	64.8
Disagreed	79	316	25.0
Undecided	33	237	10.2
Total	316	1573	100

#### Theme 2: Students' interest in latitude and longitude and mathematics generally

Theme two sought to find out about students' interest in learning the concept of latitude and longitude and mathematics. Students' response before the intervention showed that the majority lacked interest in mathematics and the concept of latitude and longitude.

**Table 4.29: Students' interest in latitude, longitude, and mathematics generally**

Likert Scale	Frequency ( $\Sigma F$ )	Cum. Freq. ( $\Sigma FX$ )	%
Agreed	252	1260	79.8
Disagreed	61	244	19.2
Undecided	03	09	01
Total	316	1513	100

From the table, 79.8% agrees that the concept is not clear to them while only 19.2% indicate having little interest in the concept. Of the participants, 1% is undecided in their response. The participants' response showed that mathematics is not one of their favourite subjects, and that they do not like the subject.

### Theme 3: Students' perceptions/opinions about the subject teacher

Participants responded to the statement that seeks to discover whether they receive encouragement from their teachers to like mathematics.

**Table 4.30: Students' perceptions/opinions about the subject teacher**

Likert Scale	Frequency ( $\Sigma F$ )	Cum. Freq. ( $\Sigma FX$ )	%
Agreed	214	1070	68
Disagreed	87	244	27.6
Undecided	15	45	40.4
Total	316	1363	100

Results from the table show that subject teachers' attitudes to the teaching of mathematics discouraged many of the students. For instance, 68% of students agreed that their subject teacher discouraged them from liking mathematics while 27.6% stated that their teachers do encourage them to like it. Other participants are undecided on the statement. This indicates that the subject teachers have significance influence on students learning of mathematics.

### Theme 4: Students' anxiety about mathematics/latitude and longitude.

Theme four consists of items that seek to discover students' anxiety towards mathematics/latitude and longitude. Results show that many students have a phobia about mathematics and latitude and longitude.

**Table 4.31: Students' anxiety about mathematics/latitude and longitude**

Likert Scale	Frequency ( $\Sigma F$ )	Cum. Freq. ( $\Sigma FX$ )	%
Agreed	236	1180	74.9
Disagreed	47	188	15.1
Undecided	33	99	10.0
Total	316	1467	100

As indicated in the table, larger percentage of the participants agreed that they hate mathematics and the concept of latitude and longitude while only 15.1% indicate their interest in mathematics and the topic. A few remaining students are undecided on the statement. The participants admit that they are not interested in calculations that involve lines and angles. In addition, many of the participants' believe that mathematics is only for science students.

### Theme 5: Usefulness of mathematics and latitude and longitude

Students' response to the statements in theme 5 on the usefulness of mathematics and the concept of latitude and longitude indicate that mathematics is necessary for designing practically everything in life.

**Table 4.32: Usefulness of mathematics and latitude and longitude**

Likert Scale	Frequency ( $\Sigma F$ )	Cum. Freq. ( $\Sigma FX$ )	%
Agreed	226	1130	72
Disagreed	76	394	21
Undecided	14	42	07
Total	316	1566	100

Of the participants, 72% agree, while 21% disagree, and the other 7% is undecided on their response of mathematics in general. Similarly, their response to the statement that mathematics is fundamental to all engineering subjects further confirms the importance and usefulness of the topic. This confirms the claim that mathematics is the bedrock of knowledge, and that the use of CAI to teach latitude and longitude is capable of helping students to master the topic more easily.

#### 4.2.3.2. Students' learning attitude after the intervention

Table 4.33 shows students' response to theme one on Self-confidence in learning/solving latitude and longitude problems after the intervention. This confirmed their confidence towards the learning or solving of latitude and longitude mathematical problems.

**Table 4.33: Self-confidence in learning/solving latitude and longitude problems**

Likert Scale	Frequency ( $\Sigma F$ )	Cum. Freq. ( $\Sigma FX$ )	%
Agreed	189	946	59.9
Disagreed	121	594	38.2
Undecided	06	66	1.9
Total	316	1606	100

Results show that 59.9 % of the participants claim they now have confidence towards the learning or solving of latitude and longitude mathematical problems while 38.2% of students still have difficulties. Similarly, the percentage of participants that have challenges with calculation that involves distances and lines diminished when CAI was used to teach the concept of latitude and longitude. Many participants claim that a calculation that involves

distances and lines, such as latitude and longitude, is longer a challenge using CAI to teach the concept. This is an indication that the intervention has had a positive impact on their attitude and built their confidence towards solving latitude and longitude mathematical problems.

The use of the CAI intervention in the experimental class has improved the students' interest in learning the concept of latitude and longitude and mathematics as revealed in table 4.30. Students' responses after the intervention demonstrate an improvement in their interest in mathematics and the concept of latitude and longitude (**theme two**). This is evident because 85.1% of participants claim that the topic is now clear to them.

**Table 4.34: Students' interest in latitude and longitude and mathematics**

Likert Scale	Frequency ( $\Sigma F$ )	Cum. Freq. ( $\Sigma FX$ )	%
Agreed	236	1130	85.1
Disagreed	80	240	14.9
Undecided	00	00	00
Total	316	1370	100

Similarly, participants' response to the statement that sought to find out if their poor foundation in mathematics had contributed to the negative attitude to mathematics revealed that the CAI intervention had motivated students' interest in learning latitude and longitude. This supports the qualitative reports claims (see section 4.6) that the use of CAI motivated their learning of latitude and longitude topic in mathematics.

From Table4.35, participants' perceptions of their subject teacher have not changed despite the intervention. They hold to their opinion on the statement that sought to discover whether they receive encouragement from their teachers to like mathematics.

**Table 4.35: Students' perceptions/opinions about the subject teacher**

Likert Scale	Frequency ( $\Sigma F$ )	Cum. Freq. ( $\Sigma FX$ )	%
Agreed	221	1105	70.1
Disagreed	80	320	25.6
Undecided	15	45	4.3
Total	316	1470	100

Of the participants, 70.1% indicate that they are discouraged from liking mathematics by the subject teacher while 25.6% indicate that they are encouraged by their teachers to like the subject (**theme three**). The rest of the participants are undecided on the statement. Similarly, many of the participants still claim that their teachers do not always regularly attend the mathematics classroom to teach them. This suggests that some of these subject teachers have contributed to students' poor performance in latitude and longitude and mathematics in general.

Table 4.36 revealed that Students' anxiety towards mathematics/latitude and longitude has greatly diminished since the use of the CAI intervention.

**Table 4.36: Students' anxiety about mathematics/latitude and longitude**

Likert Scale	Frequency ( $\Sigma F$ )	Cum. Freq. ( $\Sigma FX$ )	%
Agreed	237	1185	75.2
Disagreed	69	276	22.0
Undecided	10	30	3.8
Total	316	1491	100.0

The students' responses show a decreased phobia for mathematics and latitude and longitude (**theme four**). A total of 75.2% of participants claim a decreased phobia for mathematics and the concept of latitude and longitude while 22.0 % is still afraid of mathematics and the topic. The few remaining students are undecided on the statement. Similarly, participants' interest in calculation that involves lines and angles has changed with the use of the CAI intervention to teach the topic.

Table 4.37 revealed that 78.4% of the participants agree on the usefulness of mathematics and the concept of latitude and longitude. The other 21.6% disagree.

**Table 4.37: Usefulness of mathematics and latitude and longitude**

Likert Scale	Frequency ( $\Sigma F$ )	Cum. Freq. ( $\Sigma FX$ )	%
Agreed	247	1238	78.4
Disagreed	69	594	21.6
Undecided	00	00	00
Total	316	1832	100

Majority of the participants' agreed that mathematics is one of the core subjects in engineering courses. This further established the place and usefulness of latitude and longitude in mathematics.

#### 4.2.4: ANALYSIS OF STUDENTS' PRE AND POST SELF- WRITTEN WORK

To further corroborate students' performance on the ATLL (pre-test) and (post-test), samples of their self-written work were used to support the claims made from descriptive and inferential statistics. The students' performance on the basis of computer assisted instruction achievement test scores were analysed in order to assess the knowledge and skills gained before and after the intervention as described in the following section.

##### 4.2.4.1: Analysis of students' pre-test self-written work

Each of the five ATLL items attracted a maximum score of 20 marks; the total marks obtainable by any student were therefore 100 % (see Table 3.2). Participants are graded as Excellent (A) very good (B2), good (B3), credit(C), pass (P) and Fail (F) as indicated in the nine-point rating table(see Table 3.6).

##### Question one:

*Sketch the diagram or the coordinate of movement, of a boy who walks 6 km from a point P, to a point Q, on a bearing of  $065^{\circ}$ . He then walks to a point R, a distance of 13 km, on a bearing of  $146^{\circ}$  and also calculates, correct to the nearest kilometre, the distance PR*

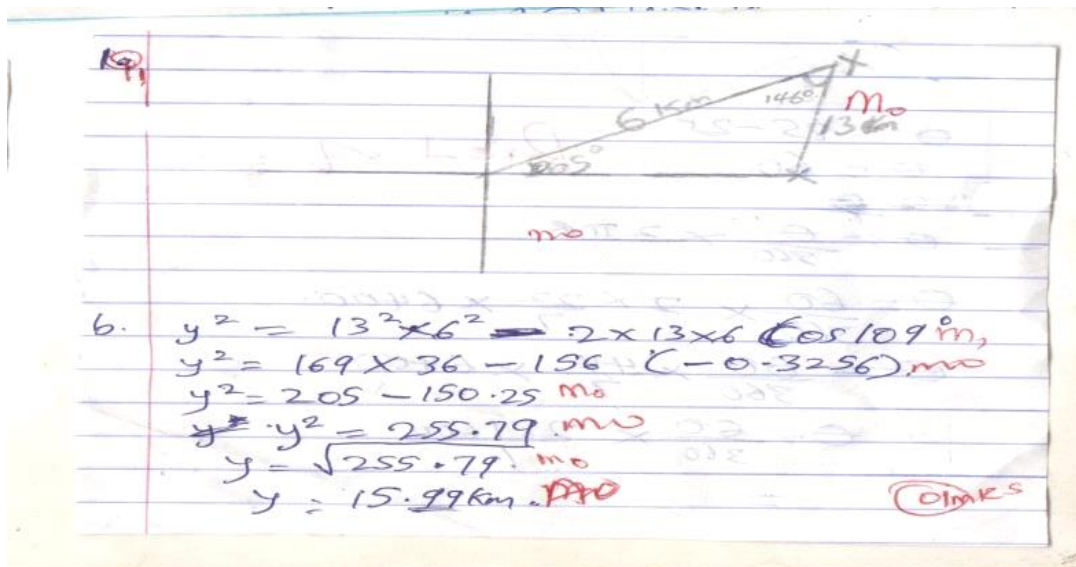


Figure 4.2: Student's solution to question one ATLL pre-test

In both the experimental and the control groups, 162 and 154 students were challenged by the question. The poor performance in the question indicates that students cannot answer it

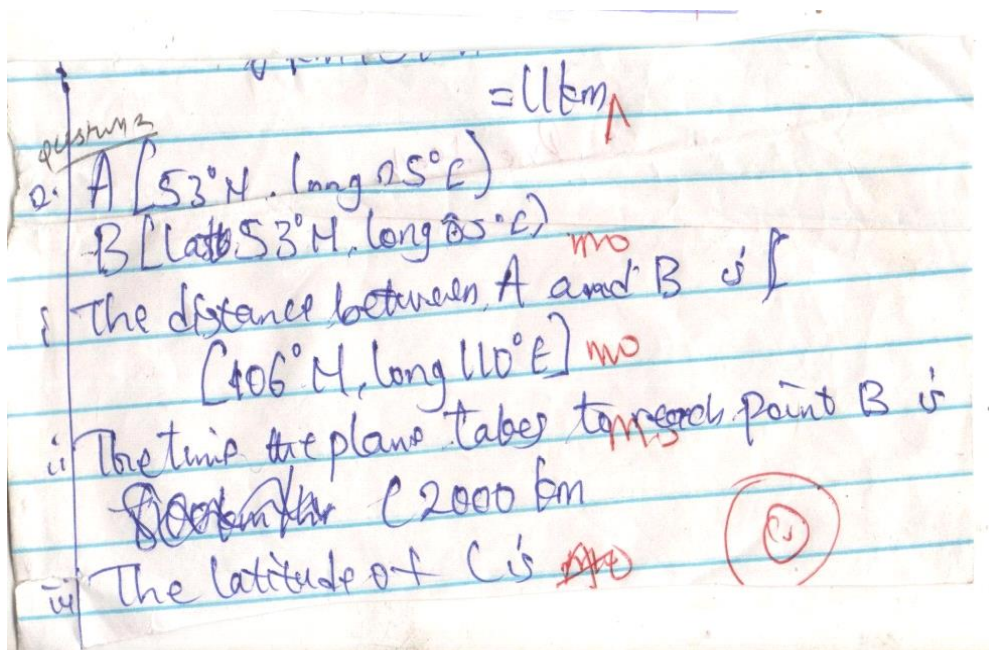


correctly due to their inability to apply correctly the required solution strategies in solving the problem. Students in both groups find difficulties in sketching the diagram or locating the coordinate of the boy's movement. They find difficulties in locating the bearing of a point and cannot calculate the distance between two points. The script reveals their lack of procedural knowledge on the topic.

**Question two:**

*Calculate, correct to the nearest whole number*

- (i) the distance between A and B
- (ii) the time the plane takes to reach point B
- (iii) The latitude of C when a plane flies due east from A ( $53^{\circ}\text{N}$ , long.  $25^{\circ}\text{E}$ ) to a point (lat.  $53^{\circ}\text{N}$ , long.  $85^{\circ}\text{E}$ ) at an average speed of 400 km/hr. (Take  $\pi = 22/7$ ;  $R = 6400$  km.)



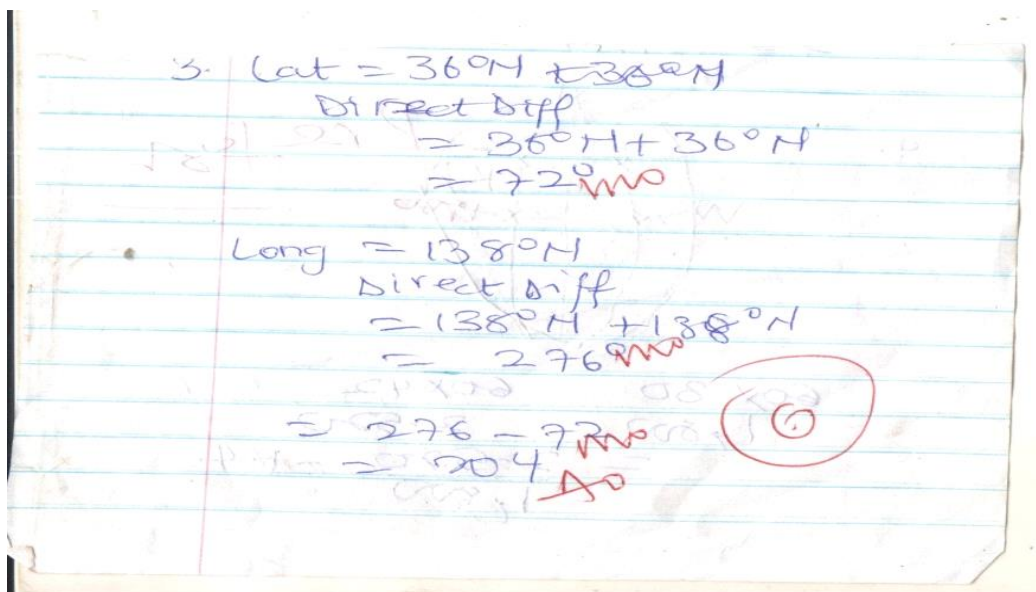
**Figure 4.3: Student's solution to question two ATLL pre-test**

From the above script, students find difficulties in differentiating between the lines of latitude and longitude. Question 2 falls under the second and the third categories of the Bloom's taxonomy cognitive domain which requires students to have the ability to organize ideas, translate, interpret information, extrapolate, and explain correctly. Students are expected to combine the elements of learned knowledge into new integrated wholes. The questions expected students to recall their knowledge of facts, terminologies, structures and/or

algorithms, which they failed to. The major error was their inability to apply the required solution strategies. This accounted for their poor performance in the question.

**Question three:**

(i) Calculate the distance travelled if an aircraft flies due south from an airfield on latitude  $36^{\circ}\text{N}$ , longitude  $138^{\circ}\text{E}$  to an airfield on latitude  $36^{\circ}\text{S}$ , longitude  $138^{\circ}\text{E}$  (correct to three significant figures). (ii) Calculate the time taken, if the speed of the aircraft is 800 km per hour (take  $\pi = 22/7$ ;  $R = 6400$  km)



**Figure 4.4:** Student’s solution to question three ATLL pre-test

Question 3 expected the students to have the ability to pass judgment. The question required students to be able to form abstracts from learned material to solve new situations. However, their scripts reveal the difficulties they have with the calculation of time and speed of the aircraft along lines of longitude. They were new to the topic and the question was distasteful to them. This indicates that they did not have prior knowledge of the topic before the intervention. Major errors committed by students were their inability to form abstracts from learned material to solve new situations.

**Question four:**

Calculate, the radius of the circle of latitude on which A and B lie (ii) the distance on the earth's surface between A and B along the circle of latitude if points A (600N, 300E) and B (600N, 420W) are two towns on the surface of the earth.

$$\frac{C}{860} \times 2\pi r$$

$$= \frac{192 \times 2 \times 22 \times 192}{7}$$

$$= \frac{1622016}{7} = 6043$$

Figure 4.5: Student's solution to question four ATLL pre-test

Students' scripts indicate that they have an idea about the formula to be used in calculating distance between two points on the surface of the earth. May be they tried to use the knowledge gained from plane geometry at the junior secondary school. Many of the students committed error of omission and eventually missed out the whole question.

#### Question five:

- (i) Calculate the distance between P and Q along their parallel of latitude,
- (ii) Distance between Q and T along the line of longitude
- (iii) Average speed at which the aeroplane will fly from P to T via Q (if the journey takes 12 hr) when an aeroplane flies from a town P (lat. 40°N, 38°E) to another town Q (lat. 40°N, 22°W) and later flies to a third town T (28°N, 22°W). (Take the radius of the earth to be 6400 km and  $\pi = 3.142$ ).

(5) (1) The circumference of the parallel of latitude on which P and Q is lying is  $2\pi R \cos \theta$   
 (2)  $2\pi R \cos \theta = 2 \times 3.142 \times 6400 \cos 40^\circ$   
 $= 40,217.6 \cos 40^\circ$   
 $= 30,810 \text{ cm}$   
 Difference in longitude between P and Q is  $388 + 25^\circ = 60^\circ$   
 $\text{Arc PQ} = \frac{360 \times 2\pi R}{360} = \frac{60}{360} \times 30810$   
 $= \frac{30810}{6} \text{ m} = 5,135 \text{ cm}$

**Figure 4.6.: Student's solution to question five ATLL pre-test**

In question 5 students' were expected to pass judgment on the basis of internal and external evidence. To evaluate indicates making judgment about the value or the worth of the information (Okpala, et.al., 1993). In the Bloom's taxonomy cognitive domain, evaluation is a way of assessing how well students use their foundation knowledge to perform complex tasks. The students' scripts indicate that they have an idea about the formula to be used but lack the procedural approach. In this case, many students committed an error of omission by not answering the question at all. In this case, many students committed an error of omission by not answering the question at all.

**Table 4.38: Summary of pre- achievement test performance in the two groups**

Groups	Students' pre-test scores		Performance category	
	No of Students tested	% passed		
<b>Experimental n= 160</b>	0	0.0%	A1	Excellent
	0	0.0%	B2	Very Good
	2	1.2%	B3	Good
	4	2.4%	C4	Credit
	15	9.2%	C5	Credit
	85	52.5%	C6	Credit
	34	20.9%	D7	Pass
	10	6.1%	E8	Pass
	12	7.4%	F9	Fail
<b>Control n=156</b>	0	0.0%	A1	Excellent
	0	0.0%	B2	Very Good
	0	0.0%	B3	Good
	2	1.2%	C4	Credit
	2	1.2%	C5	Credit
	10	6.4%	C6	Credit
	90	58.4%	D7	Pass
	30	19.4%	E8	Pass
	20	12.9%	F9	Fail

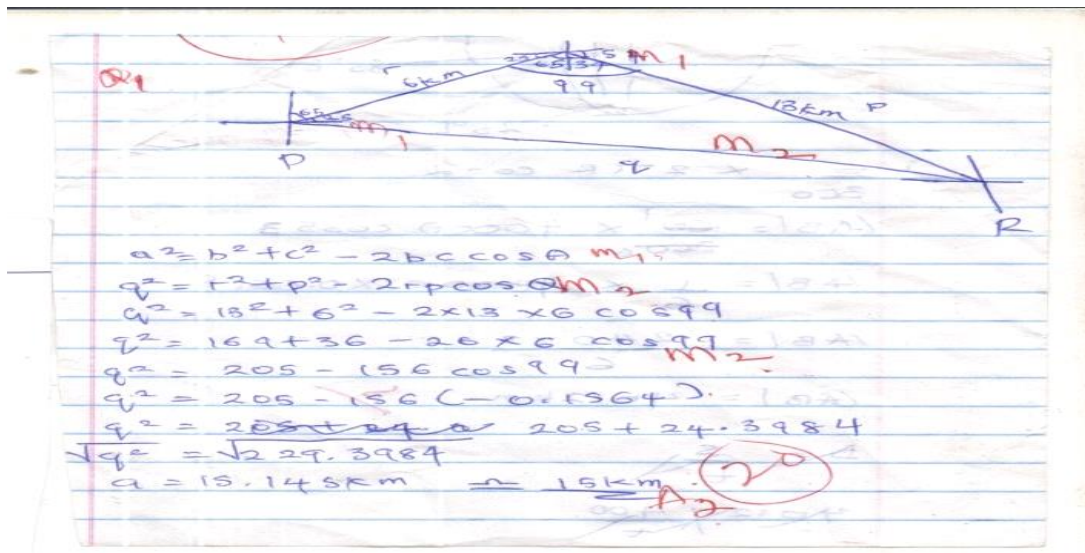
In conclusion, students' poor performances in the ATLL pre-tests in both the experimental and control classes indicates their inability to implement correct solution strategies in answering related questions on latitude and longitude, hence the two groups were comparable in terms of their knowledge of the topic(see table 4.10).

#### 4.2.4.2: Analysis of students' post-test self-written work

In order to assess the knowledge and skills gained after the intervention, students were post – tested in both groups. The marked scripts have been analysed and presented in this section.

#### Question one:

*Sketch the diagram or the coordinate of movement, of a boy who walks 6 km from a point P, to a point Q, on a bearing of  $065^{\circ}$ . He then walks to a point R, a distance of 13 km, on a bearing of  $146^{\circ}$  and also calculates, correct to the nearest kilometre, the distance PR.*



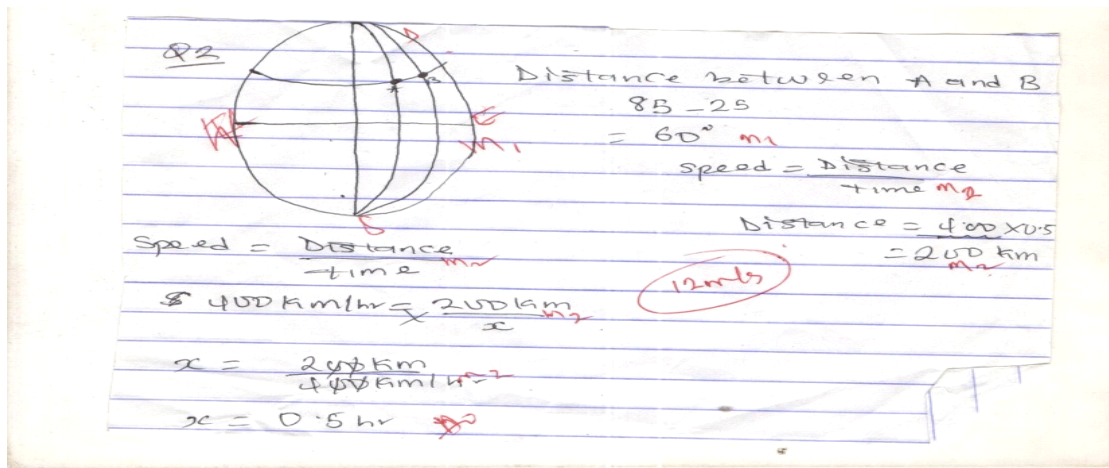
**Figure 4.7: Student's solution to question one post-test**

After the intervention in the experimental class, students' post-test scripts were marked and their scores are presented. Students overall performance in question one indicates that they have improved. They were able to read and interpret the questions, and apply the required solution strategies in solving the problem. The script reveals an improvement in students' procedural knowledge on the topic.

**Question two:**

*Calculate, correct to the nearest whole number*

- (i) *The distance between A and B*
- (ii) *the time the plane takes to reach point B*
- (iii) *the latitude of C when a plane flies due east from A (53°N, long. 25°E) to a point (lat. 53°N, long. 85°E) at an average speed of 400 km/hr. (Take  $\pi = 22/7$ ; R = 6400 km.)*



**Figure 4.8:** Student's solution to question two post-test

The sample of a student's script for question 2 reveals their ability to differentiate between lines of latitude and longitude. Their ability to sketch the diagram or locate the coordinates of movement helped them to translate, interpret information, extrapolate, and explain correctly. They were able to recall the knowledge of facts, terminologies, structures and algorithms which they had failed to recall when pre-tested earlier. This indicates that they have improved in their performance on the question.

### Question three:

- (i) Calculate the distance travelled if an aircraft flies due south from an airfield on latitude  $36^\circ\text{N}$ , longitude  $138^\circ\text{E}$  to an airfield on latitude  $36^\circ\text{S}$ , longitude  $138^\circ\text{E}$  (correct to three significant figures). (ii) Calculate the time taken, if the speed of the aircraft is 800 km per hour (take  $\pi = 22/7$ ;  $R = 6400 \text{ km}$ )

3 Difference in latitude =  $36 + 36 = 72^\circ$

$$r = R \cos \theta$$

$$= 6400 \times \cos 72^\circ$$

$$= 6400 \times 0.3090$$

$$= 1977.6 \text{ m}$$

Distance =  $\frac{360}{360} \times 2 \times \frac{72}{360} \times 1977.6$

Distance =  $\frac{360}{360} \times 2 \times \frac{72}{360} \times 1977.6$

$$= 2485.13$$

$$\approx 2500 \approx 2470 \text{ km}$$

Figure 4.9 Student's solution to question three post-test

The question requires students' ability to form abstracts from learned material to solve problems in new situations. With the use of the CAI package to teach students, their scripts reveal that they have developed the ability to form abstracts from learned material by being able to calculate the time taken and speed of the aircraft along the lines of longitude. This reveals the positive impact of the CAI intervention in the classroom to teach the topic.

**Question four:**

Calculate, the radius of the circle of latitude on which A and B lie (ii) the distance on the earth's surface between A and B along the circle of latitude if points A (600N, 300E) and B (600N, 420W) are two towns on the surface of the earth.

04

Radius of Circle  $m_1$

$$r = R \cos \alpha$$

$$r = 6400 \times \cos 60^\circ m_2$$

$$r = 6400 \times 0.5$$

$$= 3200 m_1$$

Distance along Circle of Lat  $m_1$

$$|AB| = 42 + 30 = 72^\circ m_2$$

$$\frac{72}{360} \times 2\pi r m_2$$

$$\frac{72}{360} \times 2 \times \frac{3.14}{2} \times 3200 m_1$$

$$= 2880 m_2$$

800 km



**Figure 4.10: Student's solution to post-test**

Students' scripts on question four indicate their conceptual knowledge of the topic. They were able to apply the correct formula and use it to calculate the distance between two points on the surface of the earth. There were fewer limitations to error of omission committed than when they were pre-tested with the same question.

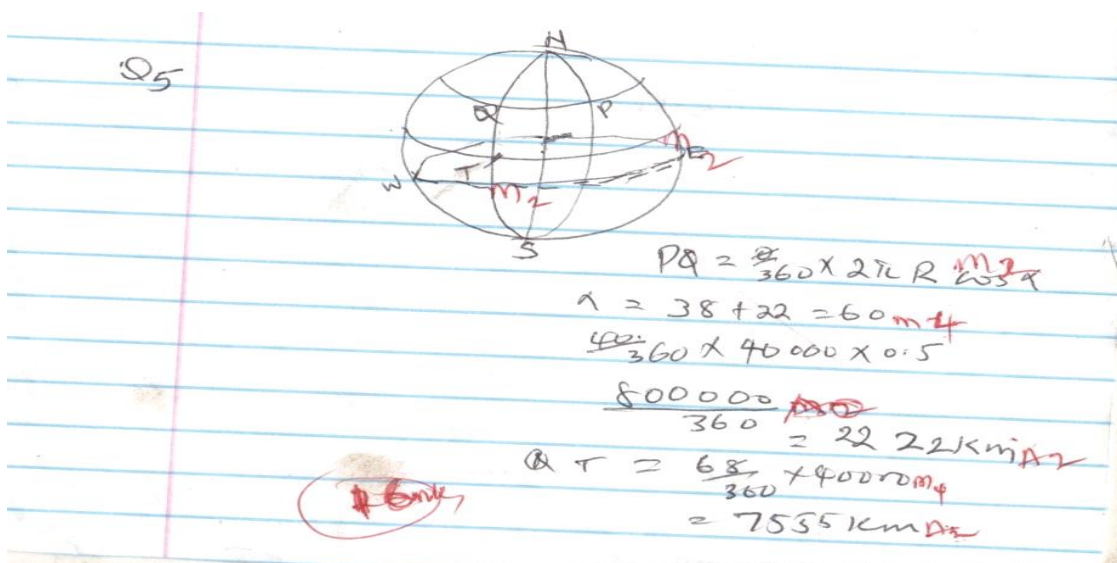
**Question five:**

Calculate the distance between P and Q along their parallel of latitude,

(ii) Distance between Q and T along the line of longitude

(iii) Average speed at which the aeroplane will fly from P to T via Q (if the journey takes 12 hr) when an aeroplane flies from a town P (lat.  $40^{\circ}\text{N}$ ,  $38^{\circ}\text{E}$ ) to another town Q (lat.  $40^{\circ}\text{N}$ ,  $22^{\circ}\text{W}$ ) and later flies to a third town T ( $28^{\circ}\text{N}$ ,  $22^{\circ}\text{W}$ ).

(Take the radius of the earth to be 6400 km and  $\pi = 3.142$ ).



**Figure 4.11: Student's solution to question five post-test**

The sample of a student's script indicates the new knowledge gained on the question when compared to pre-tested scores. The question requested the students to calculate and pass judgment based on the internal and external evidence. The scripts reveal an improvement in

their ability to apply correct formulas, less error of omission, ability to read, solve the problems with sketched diagrams, and eventually answer correctly. (See Tables 4.10 & 4.11).

Overall, the intervention adopted to teach the topic has enhanced students' post-test achievement scores in the experimental class in comparison to their counterparts in the control class. From table 4.39; 96.6% of the students in the experiments group obtained 50% credit and above whereas, only 21.3 % of the participants in the control group passed with 50% credits and above. Furthermore, there were limitations to some of the errors committed by experimental group students when they were post-tested with the same question after the intervention. The scripts show students' ability to read, apply correct formulas, solve the problems with sketched diagrams, and less error of omission. It also revealed that they have developed the ability to form abstracts from learned material by being able to calculate the time taken and speed of the aircraft along the lines of longitude.

**Table 4. 39: Summary of post- achievement test performance in the two groups**

Groups	Post-test		Performance category
	No of students	% passed	
<b>Experimental n= 162</b>	10	6.1%	A1 Excellent
	21	12.9%	B2 Very Good
	25	15.4%	B3 Good
	62	38.2%	C4 Credit
	12	7.4%	C5 Credit
	27	16.6%	C6 Credit
	2	1.2%	D7 Pass
	3	1.8%	E8 Pass
	0	0.0%	F9 Fail
<b>Control n=154</b>	0	0.0%	A1 Excellent
	1	0.6%	B2 Very Good
	6	3.8%	B3 Good
	12	7.7%	C4 Credit
	45	29.2%	C5 Credit
	41	26.6%	C6 Credit
	20	12.9%	D7 Pass
	25	16.2%	E8 Pass
	4	2.5%	F9 Fail

### 4.3: SUMMARY OF QUANTITATIVE DATA ANALYSIS

In the first part the chapter of the study, quantitative data analysis was presented using statistical methods. In section (4.1), reports of the pilot study, which was purposely conducted to try out the achievement tests, were presented using descriptive statistics. In section (4.2), breakdown of the participants in the achievement tests based on gender and their subject classifications was discussed. Furthermore, section 4.2.5 and section 4.2.6 discussed the analysis of students' pre and post attitude questionnaire, and students' self-written work in ATLL before and after the intervention. The T-test conducted to determine the effectiveness of the CAI strategy using the pre-test scores of the pilot study (see section 4.1) showed that a statistically significant difference existed between the mean scores of the pre-test and the post-test in the two groups. In addition, the ANCOVA results revealed that after the removing the effect of pre-test, the effect of the CAI becomes obvious and significant confirmed by  $F(1,311) = 539.596, p < 0.05$ . The significant result at level  $P < 0.05$  indicates a less than 5% chance that the result is due to randomness. Meaning, the difference

in the post-test achievement scores between the two groups is real difference and not simply due to chance. The ANCOVA analysis result confirms the superiority of CAI method of instruction over the Traditional method employed to teach the topic in the control group by teachers.

#### **4.4 CONCLUSION OF PHASE 1: QUANTITATIVE RESEARCH**

The following conclusions are drawn from the research findings of phase 1:

1. There is a statistically significant difference between the students' achievement in latitude and longitude for the control and the experimental groups, and the difference favours the experimental group.
2. There is no statistically significant difference in the pre-test and the post-test achievement scores of male and female students in the two groups
3. Science students are not significantly different from their counterparts in the commercial and art classes.
4. Students' post-test achievement mean scores reveal a non-significant difference between science students' achievement in latitude and longitude and that of their counterparts in the commercial and art classes as they attained almost the same achievement scores as their counterparts in the science classes.
5. Students in the experimental group show a significant difference in their attitude towards the learning of latitude and longitude when taught by using the CAI method.

#### **4.5 QUALITATIVE FINDINGS**

The Qualitative findings from the semi-structured interviews and classroom observations further strengthened the quantitative results of this study which justifies the mixed method design adopted by the researcher (see section 3.2). Mainly, the research questions (section 1.10), and the objectives (section 1.9) raised for the study guided the qualitative analysis. As used by Dhlamini (2012), the researcher adapted Burnard, (1991) as guided steps in qualitative data analysis. For instance, a response such as "*I am so confidence that computer will help men to learn more mathematics especially this topic*" can be considered to link the research objective or research question one of the study. The researcher did identify and categorized the themes in the study (see sections 4.6.1.1 - 4.6.1.5). Both the students and the teachers were approached to compare if the quotations from the interview fits the category.

The final focus group interviews' transcriptions were discussed with colleagues for cross checking. Thereafter, all the sections were filed together for reference purposes during a write up stage.

#### 4.5.1 Semi-structured interviews

Four teachers and sixteen students were sampled for the interview between 2pm and 2.30 pm respectively. The question was easy to understand and caused the participants to reflect on an experience that they could easily discuss. The interviews lasted for 20 minutes and were audio-taped by the researcher (see appendix 5). I decided to continue with the respondents that were available in each school to avoid time wastage. In all twelve students and four teachers were interviewed.

**Table 4.40: Participants' Interview attendance**

Groups	School codes	No of students expected for interview	No of teachers expected for interview	No of students absent for the interview	No of teachers for absent interview
Experimental	E1	2	2	2	NONE
	E2	2			
	E3	2			
	E4	2			
Control	C1	2	2	2	NONE
	C2	2			
	C3	2			
	C4	2			
TOTAL		16	4	4	NONE

From table 4.40, the expected (4) teachers for the interview in the two groups were present. However, out of the 16 students expected in the two groups, four (4) of them did not respond for the interview. Eventually, 12(75%) students were interviewed for the study.

#### 4.5.2 Classroom Observations

Classroom observation was conducted as scheduled (see section 3.8.2.4; section 3.8.2.5 & Appendix 4, 5). In the control schools, the researcher only conducted one classroom observation as agreed upon by the teachers in charge. All the participating teachers were observed to see how they present and discharge the contents of latitude and longitude in the control classes. However, in the experimental group, class observation continued throughout

the intervention. During the regular mathematics classroom observation, the researcher took field notes and photographs for post-observation analysis.

#### **4.6: ANALYSIS OF SEMI-STRUCTURED INTERVIEWS**

The researcher decided to code the interviewees in term of the sequence in which they were interviewed in their groups. For instance, L1, L2, L3...L6 were students for the experimental group whereas, L7, L8, L9 ...L12 were the control group's interviewees. Similarly, T1, T2, were teachers for the experimental group while T3, T4 were the control schools teachers. The first open-ended questions serve the purpose of making the interviewee relax and motivated to talk (Appendix4).

The identified thematic areas are as follows: students' engagement; excitement and self-confidence; classroom mathematical discourse; collaboration among students; and general opinion on the use of CAI to teach latitude and longitude. The inter-linked qualitative results according to the themes, research questions, research objectives and categories specified for the study are in the subsequent discussion.

##### **4.6.1: Analysis of students' semi-structured interviews**

Semi-structured interview was conducted with the twelve students that were available for study from the two groups. The key thematic areas identified for the qualitative data are discussed in the subsequent section in line with the study objectives, and the research questions.

##### **4.6.1.1 Theme one: Students' engagement**

The use of CAI in the mathematics classroom enabled the students to recognize the value of learning through their active participation and involvement in academic and social activities. Project tomorrow (2010) stressed that to improve students' performance in core subjects and to foster the development of 21<sup>st</sup> century skills in mature and emerging economies, schools should develop the ability to model student-centred and highly personalized learning environments.

**Research objective 1:** To examine the effect of the CAI method on students' achievements in latitude and longitude.in comparison with the traditional method of teaching.

**Research question 1:** Does Computer Assisted Instruction (CAI) affect learners' academic achievements in Latitude and Longitude?

To address the first objective and the research question for the study, the following questions were posed to students according to the themes and categories specified for the study. Students' responses to the questions are presented as verbalized by the respondents and transcribed by the researcher.

**Researcher asks question (a):**

*Do you think you learn mathematics better with the use CAI to teach it?*

Most of the students in the experimental schools favoured the use of CAI to teach mathematics. Out of the six students from the experimental group, 5(83.3%) of them supported the use of CAI to teach mathematics.

**L1:** *Yes, the use of this computer of a thing has really helped me to understand and learn mathematics better than before, my eyes is now open to some of the ways I can follow to solve mathematics problems now. This computer is good for me.*

**L3:** *I hope so because I do not like mathematics generally. I hate doing mathematics. I hope I can be helped more with the use of computer.*

**L4:** *The computer programme is fine. Yeah, fine indeed! It helps to learn mathematics better.*

**L5:** *Sir, it is my dream to do better in mathematics and I hope with the use of CAI to teach it I can do better.*

**L6:** *Using computer to teach this topic has opened my eyes to mathematics, and I am happy with it. "Thank you sir"*

In the control schools, students' responses were quite different from their counterparts in the experiment schools. Students' in the control schools complaint that teachers were impatient to explain things to them in the classroom. Some other students said they were not given opportunity to express themselves.

Comments from the interviewees in the control schools include the following:

**L7:** *The class is too boring .... How I wish I understand what the man was teaching.*

**L9:** *Anyway, I was just copying the notes. I did not understand what the teacher was saying.*

**L11:** *Sir, mathematics is too difficult to know ... I only try to memorise some points for me to pass the examination.*



As discussed in section 1. 2.1, of the study (teacher approach); a teacher-centred approach does not give students the opportunity to actively construct their own mathematical knowledge, and this has adversely affects learning at different levels of education. The teaching method is most defective, conventional, teacher-centred and didactic, where the learners' simply listening and copying notes. This link the second question posed to students by the researcher during the interview.

**Researcher asks question (b):**

*How do you know that CAI has enabled you to learn mathematics and in particular, latitude and longitude better and give reasons for your answer?*

Students' comments in the experimental schools include the following:

*L1: The use of the computer to explain some mathematics is very interesting and it has never happened like this in our school. I am so confident that computer will help me to learn more mathematics especially this topic.*

*L2: Because I can see it demonstrated in the computer laboratory by me.*

With the use of CAI in the mathematics classroom, students were involved in academic activities, and their active participation enhanced their learning of the topic. Furthermore, students' active participation and involvement in academic and social activities allowed them to explore the world around them and recognize the value of learning. Students' responses indicate that the concept of latitude and longitude engaged them to learn more easily than before. Since they were involved in academic activities, their learning of the topic was positively enhanced.

**4.6.1.2: Theme two: Students' excitement and self-confidence with the use of CAI**

The fourth objective and the research question for the study linked the second theme and category specified for the study.

**Research objective 4:** To investigate the effect of Computer Assisted Instruction on students' attitude towards latitude and longitude

**Research question 4:** Does the use of CAI method affect students' learning attitude towards latitude and longitude?

In addressing the objective and the research question raised for the study, the researcher posed the following question to students, and their responses are presented as verbalized by the respondents and transcribed by the researcher.

**Researcher asks question (a):**

*How did you feel when you were taught latitude and longitude with the use of CAI?*

Respondents in the experimental schools favoured the use of computer-assisted instruction to have enhanced their attitude towards latitude and longitude. Of the total number of students interviewed from the experimental group, all of them 6(100%) supported the use of CAI to teach the topic.

This indicates that the use of CAI techniques in the classroom had powerful impact upon students' learning of mathematics and the topic.. The students were most excited to have used a computer to answer mathematics questions on latitude and longitude.

**L1:** *Sir, I must tell you the truth, I was very happy because it has never happened like this before in our class. I have seen a computer before but we have never used it to solve mathematics problem like we are doing now.*

**L2:** *I feel good about it and it makes me learn better...very enjoyable indeed.*

**L3:** *From the way she responded to the question, she was very excited: I think our teachers should use it for other subjects in our class. Let the school have this computer for all our science subjects like physics, chemistry and even biology. We loved it so much, sir.*

**L4:** *We enjoyed the teaching and learned the topic better and faster.*

Students' response to **question (a)** led the researcher to probe further with question (b)

**Researcher asks question (b):**

*Have you ever used a computer to solve mathematics problems like this before now?*

**L3:** *No, we have never seen anything like this before in our school and lifetime.*

**L5:** *I am just seeing this for the first time in my life.*

**L6:** *No sir, I am just learning how to operate the computer...but this is very fine and we are excited about it.*

The students were excited to have learnt how to use the computer to answer mathematics questions. L3 and L5 say: *...we have never seen anything like this before in our school and lifetime. ...I am just seeing this for the first time in my life, this is very fine and we are excited about it.* Indeed, this strategy positively influenced students' learning attitude towards latitude and longitude when taught by using the CAI method. The literature reveals that learners working with computer show high levels of enthusiasm and are willing to continue with a school task (Ogbonnaya & Mji, 2013).

#### **4.6.1.3: Theme three: Mathematical discourse among students**

Research questions 2&3 linked the third theme and category specified for the study.

To address the research objective and the research questions 3, the following questions were asked from the respondents, and are presented by the researcher.

##### **Researcher asks question (a):**

*Does your CAI knowledge help you interact with your peers?*

Comments from the respondents in the experimental schools as verbalized, and transcribed by the researcher:

**L1:** *Yes...It is true that I have computer knowledge but I don't have the opportunity of practising or working on a computer system as we are doing now. CAI now helps me to interact with other students in group discussions.*

**L3:** *I didn't have any computer knowledge before, now I think we can discuss mathematics on a group basis.*

**L4:** *I had never typed or opened a computer before...now things have changed! I told my friends it is time for discussion in the class.*

**L5:** *I have no idea of computer. Although we have a computer at our house, class discussion in groups is very important to me now.*

It is evident that using CAI in mathematics classroom allowed the students to discuss and interact with their peers (see section 4.12). They learn to engage in mathematical reasoning and debates, ask strategic questions on how they can solve problems and why a particular method is chosen. This linked the next question in the interview schedule.

**Researcher asks question (b):**

*How do you think you can engage yourselves in classroom mathematical discussion with the use of a computer?*

**L1:** *I will send my difficult topic to friends for discussion through the use of social network for their inputs.*

**L2:** *I will post the questioning for group discussion.*

**L3:** *I will contact all other students to help me out of the problem.*

**L4:** *The challenge is electricity in our country...then I can discuss with friends if all are fixed.*

**L5:** *Mathematics discussion requires lot of effort but I will post questions online for group discussion to have others' view on the way forward.*

As observed by the researcher, there was sense of accomplishment on the part of the students as they interacted together in groups using the software. As they engage in discourse, they acquire new ways of talking and thinking that characterize the particular area of the curriculum.

#### **4.6.1.4: Theme four: Collaboration among students**

The objective and the research questions 2&3 linked theme four and category specified for the study, and discuss in this section.

**Research objective 2:** To compare the achievements of female learners and their male counterparts in Latitude and Longitude.

**Research objective2:** To compare the achievements of science learners and their counterparts in the Commercial and Art classes in Latitude and Longitude.

**Research question3:** Does gender have any influence on students' achievements in latitude and longitude when taught with CAI method?

**Research question 3:** Do science students achieve better in latitude and longitude than their counterparts in the commercial and art classes when taught with the CAI method?

In addressing the objective and the research question, the researcher posed the following question to students, and their responses are presented as verbalized and transcribed by the researcher as follows:

**Researcher asks questions (a) and (b):**

*Do you think the use of CAI in the classroom has helped you to share knowledge and solve problems in latitude and longitude? Have you been having this type of mathematics interactions like this before now?*

**L2:** *Really, the use of CAI helped us greatly to discuss and solve problems in groups...but our teachers did not give room for these types of interactions.*

**L3:** *Since we started this lesson, we have been discussing our mathematics problems in the computer laboratory but the teachers always sends us out because he thinks we are going to damage the computer system in the laboratory.*

**L4:** *It is good we are having it now. We hope to continue.*

**L5:** *No problem, sir, we have stated discussing among ourselves and work together. It is so fantastic we have this. I feel so good about this.*

**L6:** *The way he responded was very amusing... "You will see us in the video how we discuss together. The program is good for discussion".*

The use of CAI to teach latitude and longitude has opened the door for collaboration among the students. They have learnt to be more proactive and interact with their peers to deepen their understanding on the topic.

#### **4.6.1.5: Theme five: General opinion on the use of CAI**

The researcher had some unstructured interviews with the students and their teachers after each lesson. These were based on the usefulness of CAI software in assisting learners to learn latitude and longitude. Both students and teachers comments on the usefulness of the instruction strategy were encouraging. The general opinion from students and the teachers was that CAI tools assist them to understand and master longitude and latitude.

Few comments from the respondents as verbalized, and transcribed by the researcher:

#### **Researcher asks:**

*What is your opinion about the use of CAI to teach latitude and longitude?*

**L1:** *This CAI program has assisted me a lot...I felt like working on the computer every day...I really enjoy using this program.*

**L2:** *This program was enriching and satisfying...I never imagined myself working with it...I never dreamt I would understand latitude and longitude so easily until I was exposed to this.*

**L3:** (whose response was emotional?) *...our teachers had not beendoing anything...why not introduce this type of program to us at the junior secondary school? This is fantastic...Thank you, sir...when next are you coming?"*

**L4 :***We should be using this software for all mathematics topics ...in fact for all subjects...Our school should buy this software...because we will learn better and faster by using it.*

#### **4.6.2 Analysis of teachers' response to the interview**

Semi- structured interviews was conducted with the selected four teachers from the two groups. To analyse teachers' responses to the interviews, the researcher employed same techniques that were used during students' interviews analysis. The following are the identified themes during the interview; successful implementation of CAI, effectiveness of the strategy, comparison of CAI and TM, Teachers' opinion pool.

However, teachers from the control schools were simply interviewed to give general comments on students' response during the teaching of latitude and longitude, because the CAI strategy was not used in their schools. The qualitative results are discussed in section 4.6.2.1 to section 4.6.2.4 of the study.

The following questions were posed to teachers in the experimental schools in order to address the first objective and research question raised for the study.

#### **4.6.2.1 Theme one: Successful implementation of CAI**

**Researcher asks question:**

*In your opinion, do you think CAI implementation in the mathematics classroom is better when compared with other teaching methods employed by teachers to teach mathematics in Nigerian secondary schools?*

Teachers in the experimental schools favoured the use of CAI to teach mathematics in Nigeria secondary schools. The two of them supported the use of CAI approach to teach mathematics.

Comments from the teachers in the as transcribed by the researcher:

**T1:** *Well, working with the CAI software to teach mathematics to students gives them opportunities to interact with computer and learn mathematics in groups. My concern is our government disposition on the general use of the software in all our schools especially schools in the rural areas where we have inadequate electricity power supply.*

**T2:** *The CAI package is super. You will only need to appeal to our government to improve on the electricity. You can equally develop other software on statistics, geometry, and trigonometry and so on and so forth. You have tried anyway.*

#### **4.6.2.2: Theme two: Effectiveness of the strategy**

**Researcher asks question:**

*Do you think the use of CAI to teach mathematics will improve the subject teachers' content knowledge on some perceived difficult topics such as latitude and longitude in Nigerian secondary schools?*

**T1:** *This use of CAI package will surely help teachers. Imagine how our students were excited about the package when they were working on the computer system to solve latitude*

*and longitude mathematical problems. The subject teacher will also learn more as he follows the systematic guidelines that are in the software. I think the strategy is effective.*

**T2:** *Your innovation is a good one, and commendable I hope if our government could see it that way, students learning of mathematics and possibly other subjects such as physics and chemistry will improve.*

#### **4.6.2.3: Theme three: Comparison of CAI and TM,**

**Researcher asks question:**

*When compare the CAI teaching approach to other teaching approach being used by Nigerian secondary school teachers; which one would you appraise best?*

**T1:** *But you know the answer! Students learned mathematics, and discuss mathematical issues. Do we have such with the use of traditional or other methods of teaching in Nigerian schools? Well CAI is better sir.*

**T2:** *The difference is clear sir. We are waiting for other mathematics software.*

#### **4.6.2.4: Theme four: Teachers' opinion pool**

**Researcher asks question:**

*What are your comments on the CAI package that was used to teach latitude and longitude to students in your schools and what are your observations and suggestions?*

**T1:** *the package is good but I would like you to work more on the identification of points on the globe. It is better if more examples are given to students on this aspect. Generally, it is okay.*

**T2:** *I will suggest that you organise a seminar for us to learn how to use the strategy to teach our student. I hope you will install the page on all our systems before you go back.*

**Researcher asks question:**

*What are your comments on students' response to latitude and longitude in your schools? And what are your observations and suggestions?*

**T3:** *they responded well and the lesson plans you gave me were adequately followed.*

**T4:** *you need to see the school authority and solicit for students' seriousness during mathematics classes. The general preferences in this topic are always bad.*



## **4.7: SUMMARY OF STUDENTS' INTERVIEW**

### **Theme One: Students' engagement**

Students taught with the use CAI strategy were not only motivated to learn but also ensured full engagement and discussion. They handled the computer themselves to sketch and discuss how the earth is cut perpendicular to the polar axis, called lines of latitude. They discussed how its angle ranges from  $0^{\circ}$  at the equator to  $90^{\circ}$  at the North and South Poles, and how longitude is an angular distance measured east and west of the prime meridian (Greenwich meridian). Students took notes and sketched diagrams, in other words, they participated actively in their learning.

### **Theme Two: Students' excitement and self-confidence with the use of CAI**

According to Ogonnaya and Mji (2013), students show great enthusiasm when taught with the use of ICT. Leigh (2006) also noted that students of this age need more manipulative and tangible interventions to grasp problem-solving methods. This was exactly the case when taught the concept of latitude and longitude through CAI. Students were able to explore a new world, and create meaning for their learning as advocated by the constructivists.

### **Theme three: Mathematical discourse among students**

As observed by the researcher, there was sense of accomplishment on the part of the students as they interacted together using the software. They engage in discourse, they acquire new ways of talking and thinking that characterize the particular area of the curriculum.

### **Theme four: Collaboration among students**

Collaborative learning, according to Raborife and Phasha (2010), is a way of coming together to solve problems and complete projects; it deepens students' learning and builds collaborative skills. Students not only build collaborative skills, they also learn how to design activities to develop these skills. This view is supported by Davis (2012), namely, that collaborative learning not only encourages students to reach out to each other to solve problems and share knowledge but also to build collaborative skills; this leads to deeper learning and understanding.

### **Theme five: General opinion on the use of CAI**

Both students and teachers shared their experiences and feelings about the CAI software in learning the topic. General comments revealed their happiness about the usefulness of the CAI strategy to teach latitude and longitude to the students.

From students' response to the semi-structured interviews, their joy when CAI software was used to teach them was apparent as they admitted that they achieved better when compared to the traditional method of teaching.

#### **4.8: SUMMARY OF TEACHERS' INTERVIEW**

Findings from teachers revealed their happiness with the use of CAI software in their schools, and admitted that a lot is achieved among their students when compared with the traditional method of teaching. It is evident that teachers favoured the use of CAI to teach mathematics in Nigeria secondary schools. Their responses emphasized that the strategy should be adopted to teach mathematics and other perceived topics such as latitude and longitude. They also expressed their concern on the issue of electricity which apparently, is now being addressed by the Federal Government of Nigeria.

#### **4.9: CLASSROOM OBSERVATIONS' RESULTS**

This section discusses both the students and teachers components

##### **4.9.1 Students observations**

Students' observations were conducted in both the control and the experimental schools by the researcher as contained in Appendix 4, 5 of the research study. The following under listed observations were made:

##### ***Student observations in the control schools***

- Students in the control schools were not given opportunity to actively construct their own mathematical knowledge due to instruction strategy employed by their teachers.
- Students worked independently as they depend on the teacher to determine the validity of their answers. The instructor directs how, what, and when students learn.
- Because the approach radiates around the teacher who uses force, commands against the personal status of the students, they resulted to seeking assistance from other fellow students.
- Students in the control schools were not excited to learn in the mathematics classroom. The researcher observed that the lesson was boring to the students.

- It was observed in the control schools that connection between mathematics and real-life was lacked. Students were not made to see any importance or usefulness of mathematics.
- Most students in the control schools were observed memorizing the rules and algorithms of the subject in order to obtain good grades, but were not really excited about the teaching in the class.

#### ***Student observations in the experimental schools***

- Students were arranged in groups during the CAI intervention.
- Students in the experimental schools did not only build collaborative skills, they also learn how to design activities to develop the skills
- Students in the experimental school supported the use of CAI intervention as discussed in their interview responses (see section 4. 10).
- The use of the CAI tool in the experimental schools enhanced their learning of latitude and longitude concepts. Students were able to handle the computer themselves to sketch and discuss how the earth is cut perpendicular to the polar axis.
- Indeed experimental school students enjoyed the use of CAI to teach them.

#### **4.10: TRANGULATION OF QUANTITATIVE AND QUALITATIVE FINDINGS**

This section discusses how both the quantitative and qualitative results of the study are triangulated. Through triangulation, direct comparisons of the two sets of data enabled integration processes to take place. The mixed method design adopted and the triangulation of both the quantitative and the qualitative findings confirm the relationship between the two methods.

The (quantitative) findings of the study suggest an improved students' performance in latitude and longitude. This was objectively shown through statistical testing that participants in the intervention group had improved their learning performance and that this improvement was not due to chance. Similarly, the degree of subjectivity of phase 2 (qualitative) findings provide rich information on the setting of the research study and provide insight into the value and worth of the CAI method as an intervention for the study.

Both the quantitative and the qualitative findings reveal how the CAI intervention was used with ease to teach latitude and longitude, an aspect of mathematical topics that requires

higher-level mathematical skills with ease. Students' opinion on the use of CAI gives an insight into the reasons why this method of teaching was successful as a supported intervention. These were the themes identified during the analysis of the qualitative data and they support the evidence of the quantitative data. For instance, the composition of students that were interviewed included those from science, arts and commercial classes, and their responses were not at variance with each other.

The combination of both the quantitative and the qualitative findings provide a more complete picture of the CAI intervention than only one approach would have done. The collection and analysis of the two sets of data confirm the positive relationship between both quantitative and the qualitative data when integrated together. The findings of both types of data confirm the initial assumption of the thesis that use of the CAI intervention improves the performance of students in latitude and longitude in mathematics.

This viewpoint is supported by the responses of the selected students that were interviewed. For instance,

*L1 remarked: This CAI program has assisted me a lot...I felt like working on the computer every day...I really enjoy using this program.*

*L2: This program was enriching and satisfying...I never imagined myself working with it... I never dreamt I would understand latitude and longitude so easily until I was exposed to this.*

The mixed method design adopted and the triangulation of both the quantitative and the qualitative findings confirm the relationship between the two methods. For instance, the composition of students that were interviewed included those from science, arts and commercial classes, and their responses were not at variance with each other.

**Researcher asks the question:**

*Why do you think the use of CAI in the latitude and longitude classroom has helped you to share knowledge and solve problems? Have you been having this type of mathematics interaction like this before now?*

*L4: Yes, the use of the CAI helped me greatly to discuss and solve problems in groups...but our teachers did not give room for these types of interactions.*

**L5:** *Since we started this lesson, we have been discussing our mathematics problems in the computer laboratory but the teacher always sends us out because he thinks we are going to damage the computer system in the laboratory.*

**L6:** *No problem, sir, we have started discussing among ourselves and working together. It is so fantastic we have this. I feel so good about this.*

These students are from different classes. For example, L1 is a science class male student, L4 a commercial class female student while L6 is an arts class male student. This corroborates the quantitative findings that there is a non-significant difference in science students' results when compared to their counterparts in the commercial and arts classes. Arts and commercial class students attained almost the same achievement scores with their counterparts in the science classes.

#### **4.11 SUMMARY OF MAIN FINDINGS OF STUDY**

The findings of this study cannot lay claim to represent any other group apart from the sample group considered suitable for the research work since a convenient sampling was used. While it could be claimed that the quantitative findings of the study are related to other similar studies in mathematics and education, the parameter of generalizability of the work is considered appropriate.

1. There is a statistically significant difference between the students' achievement in latitude and longitude for the control and the experimental groups, and the difference favours the experimental group. ANCOVA findings reveal that the difference in means scores between the two groups is statistically significant ( $F_{(1, 310)} = 361.24, p = 0.001, \eta^2 p = 0.548$ ) and that the result is due to randomness, and is not just due to chance but a real difference. This result is supported by the qualitative response from both the students and their teachers, that CAI tools assisted them to understand and master the concept of longitude and latitude.

2. The post-test achievement scores for the male students are not significantly different from that of their female counterparts. Results show that the CAI affected both the male and female students' learning ability in the same way. Both male and female students are similar in their qualitative responses that CAI has affected their learning ability in the same way.

3. Science students are not significantly different from their counterparts in the commercial and arts classes. Students' post-test achievement means scores reveal a non-significant

difference between the science students' achievement in latitude and longitude and that of their counterparts in the commercial and arts classes. They attained almost the same post-test achievement scores as their counterparts in the science classes.

4. Furthermore, ANCOVA results prove that students showed a significant difference in their post-attitude means scores ( $F_{(1,299)} = 23.405$ ,  $p = .000^*$ ,  $n^2_p = .073$ ). This is evident in the qualitative findings as many of the respondents expressed their happiness when CAI software was used to teach them. They admitted that they achieved better when compared to the traditional method of teaching.

5. The use of CAI to teach latitude and longitude motivated students to learn more, opened the door for collaboration among them, and enabled them to fully engaged in discussion and constructive learning. It also afforded the students opportunity to handle the computer themselves to sketch and solve mathematical problems. They were able to discuss common problems confronting them in latitude and longitude, and interact with their peers to deepen their understanding of the topic and in mathematics generally. Both teachers and students were excited at the use of the CAI strategy in their schools. Their opinions on the use of CAI shed more lights on the reasons why this method of teaching was successful as a supported intervention. The statistical evidence of the quantitative data analysis supported the identified themes during the qualitative data analysis.

## CHAPTER FIVE

### DISCUSSION OF FINDINGS/RESULTS

This chapter discusses the summary of the major findings in terms of the research objectives, research questions and the theory adopted for the study. The main aim of the research study was to investigate the effect of CAI method of teaching on 2<sup>nd</sup> year (equivalent of grade 11) senior secondary school students' achievement and attitude in latitude and longitude in Ogun State, Nigeria. Based on the findings, suggestions and recommendations are made. The chapter concludes with suggestions for future research on the use of CAI in teaching and learning the concept of latitude and longitude in Nigeria secondary schools.

#### 5.1 SUMMARY OF STUDY

The purpose of the study was to investigate the effect of CAI on students' achievement and attitude towards latitude and longitude in Ogun State, Nigeria. A quasi-experimental design involving two groups, experimental and control, with a mixed method research design has been employed in the study. The researcher implemented the CAI in two experimental schools while the subject teachers implemented traditional method to teach the concept of latitude and longitude in two control schools (see section 3.7.2.2).

A total number of 316 2<sup>nd</sup> year students (equivalent of grade 11) who were on average 15.5 to 16 years of age were randomly selected from four (4) senior secondary schools in Ogun State to participate in the study based on gender and their subject combinations (see section 3.3). A total number of six (6) students and four (4) teachers were interviewed on the usefulness of CAI software to learn latitude and longitude (see section 4.5).

To form the theoretical framework for the study, two learning theories namely, (i) constructivism learning theory, and (ii) Cognitive information processing theory were selected by the researcher in order to facilitate the interpretation and explanation of students' computer assisted instruction performances. Justification for using more than one learning theory was carefully explained in section 2.1.1 and section 4.9.2 of the study.

The principal instrument for data collection was a standardised Achievement Test in latitude and longitude tagged as ATLL (see section 3.4). All participants in the two groups used the same instrument as pre-test and post-test. The pre-test determined the participants' background knowledge in latitude and longitude before the intervention whereas, the post-test determined the knowledge gained by the participants after the intervention, and to ascertain

the functionality of the CAI intervention in the experimental group. Students' performance after the intervention reveals an improvement in their post-test scores (see section 4.2.1.4).

Based on the results of their pre-test scores, it was evident that the two groups have limited knowledge in latitude and longitude. Hence, they were found homogeneous in term of their performances. This assertion was further confirmed by the participants' pre-test written work before the intervention (see section 4.2.6). To measure students' attitude towards the learning of latitude and longitude before and after the intervention in the two groups, the researcher used a questionnaire tagged as QSALL. The five major themes that emerged from the instrument were analysed using descriptive statistical tools. The study found that students in the experimental group show a significant difference in their attitude towards the learning of latitude and longitude when taught by using the CAI method (see section 4.2 & section 4.2.3). To support the claims made from the descriptive and inferential statistics, the researcher conducted post- intervention semi-structured interview with selected students and teachers (see section 4.6). The researcher conducted classroom observations to further support the claims from quantitative data. In the experimental schools, the researcher exploited the potential of more learning with the use of computer assisted instruction package tagged as CAIP where individual student, and in groups sit with computer to solve mathematical problems following the guided steps outlined in the package.

The study revealed a significant difference between the students' achievement in latitude and longitude for the control and the experimental groups, and the difference favours the experimental group. The study also revealed a significant difference in experimental group students' attitude towards the learning of latitude and longitude when taught by using the CAI method. In addition, general opinion of students and teachers rated the use of CAI method of teaching highly as a supported intervention (see section 4.6.1 & section 4.6.1.2). Overall, the results of this study revealed a statistically significant difference of  $P < 0.05$  between the experimental and the control groups.

The results of the study are discussed in section 5.2 in terms of the research questions, objectives and hypothesis raised for the study.



## 5.2: DISCUSSION OF THE FINDINGS IN TERM OF RESEERCH QUESTIONS AND HYPOTHESES

### 5.2.1 Main research question

The main research question of the study is the following: What is the effect of Computer Assisted Instruction (CAI) method on learning latitude and longitude?

To answer the main research question for the study, the study has to provide answers to the following sub-research questions and hypotheses to expand the details and the content in the specific terms of the main question.

#### 5.2.1.1a Sub-research question one

*How can CAI affect students' academic achievements in latitude and longitude in comparison with the traditional method of teaching (TM)?*

#### 5.2.1.1b Research hypothesis:

**H<sub>01</sub>:** *There is no statistically significant difference between the students' achievement in latitude and longitude for the control and the experimental groups*

Post-test results revealed a statistical improvement in the experimental schools ( $M=55.67$ ,  $SD=6.35$ ,  $n=160$ ) in comparison to the control schools ( $M=40.83$ ,  $SD=6.75$ ,  $n=156$ ). Hence, it is interpreted that the experimental and control group differ in their post-test and that the difference favours the experimental group. Students that were taught using CAI demonstrated higher achievement than those taught with the traditional method of teaching.

In addition, section 4.2.6 revealed that students in the experimental schools committed lower rates of errors after the intervention than their counterparts in the control schools. This suggested that the use of CAI to teach latitude and longitude in the experimental schools is more effective on students' performance than the traditional instruction (TM) that was used in the control schools. Furthermore, the ANCOVA result in section 4.2.2.4 shows a statistically significant difference  $F(1,311) = 539.596$ ,  $p < 0.05$  between the students' achievement in latitude and longitude for the control and the experimental groups.

In the experimental schools, the CAI strategy provided students with opportunities to increase their attention span, to enjoy mathematics and to become more confident at solving problems and answering questions related to the concept of latitude and longitude. Students interact with computer, ask a question by the computer, types in an answer and then get an immediate response to the answer. If the answer is correct, the student is routed to more challenging problems; otherwise various computer messages will indicate the flaw in procedure, and the program will bypass more complicated questions until the student shows mastery in that area (Tabassum, 2004). This is in line with constructivism learning theory. The theory posits that learners construct new understanding by using what they already know, and that learning is not passive but rather active (Dewey, 1933; Owusu, Monny, Appiah & Wilmot, 2010). In the constructivism classroom, teacher only provides students with opportunities to test the adequacy of their current understanding, and apply this to the new situations. Students are engaged to build their knowledge, and are encouraged on group interactions (Kozulin, 2003).

From cognitive information processing theory perspective, Kirschner et al. (2011), considered groups of collaborating students to be information-processing system consisting of multiple limited working memories, which can create a collective working space. It is argued that as long as the information is communicated between group members all of them benefit from group mathematics tasks activities. Thus, this study supports the inclusion of collaboration and classroom discourse among students.

During the semi-structured interviews in section 4.10, participants acknowledged the beneficial effect of the computer assisted instruction package that was used to teach latitude and longitude topic. For example:

*L1 remarked: This CAI program has assisted me a lot...I felt like working on the computer every day...I really enjoy using this program.*

*L2: This program was enriching and satisfying...I never imagined myself working with it... I never dreamt I would understand latitude and longitude so easily until I was exposed to this.*

The results of this study indicate that a significant difference exists between the post-test means scores of the control and the experimental group. Hence, CAI is effective in promoting students' achievements in latitude and longitude. This finding supports earlier findings (Awolola, 2011; Akay & Boz, 2010; Akinsola & Awofala, 2009; Nicolaou & Philippous,

2004; English, 1997; Silver, Mamona-Downs, Leung & Kenney, 1996; Brown & Walter, 1993) which associate improved content learning to learners'-centred teaching strategy. The findings support the assertion of Awofila and Nneji (2012) and Akinsola and Igwe (2002) that such a strategy can promote students' achievements significantly in subject content. The findings are consistent with the studies of Hamtini, (2000), Kumar (2010), Singh (2010) and Hsu (2003), who reported that CAI is a useful tool in enriching, supporting, and mediating the learning of mathematical concepts. This was obvious in the experimental group, which was taught according to the CAI strategy, as they exhibited a higher achievement level than their counterparts who were taught using the traditional method of teaching. The findings also support those of Yusuf and Afolabi (2010), that the use of CAI mathematics software to teach students for a better output is an effective mode of instruction for teaching in both individualized and cooperative settings.

The empirical research evidence supports the hypothesis that significant difference exists between the students' who were presented with the CAI method of teaching and those students that were taught with traditional method (Adeyemi, 2012; Akintade, Ogbonnaya & Mogari, 2015; Bilwise, 2005; Biehl, 1996; Chen, Lee, Hung & Wei, 2011; Chen, Suraya, Wan, & Ali, 2008; Chen & Liu, 2007; Ochoyi & Ukwummu, 2008; Owusu, Monny, Appiah & Wilmot, 2010).

Report findings from students and the classroom observation by the researcher revealed that the computer instruction method of teaching guides students better in their learning, and assists them in recalling important information with less anxiety. The findings also showed that using CAI strategy to teach makes learning meaningful, improved students' attitude and enhances their understanding. Akay and Boz (2010) further substantiate this that the learner-centred teaching strategies alleviate misunderstanding about the nature of mathematics. In this present study, the teaching strategy of computer-assisted instruction made students to be more confident increased their liking of mathematics and reduced anxiety toward latitude and longitude when compared with the traditional method of teaching. Traditional method of teaching according to Ige (2001), has not only been criticised for emphasising teaching activity at the expense of students' involvement, but that it has negative effect on students achievements and attitude toward mathematics.

On the whole, in this study, students' achievement in latitude and longitude differ significantly in favour of those treated with CAI.

### **5.2.1.2a Sub-research question two**

*Will gender have any influence on students' achievements in latitude and longitude when taught with CAI method?*

### **5.2.1.2b Research hypothesis two**

**H02:** *There is no significant difference between students' achievement in latitude and longitude for both the control and the experimental groups based on gender.*

The male students' post-test achievement mean scores, and the standard deviation ( $Mean = 54.04$ ;  $S.D = 9.66$ ) compared to the females' post-test achievement mean scores, and the standard deviation ( $M = 53.98$ ;  $S.D = 9.52$ ) reveals a non-significant difference for the two groups. This implies that the CAI intervention positively influenced both male and female students' achievements in the same way. The ANCOVA results in section 4.4 further supports the claims. The result shows a non-statistically significant difference in male and female students' achievements when they were both taught latitude and longitude with the use of CAI ( $F(1, 310) = 0.008$ ,  $p = 0.987$ ,  $n^2 p = 0.001$ ). This indicates that the use of CAI to teach both male and the female students does not produce any significant difference in their post-test performances.

Similarly, semi-structured interviews' findings conducted in section 4.12 revealed that the CAI intervention positively influenced both male and female students in the same way. They both testified to the beneficial effect of the computer assisted instruction package that was used to teach the topic in the class. The participants' responses to the interview questions corroborate the quantitative findings that there was non-significant difference in their post-test performances. For instance, L4 is a female science student, while L5 is a male commercial student.

**L4:** *Yes, the use of the CAI helped me greatly to discuss and solve problems in groups...but our teachers did not give room for these types of interactions.*

**L5:** *Since we started this lesson, we have been discussing our mathematics problems in the computer laboratory. We enjoyed your teaching sir.*

The non-significant main effect of gender on students' achievement in latitude and longitude is in line with previous studies (Arigbabu & Mji, 2004; Ding, Song&Richardson, 2007; Fatade&Nneji, 2012; Kogce et al, 2009; Mohd et al, 2011; Nicolaidou & Philippou, 2003) who reported a non-significant main effect of gender on students' performance in science and mathematics. This finding is consistent with earlier findings (Ericikan, McCreith & Lapointe, 2005; Fierros, 1999; Johnson, 2000 Leahey & Guo, 2001) that no significant differences exists in achievement between boys and girls as they start getting acquitted with mathematics. The finding supports the studies of Croxford (2010), who believed that the intellectual potential of girls is an untapped labour resource for science and technology in England and Wales. Finding of the study is also consistent with those of Meltem and Serap (2007) that reported a non-significant difference in mathematical achievement between girls and boys in the school system. However, the study is at variance with the results of Awofala, Arigbabu and Awofala (2013) and of Ok'wo and Otubar (2007), who proposed that gender, stereotyping is still dominant in the Nigerian educational system.

This, notwithstanding, results of this present study revealed that female students attain almost the same achievement scores as their male counterparts when taught the concept of latitude and longitude using CAI strategy in the mathematics classroom. The result of the study suggests that CAI strategy did not produce any significant difference in their post-test performances.

### **5.2.1.3a Sub-research question three**

*Will science students achieve better in latitude and longitude than their counterparts in the Commercial and art classes when taught with the CAI method?*

### **5.2.1.3b Research hypothesis three**

**H<sub>03</sub>:** *There is no significant difference between the science students' achievement in latitude and longitude and their counterparts in the commercial and art classes for the experimental group.*

The post achievement mean scores and standard deviation of science students (M = 54.23S.D = 9.65) in comparison with the post-achievement mean scores and standard deviation of

their counterparts in the Arts, and commercial classes (55.04; 54.32; S.D = 8.86; 8.50) were not significantly different. The use of CAI strategy to teach latitude and longitude in the class did not produce a significant difference on their post-test performances see section (4.2.1.6). The class of their choice did not influence their performance in any way.

Findings of this study indicate a non- significant difference between science students' achievement results in latitude and longitude, and their counterparts in the commercial and arts classes when taught with the computer assisted instruction method. Science students did not outperform their counterparts in the commercial and arts classes when they were taught under the same conditions. Similarly, ANCOVA results reveals a non-statistically significant difference between science students and their counterparts in the commercial and arts classes  $F(2, 310) = 0.59, p = 0.943, \eta^2 p = 0.001$ . The result indicates that the significance of  $F = 0.943$  is greater than 0.05 alpha levels (see section 4.5.2).

The non-significant main effect of subject combination on students' achievement toward mathematics is in line with the previous studies (Adegoke, 2011; Awofala, 2012; Balogun & Olagunju, 2011; Devi & Dhevakrishnan, 2012; Spradlin, 2009) that reported the positive impact of CAI on students' content learning. The finding is inconsistent with other research studies (Awlola, 2011; Ige, 2001; Kulik & Kulik, 1995; Spradlin, 2009) that processing of information in analytic way improves students' achievement in and attitude toward content knowledge learning as opposed non-analytic. The finding also supports the studies of (Awofala & Nneji, 2012; Akinsola & Igwe, 2002; Bramlett & Herron, 2000; Chen & Liu, 2007; Chang, Sung & Lim, 2006) who have indicated that computer assisted instruction promote students achievements significantly in subject content.

In this present study, subject combination or the classes attended did not result in mathematics achievements, and attitudes differential between the science students and their counterparts in the commercial and art classes for the experimental group. Apparently, result of this study suggested that students' poor performance in latitude and longitude, and mathematics generally, might not be due to their subject combination or the classes they attend.

#### **5.2.1.4a Sub-research question four**

*What challenges, if any will the use of CAI method have on students' learning attitude towards latitude and longitude?*

#### **5.2.1.4b Research hypothesis four**

**Ho4:** *There is no significant difference in students' learning attitude in latitude and longitude for the control and the experimental groups.*

The results presented in Table 4.27 showed significant main effect of treatment on students' attitude toward latitude and longitude. The comparison of difference between the mean of the pre-attitude scores and post-attitude scores showed significant difference ( $t=2.34, p<0.05$ ) in favour of post-test class. The results connote that the students held stronger attitude toward latitude and longitude when exposed to CAI treatment. This finding supports the earlier findings (Bobis, & Cusworth, 1994; Odell & Schumacher, 1998; Ma & Kishor, 1997; Nicolaidou & Philippou, 2003; Papanastasiou, 2000; Tezer & Karasel, 2010; Yilmaz, Altun, & Olkun, 2010) that reported a positive correlation between students' attitude to mathematics and academic achievements. This finding is inconsistent with other research studies (Capenter, Jacob & Fennema, 1998; Bramlett & Herron, 2009; Mohd et al, 2011) which showed that students' attitude towards problem solving in terms of patience, confidence and willingness has a positive relations with students mathematics.

The post-attitude treatment results and the semi-structured interviews conducted further confirm students' confidence towards the learning or solving of latitude and longitude problems. Findings of the study revealed that the percentage of participants that have challenges with calculation that involves distances and lines diminished, while their responses also show a decreased phobia for mathematics and latitude and longitude through the use of CAI to teach the concept (see section 4.2.4). This, notwithstanding, is an indication that the intervention has had a positive impact on their attitude and built their confidence towards solving latitude and longitude mathematical problems. This result finding is consistent with (Awofala, Arigbabu & Awofala, 2013; Chen, Hung, Lee & Wei, 2010; Chen & Zimmerman, 2007; Johnson & Aragon, 2003; Fatade, 2012) that the use of appropriate teaching material to teach will enhance students' attitudes in mathematics. In the same vein, participants' responses to the interview corroborated this assertion.

For example:

**L1:** *remarked, yes...It is true that I have computer knowledge but I do not have the opportunity of practising or working on a computer system as we are doing now. CAI now*

*helps me to interact with other students in group discussions. It has positively changed my attitude to learning mathematics now.*

**L3:***said, I did not have any computer knowledge before, now I think we can discuss mathematics on group basis.*

This suggests that students experiencing problems developed an interest in learning the concept of latitude and longitude when the CAI intervention was adopted to teach them. The CAI intervention made learning more meaningful to students, improved their attitude and enhanced their understanding of the topic. The result of the present study therefore suggests a significant difference between students' leaning attitude and their academic achievement in latitude and longitude when they exposed to CAI strategy to teach them.

With all the beneficial effect of computer-assisted instruction as discussed in the study, it is reasonable to conclude that the approach contributed largely to the development of students' achievement and attitude towards the learning of latitude and longitude.

### **5.3: IMPLICATIONS OF THE FINDINGS TO EDUCATIONAL PRACTICE**

The constructivism theory has emphasized that a learner is an information constructor. It emphasizes that knowledge is constructed based on personal experience and hypotheses of the environment, which learners continuously test through social negotiations. As such, this present study incorporated the use of computer-assisted instruction, which was implemented in the experimental schools to teach latitude and longitude.

The knowledge in this study has added another dimension to everyday experiences of students in mathematics when the software was used to teach the perceived difficult topics, and they were actively involved in the learning process through the use of CAI techniques.

The value of this CAI approach as opposed to the traditional method of teaching where students only listening, copying notes, doing class work and assignments, sleep while the teacher explains, and are not given the opportunity to actively construct their own mathematical knowledge is that learner is involved all times. The effectiveness of CAI in this study lays in the fact that students were stimulated and encouraged to build their knowledge, construct their team work and promotes inter and intra-relationships among their peers.

The implication of the findings of this study to educational practise is that, the use CAI to teach mathematics as advocated by several research studies (see section 2.7) is likely to make



students develop problem- solving skills to face higher-level challenges in mathematics in the atmosphere of active inquiry -based constructivist instructions environments.

In addition, the CAI embraced classroom discussion, project work, and allowed students to explore the world around them. With these observations, the study adds to the existing stock of empirical knowledge on the use of computer-assisted instruction to stimulate students to build their own knowledge, interact with their peers and, explore through a variety of CAI techniques. Therefore, this study recommends the adoption of the CAI teaching strategy in Nigerian secondary schools to arouse students' interest to learn more and consequently, improve their performances in this aspect of mathematics.

## CHAPTER SIX

Based on the findings, this chapter discusses the limitations of the study, suggestions and recommendations for future research on the use of CAI in teaching and learning the concept of latitude and longitude in Nigeria secondary schools.

### CONCLUSION AND RECOMMENDATIONS

In conclusion, the findings reveal that the CAI strategy is an effective medium of instruction for teaching the concepts of latitude and longitude in Nigerian secondary schools. It has the potential of not only improving students' achievement in latitude and longitude, but also influences their attitude towards the topic.

1. Phase 1 findings support the initial hypothesis that the use of CAI to teach latitude and longitude to Nigerian students improves their performances on the topic.
2. Phase 2 findings support the phase 1 findings through participants' experience in the CAI intervention program.
3. The triangulation of both phase 1 and phase 2 findings supports the hypotheses of the research study.
4. The claims that using the CAI intervention would improve students' achievement and attitude towards latitude and longitude are sustained.

#### 6.1: LIMITATIONS OF THE STUDY

In this present study, possible limitations, which could affect the trustworthiness, validity and reliability of the findings, are recognised and acknowledged by the researcher.

1. The duration, which the CAI intervention was implemented in the experimental schools is a notable significant limitation of the study. The eight weeks duration for a study such as this, may be too short to influence students' understanding on the learning of latitude and longitude in solid geometry. Possibly, a longer period may likely produce a significant and substantial result when studies like this are conducted.
2. Although the researcher has made every effort to minimize the basic and administrative research bias, the inherent flaws of the methodology adopted in this research may have an effect on the analyses of the study.

3. The study was restricted to 2<sup>nd</sup> year Senior Secondary School students only excluding those in the other grades/ classes. The study did not incorporate all foundation year (Junior Secondary Schools) students or all the subjects offered in their schools.
4. In addition, the study addressed only one topic in the entire SSS mathematics curriculum. However, it is assumed that factors that facilitated the enhancement of students' learning of latitude and longitude will be applicable to other classes and in other Senior Secondary School mathematics curriculum.
5. The no- randomisation of participants in experimental and the control groups limit the generalizability of the present results to only those who participated in the current study. However, there is the need for more research study to neutralise the effect of the assignment of participants to participating groups.
6. The convenient sampling for the study indicates that there was a lack of representation from the entire Junior Secondary School (JSS) and Senior Secondary School students' body in all Nigerian Schools.
7. The need to focus the study on Senior Secondary School students, and the selection of small number of students may be thought to prevent "generalisation" of the research work. However, the potentials of CAI strategy as an effective medium of instructions are usable for other Junior and senior secondary schools, and even perhaps for higher institutions.
8. The study is mainly concentrated in schools located in specific areas of the Local Government in the State. Hence, the results of this study will be applicable to Ogun State.
9. Although the study is limited to a state in the south-west geo-political zone in the country, it is an indication for the existence of the potential for future research to be undertaken by expanding its scope to cover many other states.

## 6.2 RECOMMENDATIONS

Findings from the study have shown that CAI improves the performance, learning achievement and attitudes of students in latitude and longitude. The researcher, therefore, recommends the following proposals.

The CAI strategy should be implemented in the teaching and learning of latitude and longitude, and mathematics in Nigerian secondary schools in order to enhance students' performance on the topic. The adoption of the CAI teaching strategy in Nigerian secondary schools would motivate students to learn, arouse their interest and consequently, improve their performances in mathematics.

Both the NUC and NCCE should emphasize the need for teachers to be more computer literate because lack of computer knowledge among teachers will decelerate the implementation of CAI programs in schools.

Periodic seminars and workshops should be organized for mathematics teachers, with emphasis on the usage of CAI to teach perceived difficult topics to students to minimize their failure rate in such topics.

The applications of the recommendations above would be appropriate for the improvement of the teaching methodology of mathematics and other science-related subjects in Nigerian secondary schools.

### **6.3: SUGGESTIONS FOR FURTHER STUDIES**

The present study is limited to the problems encountered by students in latitude and longitude, an aspect of mathematics; future researches could engage in longitudinal study on the effectiveness of computer-assisted instruction on students' achievement and attitude in other to teach perceived difficult areas in mathematics. Although the study has covered one (Ogun State) of the six geopolitical zones in Nigeria, future research could be undertaken by expanding its scope to cover many other states in the country to further give credence to the generalizability of this study. Other future researchers could investigate the feasibility of the CAI in a computer-mediated environment.

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## APPENDICES

### APPENDIX 1

Achievement Test for 2<sup>nd</sup> year senior secondary school

**Instructions:** Attempt all Questions. Unless otherwise told, use the values 6400km for R or 40000km for  $2\pi r$  take  $\pi=22/7$  or log  $\pi$  to be 0.4971

1. A boy walks 6Km from a point P, to a point Q, on a bearing of  $065^{\circ}$ . He then walks to a point R, a distance of 13Km, on a bearing of  $146^{\circ}$ .
  - (i) Sketch the diagram or the coordinate of his movement,
  - (ii) Calculate, correct to the nearest Kilometres, the distance PR.
2. A Plane flies due East from A ( $53^{\circ}\text{N}$ , long. $25^{\circ}\text{E}$ ) to a point (Lat. $53^{\circ}\text{N}$ , Long. $85^{\circ}\text{E}$ ) at an average Speed of 400Km/hr. The plane flies south from B to a point C 2000 km away. Calculate, correct to the nearest whole number. (Take  $\pi=22/7$ ; R=6400km)
  - (i) The distance between A. and B:
  - (ii) The time the plane takes to reach point B
  - (iii)The latitude of C.
3. An aircraft flies due South from an airfield on latitude  $36^{\circ}\text{N}$ , longitude  $138^{\circ}\text{E}$  to an airfield on latitude  $36^{\circ}\text{S}$ , longitude  $138^{\circ}\text{E}$ 
  - (i) Calculate the distance travelled, correct to three significant figures.
  - (ii) If the speed of the aircraft is 800km per hour, calculate the time taken, correct to the nearest hour. (Take  $\pi=22/7$ ; R=6400km)
4. A ( $60^{\circ}\text{N}$ ,  $30^{\circ}\text{E}$ ) and B ( $60^{\circ}\text{N}$ ,  $42^{\circ}\text{W}$ ) are two towns on the surface of the Earth. Calculate correct to three significant figures, the:
  - (i) Radius of the circle of latitude on which A and B lie;
  - (ii) Distance on the Earth's surface between A and B along the circle of latitude.
5. An aero plane flies from a town P (lat. $40^{\circ}\text{N}$ ,  $38^{\circ}\text{E}$ ) to another town Q (lat  $40^{\circ}\text{N}$ ,  $22^{\circ}\text{W}$ ). It later flies to a third town T ( $28^{\circ}\text{N}$ ,  $22^{\circ}\text{W}$ ). Calculate the:
  - (i) Distance between P and Q along their parallel of latitude
  - (ii) Distance between Q and T along the line of longitude
  - (iii)Average speed at which the aero plane will fly from P to T via Q; if the journey takes 12hrs, correct to three significant figures (Take the radius of the Earth to be 6400km and  $\pi=3.142$ )



## APPENIX 2a

### QUESTIONNAIRE ON STUDENTS' ATTITUDES TOWARDS LATITUDE AND LONGITUDE OGUN STATE - NIGERIA

Dear students,

This Questionnaire is developed for research purpose to make an investigation about  
Students' Attitude Toward the learning of latitude and longitude (QSATLL).

Please indicate your opinion about each of the statement below. Your name is not required all  
responses will be treated confidentially.

#### SECTION A

#### STUDENT DEMOGRAPHIC

Name of school.....

Class.....

Sex: Male ( ) Female ( ) Age.....

#### SECTION B

For each statement, please tick {√}.

SA=Strongly Agree, A=Agree, U = Undecided, D =Disagree, SD = Strongly Disagree

NO	QUESTIONS ITEMS	MEAN		SD	
		E	C	E	C
1	Mathematics is difficult for me especially bearing which is fundamental to the learning of latitude and longitude.				
2	Latitude and longitude is not a difficult aspect of mathematics for me				
3	The calculation of distance between two points and length between parallels of latitude are always confusing when solving questions on the topic				
4	I always enjoy the mathematics class when problems that involve application of formulas are being solved in class.				
5	I find it difficult to apply some of the formulas given when I am to solve problems with 3-dimensional solid geometry.				

6	I can still improve in mathematics if I give more attention to solving mathematical problems				
7	Communicating with other students helps me have a better attitude towards mathematics that involves lines and angles.				
8	The concept of latitude and longitude is not clear to me in mathematics				
9	I prefer topics that are difficult in mathematics to be taught with the aid of instructional materials so as to assist the low achievers to catch up quickly especially latitude and longitude.				
10	I always find it interesting when solving problems on solid geometry especially latitude and longitude.				
11	My foundation in mathematics at the junior class is poor and this contributed to my low performance in the senior class				
12	Mathematics is one of my favorite subjects and I often practice it.				
13	Detail explanations given by my teacher on latitude and longitude with the use of instructional materials give me better understanding of the topic.				
14	My teachers encouraged me to like mathematics hence they gave me adequate materials and attention whenever I asked them.				
15	If mathematics could be taught with the use of computer by our subject teacher, many students will learn it faster				
16	Our mathematics teacher is not always regular in the class to teach us				
17	We have not been having a mathematics teacher for the past one session				
18	Latitude and longitude can be the most enjoyable topic if our teacher explains it clearly in the class				
19	Mathematics that involves lines and angles always scares				

	me and I generally hate those topics				
20	I am scared about calculation of difference between angle of latitude and longitude of two points on the earth globe.				
21	My parents told me that too much practice of mathematics can have a negative effect on me, hence I hate the subject				
22	Computer assisted instruction will make students become lazy in using their brain to solve mathematical problems.				
23	Adequate power supply in our schools may hinder the proper use of computer systems in most secondary schools for the teaching of mathematics.				
24	Because I am in art class mathematics is not compulsory for me. Hence I attend the class whenever I like.				
25	Mathematics is needed in designing practically everything in life.				
26	Mathematics could be made more interesting for students if new topics are introduced through the use of computer packages, with a guided approach to real life.				
27	Mathematics could be made more interesting for students if new topics are introduced through the use of computer packages, with a guided approach to real life.				
28	Mathematics helps me to think fast whenever I help my parents at their marketplace after school hours.				
29	The use of computer assisted instruction will expose students to modern technology in solving mathematical problems.				
30	Mathematics is the only subject that promotes science and technology.				

## Appendix 2b

### Factor Analysis Results on Students' attitude

No	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared		
	Total	% of Var	Cum%	Total	% of Var.	Cum %	Total	%of Var	Cum%
1	3.652	12.17	12.174	3.652	12.17	12.17	2.615	8.716	8.716
2	2.739	9.130	21.304	2.739	9.130	21.30	2.501	8.337	17.054
3	1.992	6.640	27.944	1.992	6.640	27.94	2.476	8.252	25.306
4	1.579	5.264	33.208	1.579	5.264	33.20	2.371	7.902	33.208
5	1.436	4.786	37.995						
6	1.318	4.395	42.389						
7	1.279	4.262	46.651						
8	1.202	4.007	50.659						
9	1.119	3.731	54.390						
10	1.082	3.607	57.997						
11	1.025	3.416	61.413						
12	.967	3.224	64.637						
13	.913	3.045	67.682						
14	.858	2.858	70.540						
15	.817	2.722	73.263						
16	.765	2.550	75.813						
17	.740	2.467	78.280						
18	.697	2.323	80.603						
19	.636	2.121	82.724						
20	.614	2.047	84.771						
21	.590	1.968	86.740						
22	.578	1.927	88.667						
23	.533	1.778	90.445						
24	.505	1.683	92.127						
25	.489	1.629	93.756						
26	.453	1.510	95.266						
27	.421	1.403	96.669						
28	.379	1.264	97.933						
29	.316	1.052	98.985						
30	.305	1.015	100.00						

### APPENDIX 3

#### Item difficulty and discrimination index of ATLL

ITEM	ITEM DIFFICULTY	DISCRIMINATION INDEX
1	0.84	0.68
2	0.82	0.48
3	0.28	0.52
4	0.34	0.46
5	0.45	0.53

## APPENDIX 4

### STUDENT INTERVIEW PROTOCOL

Q1 (a) Do you think you learn mathematics better with the use CAI to teach it?

Q1 (b) How do you know that CAI has enabled you to learn mathematics and in particular latitude and longitude better and give reasons for your answer?

Q2 (a) How did you feel when you were taught latitude and longitude with the use of CAI?

Q2 (b) Have you ever used a computer to solve mathematics problems like this before now?

Q3 (a) Does your CAI knowledge help you interact with your peers?

Q3 (b) How do you think you can engage yourselves in classroom mathematical discussion with the use of a computer?

Q4 (a) Do you think the use of CAI in the classroom has helped you to share knowledge and solve problems in latitude and longitude?

Q4 (b) Have you been having this type of mathematics interactions like this before now?

Q (5). What is your opinion about the use of CAI to teach latitude and longitude?

**APPENDIX 5**  
**TEACHERS INTERVIEW PROTOCOL**

1. In your opinion, do you think CAI implementation in the mathematics classroom is better when compared with other teaching methods employed by teachers to teach mathematics in Nigerian secondary schools?
2. Do you think the use of CAI to teach mathematics will improve the subject teachers' content knowledge on some perceived difficult topics such as latitude and longitude in Nigerian secondary schools?
3. When compare the CAI teaching approach to other teaching approach being used by Nigerian secondary school teachers; which one would you appraise best?
4. What are your comments on the CAI package that was used to teach latitude and longitude to students in your schools and what are your observations and suggestions?

## APPENDIX 6

### CAIP APPLICATION ROUTINE

This section gives an insight into the application routines of the CAI package to help understand its meaning and how CAIP is used to teach latitude and longitude in the mathematics classroom.

The problem display area is indicated with different colours below.

- Blue:** Input buttons
- Black:** Module content and guided steps towards solving given problems
- Red:** Freehand sketch area
- Green:** Guided sketch area
- Yellow:** Problem display area

The problem display area is shown in the following figures below. It consists of the display area for *Problem information* and display area for a single *Question* as well as for navigation of the buttons:

*Fetch set*

*Recap*

*Next question*

*Next problem*

*Clear*



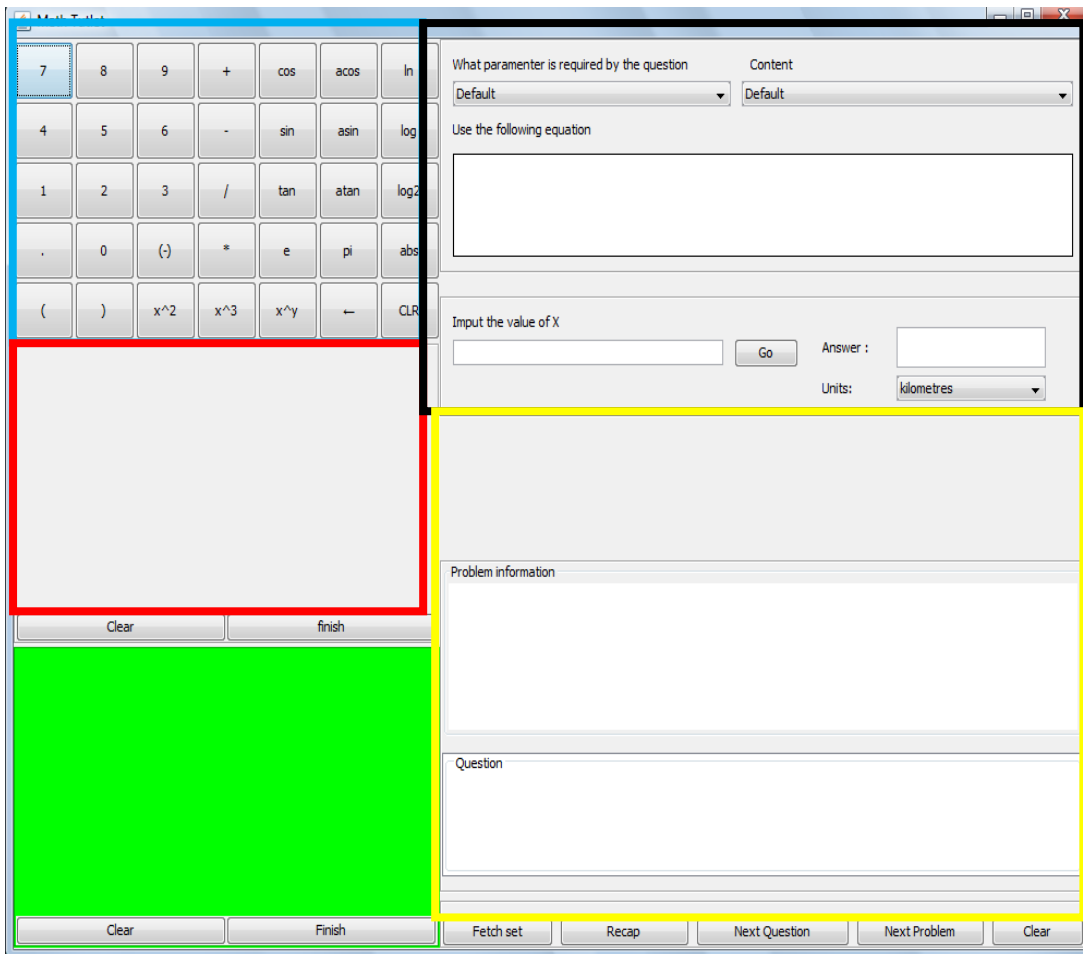
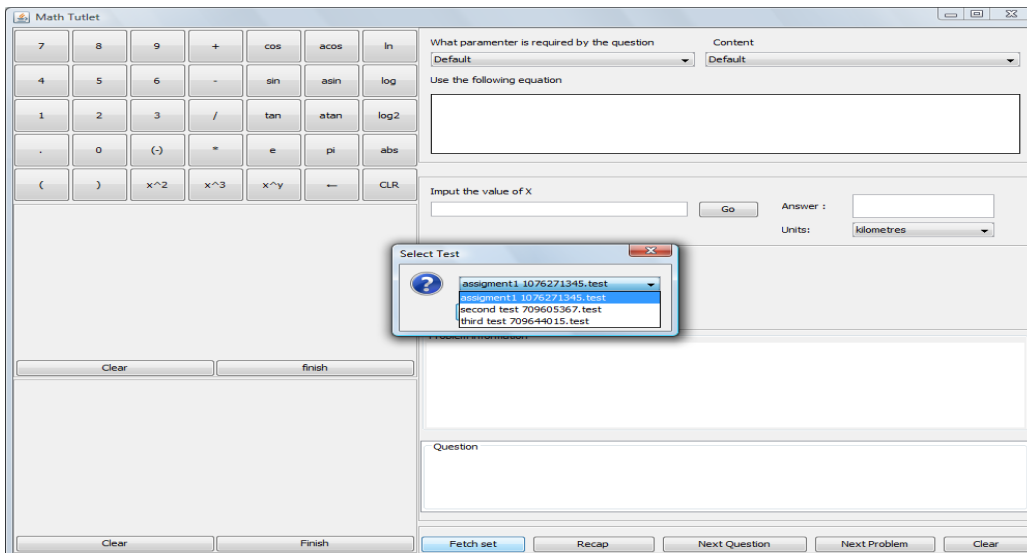


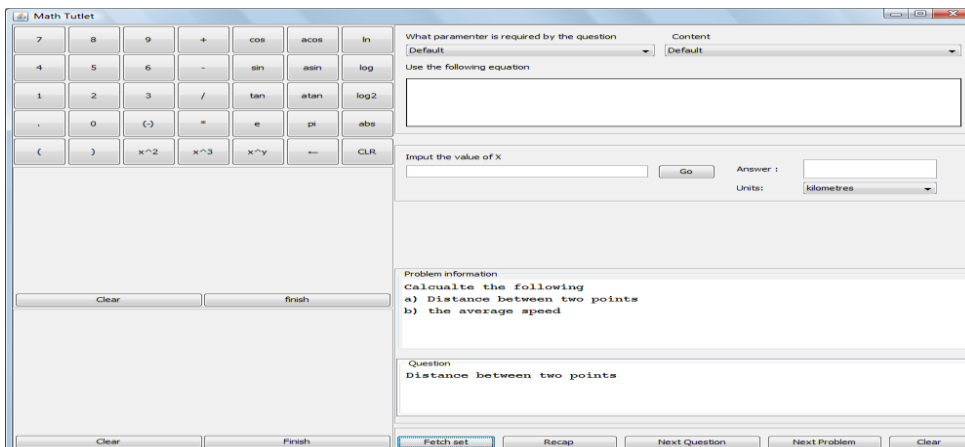
Figure 1 the problem display area



**Figure 2: Loading problem from question bank**

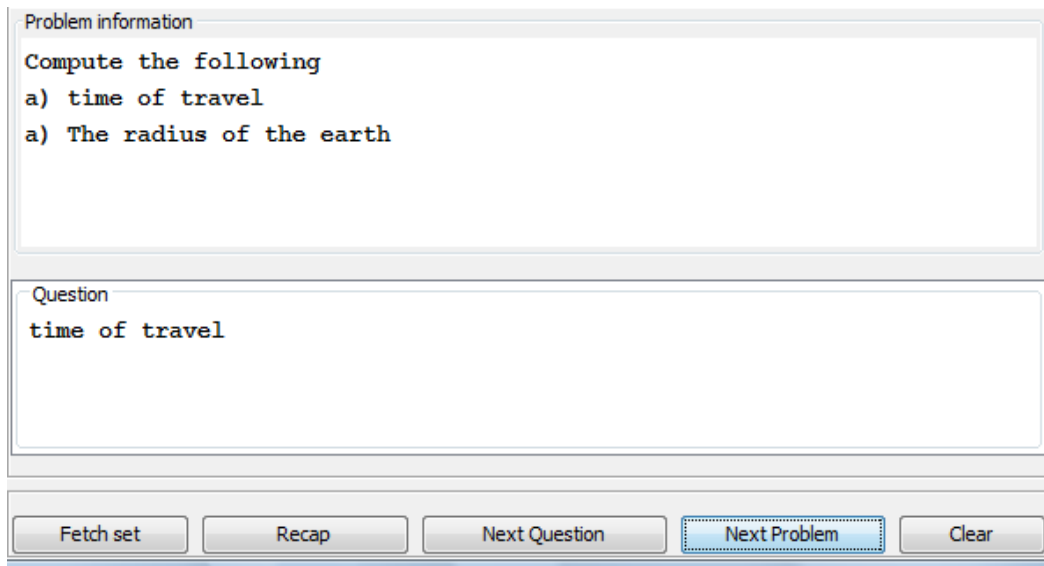
- Click on Fetch set button.
- Select the required test in the drop down list.

Problem display interface is separate from the question display unit as indicated in figure 3.1. The reason for this is that students find difficulties in how to differentiate between the two, hence the need to separate them for clarity purposes.



**Figure 3: Question displayed on screen**

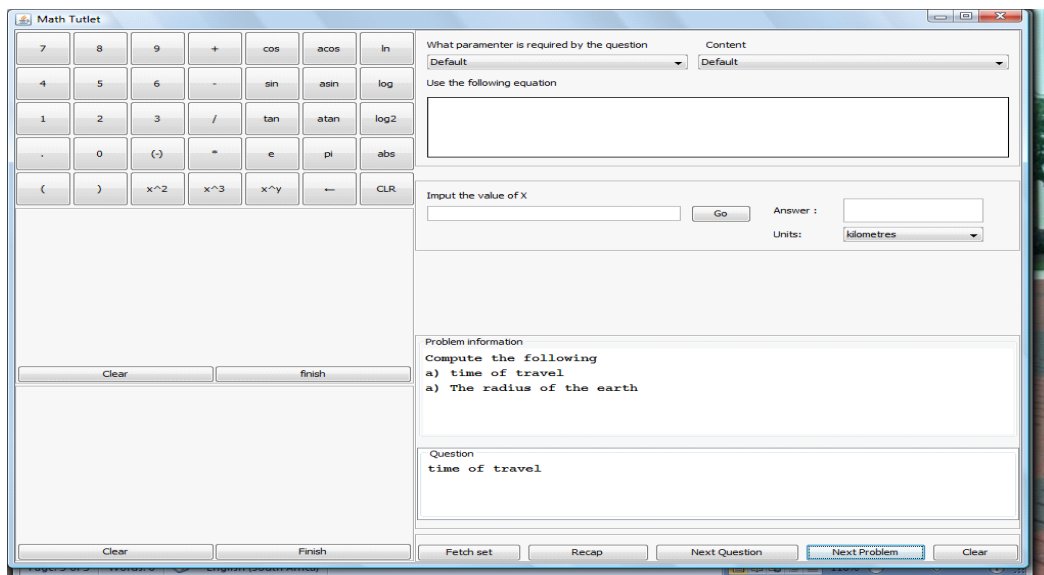
Figure 3.4 displays the problem interface unit. Students are now able to differentiate between the question and problem interface unit as indicated below for clarity purposes.



**Figure 3.4: Problem displayed on screen**

To clear the current problem information from the screen, **follow** the procedure as indicated by clicking the *Clear* button to clear the current problem information.

Figure 3.5 shows the interactive content area that consists of the content list and question list, equation display area, number input and answers display.



**Figure 5: Interactive content area**

Click on the contents list and select module one video.

- Module one video content appears.
- Use the Stop and close to exit the video.
- Use the Pause button to pause the video.
- Use the Play button to resume a paused video.

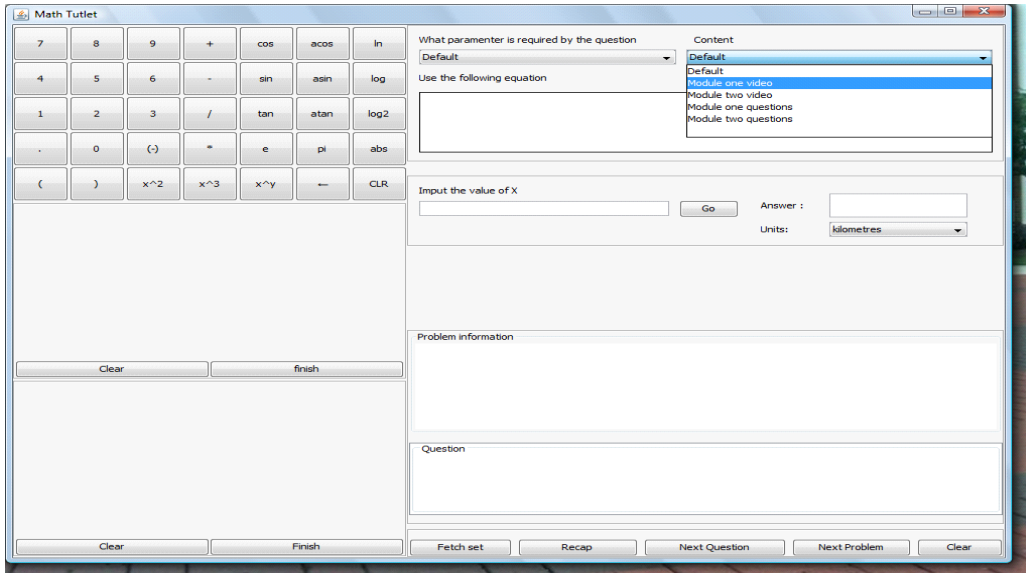


Figure 6: Content list and selection of modules

Once you have clicked on the content list and selected the module of your choice (e.g. module one video), module one appears on the screen as displayed in Figure 3.7below.

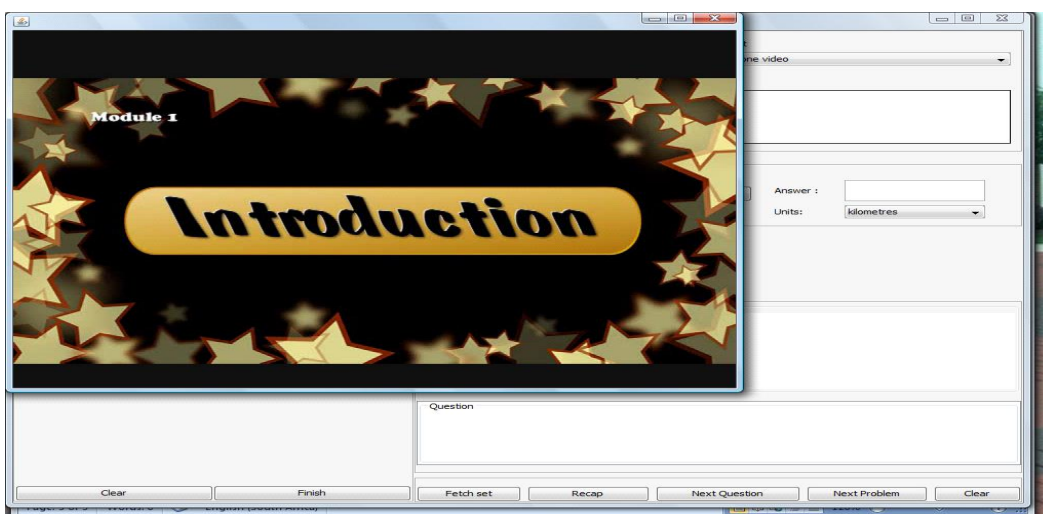


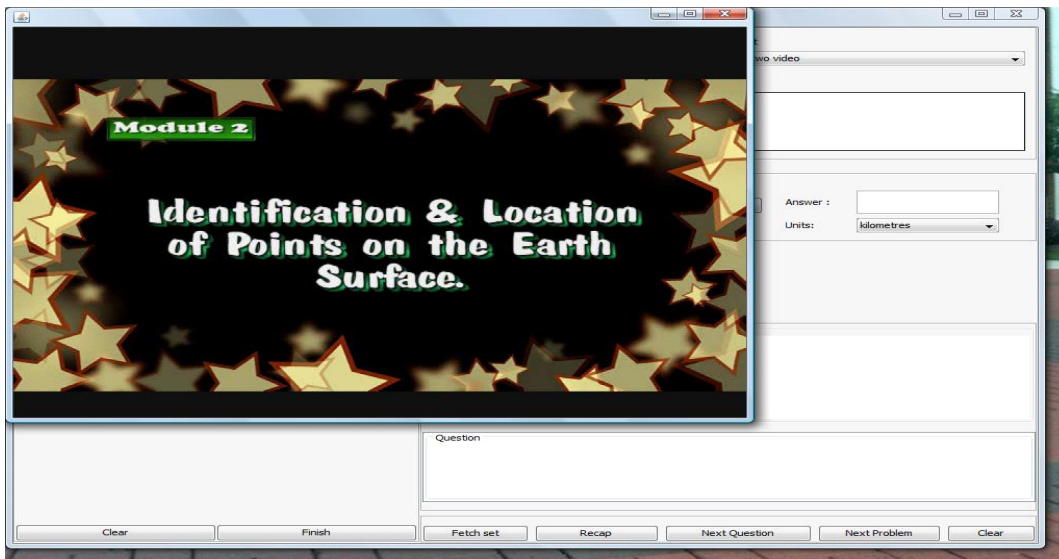
Figure 7: Appearance of module one on screen

To explore module two, follow the procedure as indicated below.

- Use the Stop and close to exit the video.
- Use the Pause button to pause the video.
- Use the Play button to resume a paused video.

Use the Play button to resume a paused video.

If you have clicked on the content list and selected the module two video, the appearance of the module will be displayed, as in figure 3.8below.

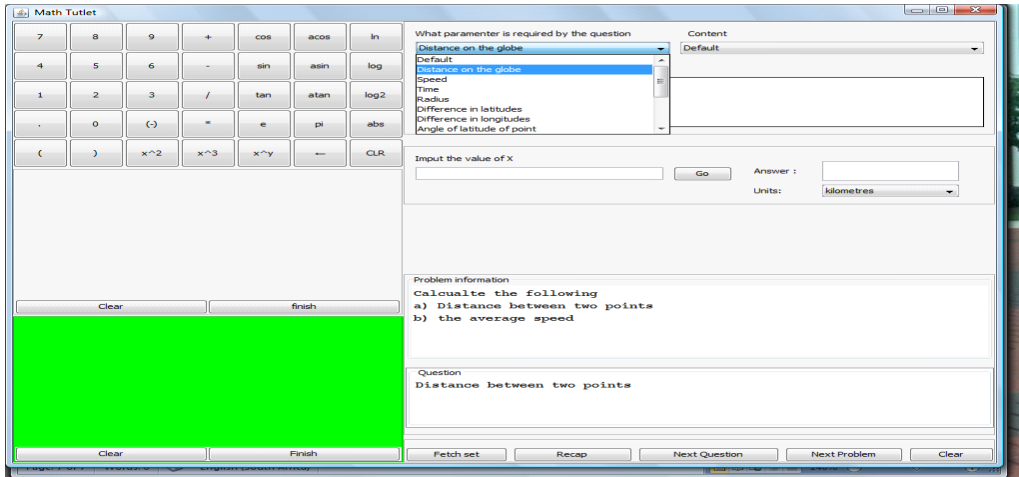


**Figure 8: Appearance of module two on screen**

### **Section Three**

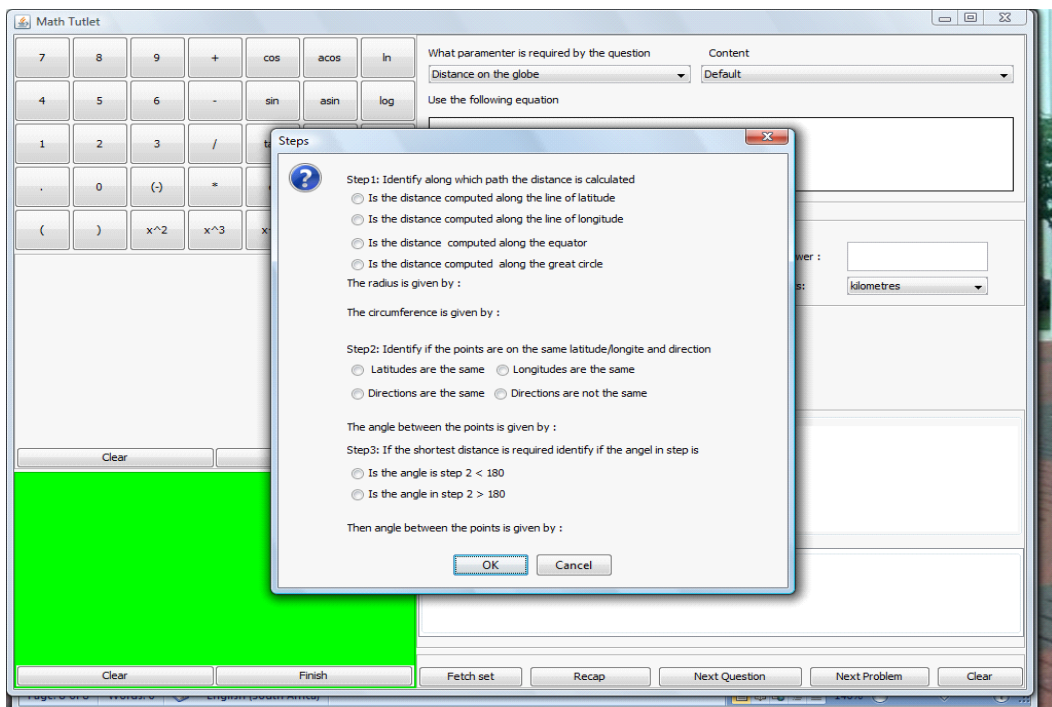
This section explains the guided steps on how to solve questions related to latitude and longitude in mathematics through CAIP.

- Start by establishing the type of question by selecting the required parameter as shown in the figure below.
- If the question requires distance between two points on the globe, then
- Select the *Distance on the globe* as in Figure 3.9



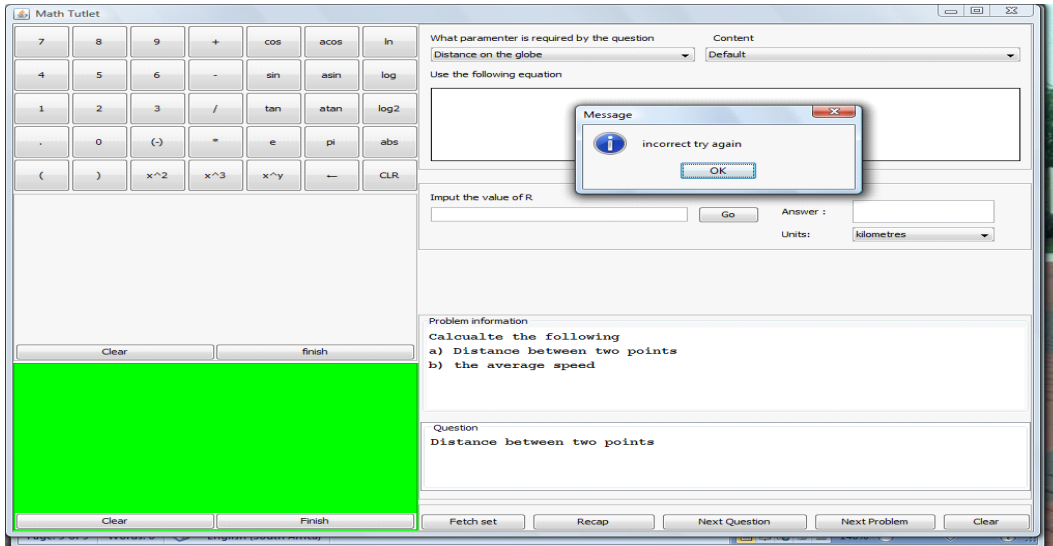
**Figure 9: Guided steps to solving latitude and longitude problems**

Follow the steps as they appear on the screen, select the appropriate response as requested and click OK as indicated in figure 3.10 below.



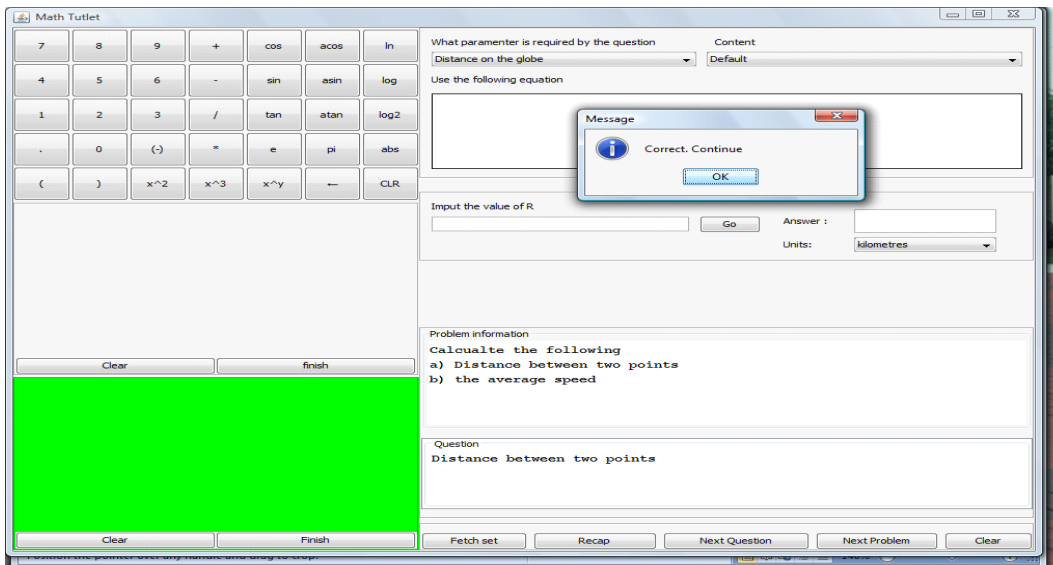
**Figure 10: Appearance of the pop-up message**

If all the steps are not completed in a satisfactory way **the incorrect and retry message** will pop up as shown on the screen in figure 3.11



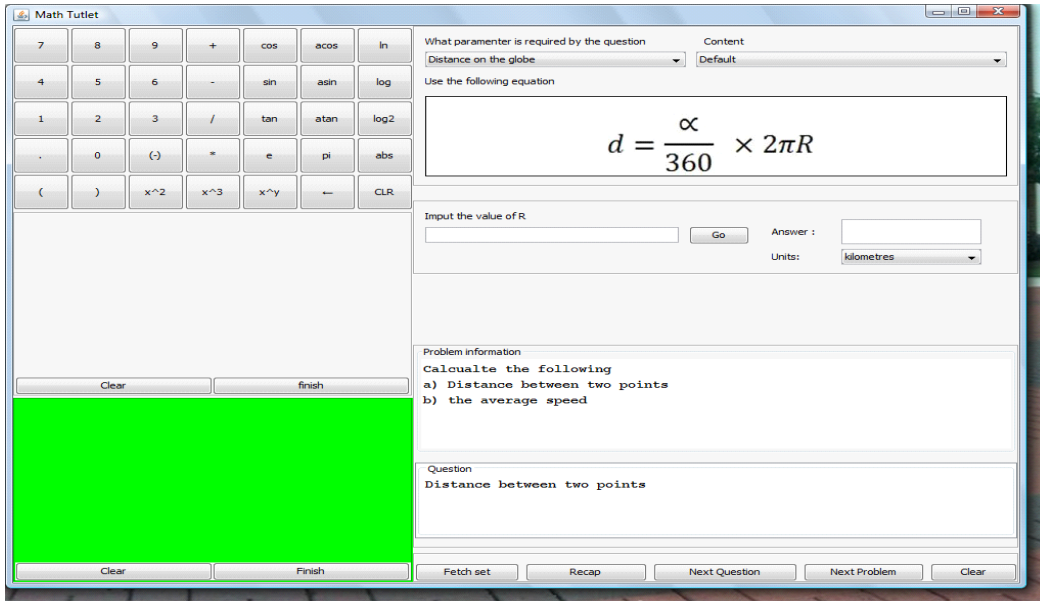
**Figure 11: Appearance of the incorrect and retry message**

However, if all the steps are completed satisfactorily, **the correct and continue message** will pop up on the screen as shown in **figure 3.12** below.



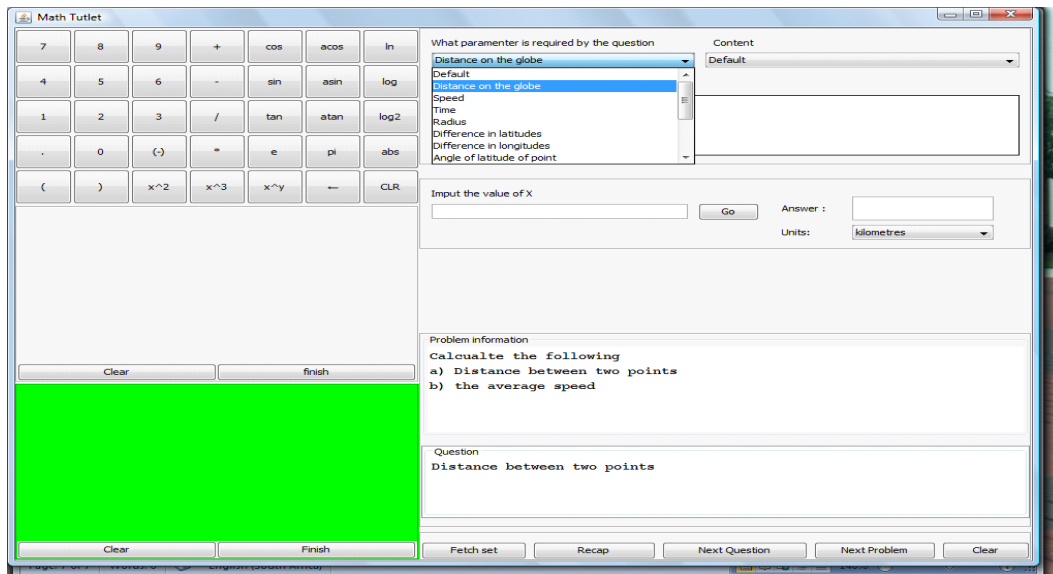
**Figure 3.12: Appearance of correct OK message**

Upon clicking OK, the correct formula to use is displayed as shown **figure 3.13** depending on the given question.



**Figure 13: Appearance of the correct formula**

If the questions require the calculation of speed, time, radius, difference in latitude, difference in longitude, etc. as shown in figure 3.14, follow the same steps as above.



**Figure 14: Related questions on speed, time and radius**

## Section Four

### Freehand sketching of movement on the globe

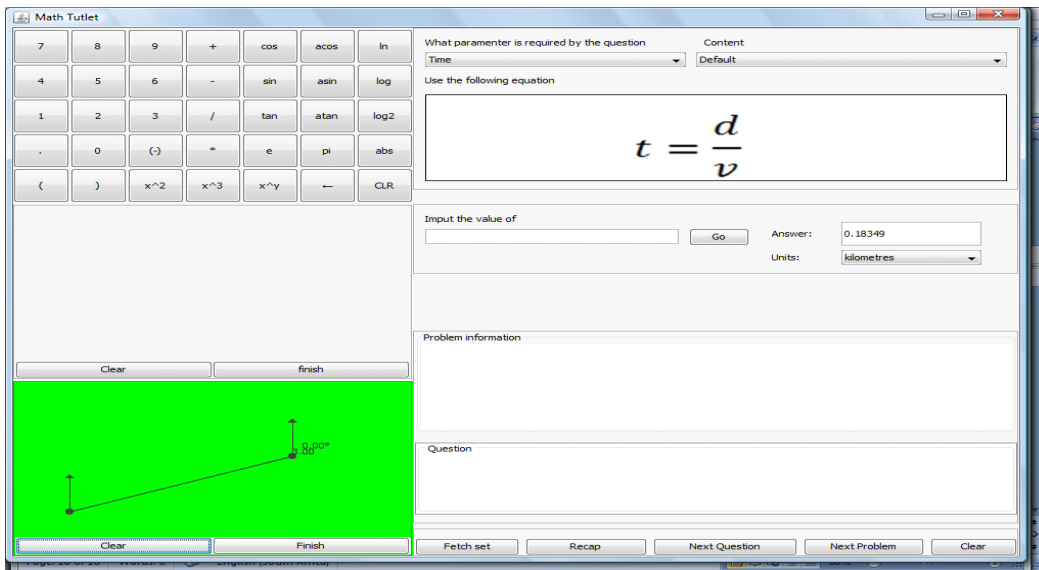
This section discusses how to use freehand for sketching the bearing of movement, distance and angles on the globe following the procedures demonstrated in figure 3.15 below.



Move the mouse towards the next point using the angle displayed.

- Click to insert the second point.
- A normal line is plotted.
- The two points remain connected.

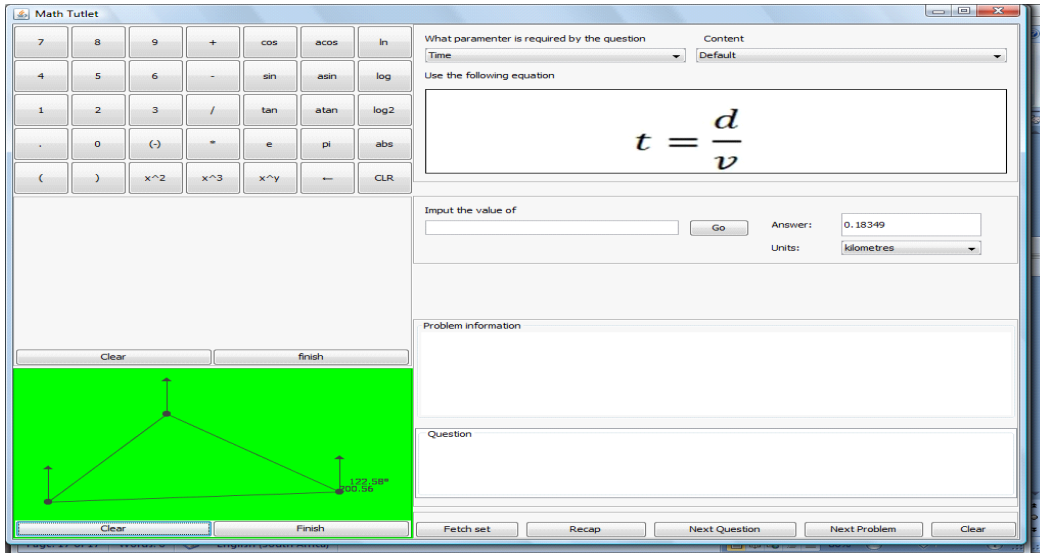
You may click clear button if unsatisfied with the type of sketch produced without any problem. A plotted diagram may be erased at your comfort and another could be drawn with the use of mouse.



**Figure 15: Free hand sketch of movement on the globe**

Follow the procedure to connect two or three points using freehand sketching as shown in figure 3.16 below.

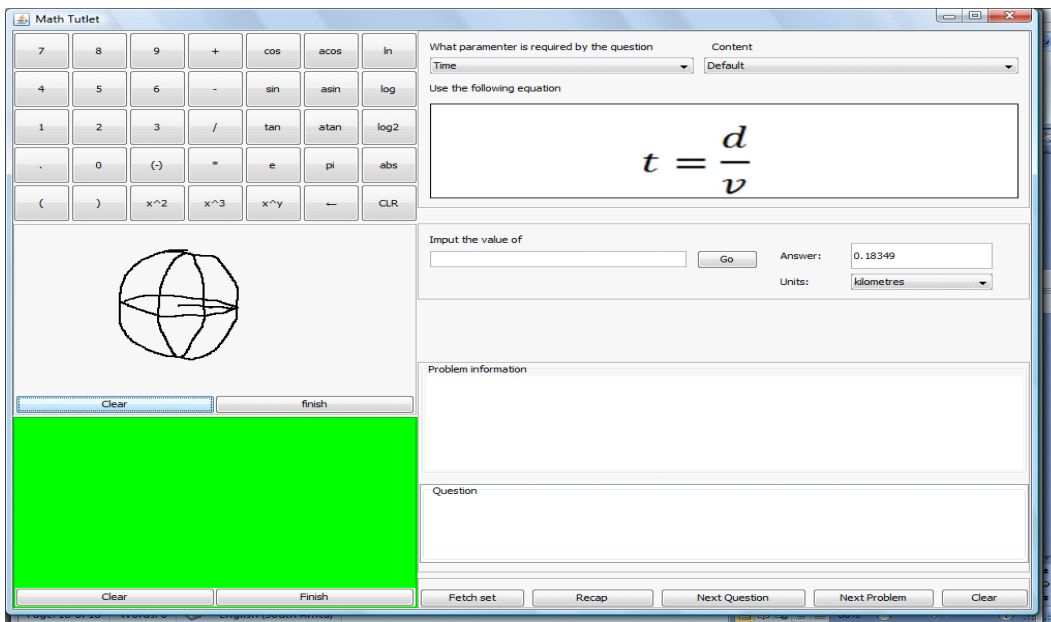
- Move the mouse towards the next point using the angle displayed.
- Click to insert the last point.
- A normal line is plotted.
- The two points remain connected and
- The first and last lines are connected automatically.
- Click on clear if there is any mistake or not drawn to satisfaction.



**Figure 16: Freehand sketch to connect three points**

To connect two or three points using freehand sketching, follow the procedure below.  
Use the mouse to perform a freehand sketch.

- Press and hold the mouse.
- While holding drag the mouse to draw the required sketch.



**Figure 17: Sketching lines of latitude and longitude on the globe**

## APPENDIX 7



Akintade Caleb Ayodele (49276441)  
College of Science, Engineering and Technology  
UNISA  
Johannesburg

2014-02-14

### Permission to conduct research project

Ref: 003/ACA/2014

The request for ethical approval for your PhD (Math/So/Tech. Ed) research project entitled "Effect of computer assisted instruction on students' achievement and attitude towards latitude and longitude in Ogun state, Nigeria" refers.

The College of Science, Engineering and Technology's (CSET) Research and Ethics Committee (CREC) has considered the relevant parts of the studies relating to the abovementioned research project and research methodology and is pleased to inform you that ethical clearance is granted for your study as set out in your proposal and application for ethical clearance.

Therefore, involved parties may also consider ethics approval as granted. However, the permission granted must not be misconstrued as constituting an instruction from the CSET Executive or the CSET CREC that sampled interviewees (if applicable) are compelled to take part in the research project. All interviewees retain their individual right to decide whether to participate or not.

We trust that the research will be undertaken in a manner that is respectful of the rights and integrity of those who volunteer to participate, as stipulated in the UNISA Research Ethics policy. The policy can be found at the following URL:

[http://om.unisa.ac.za/contents/departments/res\\_policies/docs/ResearchEthicsPolicy\\_approvCounc\\_21Sept07.pdf](http://om.unisa.ac.za/contents/departments/res_policies/docs/ResearchEthicsPolicy_approvCounc_21Sept07.pdf)

Please note that if you subsequently do a follow-up study that requires the use of a different research instrument, you will have to submit an addendum to this application, explaining the purpose of the follow-up study and attach the new instrument along with a comprehensive information document and consent form.

Yours sincerely

Chair: College of Science, Engineering and Technology Ethics Sub-Committee

University of South Africa  
College of Science, Engineering and Technology  
The Sunnyside Campus  
7/A, Christieside Way, Bedford and Pioneer Avenue,  
Florida Park, Rosebank  
P.O. Box 26, Hatfield, 1110  
www.unisa.ac.za/cset





# NAWAIR-UD-DEEN GRAMMAR SCHOOL

## SENIOR SECONDARY SCHOOL

P.O BOX 3049, OBANTOKO, ABEOKUTA.

Odeda Local Government Area

Our Ref:-

Your Ref:

Date: 30<sup>th</sup> April, 2013.

Mr. C.A. Akintade,  
Institute for Science and Technology Education,  
University of South Africa,  
Pretoria,  
South Africa.

Dear Sir,

### RE: REQUEST FOR LETTER OF CONSENT TO CARRY OUT RESEARCH WORK IN THE SCHOOL

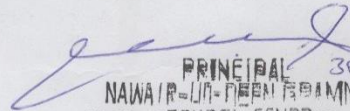
With reference to your letter dated 25<sup>th</sup> April, 2013 on the above subject, I wish to convey to you that the request has been granted.

You should however take the following conditions as your guide:

- (i) That your programme should be during the school official hours (i.e. 8.00a.m – 2.00p.m. Monday – Friday) every week.
- (ii) That the programme should not have any financial implication on either the students or the school and
- (iii) That the programme should be based purely on academics.

While wishing you success in your programme, I remain.

Yours faithfully,

  
PRINCIPAL 30/04/13  
NAWAIR-UD-DEEN GRAMMAR  
ALH. ABDUL-AZEEZ K.A.R.  
Principal, OBANTOKO, ABEOKUTA



**EGBA COMPREHENSIVE HIGH SCHOOL**  
(SENIOR SECTION)

Asero, Abeokuta  
P.M.B. 3051, Ibara, Abeokuta.  
Email: egbahighschoolabk@exite.com

6<sup>th</sup> May, 2013

Mr. C.A. Akintade,  
Institute for Science and Technology Education,  
University of South Africa,  
Pretoria, South Africa.

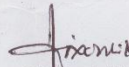
Dear Sir,

**Re: Request for Letter of Consent on Research Work**

I wish to inform you that your request for letter of consent to use some of the Senior Class One Students of Egba Comprehensive High School for your research work in Mathematics is hereby accepted but it must not affect the school Time-table.

Thanks.

Yours faithfully,

  
Dixon L.K. 6/5/13  
Principal  
EGBA COMPREHENSIVE HIGH SCHOOL  
(SENIOR SECTION) ABEOKUTA

# ASERO HIGH SCHOOL, SENIOR, ABEOKUTA.

P.M.B. 2048, SAPON, ABEOKUTA, OGUN STATE.



Our Ref: AHS/GEN/VOL. 6/49

Your Ref: \_\_\_\_\_

Date: 6th May, 2013

Mr. C.A. Akintade,  
Institute for Science and Technology  
Education,  
University of South Africa,  
Pretoria,  
South Africa.

Dear Sir/Ma,

RE - REQUEST FOR LETTER OF CONSENT

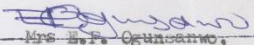
The school has accepted your request in making use of the Senior Class S.S. One students for your research work in Mathematics.

The period for the research should be in the morning between 7.00a.m. - 8.00a.m. before the commencement of the school work.

It will be appreciated, if the school programme is not disrupted by your complying strictly with the given time period.

Thank you.

Yours faithfully,

  
Mrs. M.P. Ogunbanwo,  
Vice Principal,  
VICE PRINCIPAL ACADEMIC  
ASERO HIGH SCHOOL  
(SENIOR) 6/5/13  
ASERO, ABEOKUTA



# SALWU ABIOLA

SENIOR SECONDARY SCHOOL

Institute for Science and Technology Education,  
University of South Africa  
Pretoria  
South Africa.

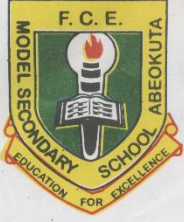
RE: Mr. C.A. Akintade

Permission to use School Facilities and Students

I hereby write to confirm that Mr. C.A. Akintade has been permitted to come and use the school for the conduct of the research intended, for the period of four weeks among science students.

Thanks.





## FEDERAL COLLEGE OF EDUCATION MODEL SECONDARY SCHOOL

P. M. B. 2096,  
Osiele, Abeokuta.  
Ogun State, Nigeria.  
☎ 039-241443

Our Ref: \_\_\_\_\_ Your Ref: \_\_\_\_\_ Date: 22-07-2013

Mr. C. A. Akintade,  
Institute of Science and Technology Education,  
University of South Africa,  
Pretoria, South Africa.

Dear Sir,

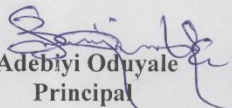
### RE: REQUEST FOR LETTER OF CONSENT

With reference to your letter referred to above, I hereby use this medium to convey the approval of the school to you. The school will assist you within its capability in making the exercise a resounding success. It is hoped that the school will be furnished with further detail (if there is any).

We wish you a successful academic endeavour and a safe return.

Thank you.

Yours faithfully,

  
Adebisi Oduyale  
Principal



## APPENDIX 8

### SOLUTIONS TO THE ATLL QUESTIONS IN THE EXPERIMENTAL CLASSES

#### Question 1

1. A boy walks 6Km from a point P, to a point Q, on a bearing of  $065^{\circ}$ . He then walks to a point R, a distance of 13Km, on a bearing of  $146^{\circ}$ .
- Sketch the diagram or the coordinate of his movement,
  - Calculate, correct to the nearest Kilometres, the distance PR.

#### Solution:

- (i) Sketch the diagram (ii) identify the line of latitude and longitude on the globe

$$a^2+b^2+c^2-bccosA$$

$$q^2=r^2+p^2-rpcosQ$$

$$q^2=205-156(-0.1564)$$

$$a=15.145\text{Km}$$

#### Question 2

A Plane flies due East from A ( $53^{\circ}\text{N}$ ,  $\text{long.}25^{\circ}\text{E}$ ) to a point (Lat. $53^{\circ}\text{N}$ , Long. $85^{\circ}\text{E}$ ) at an average Speed of 400Km/hr. The plane flies south from B to a point C 2000 km away. Calculate, correct to the nearest whole number. (Take  $\pi=22/7$ ;  $R=6400\text{km}$ )

- The distance between A. and B:
- The time the plane takes to reach point B
- The latitude of C.

#### Solution:

- Sketch the diagram
- identify the line of latitude and longitude on the globe

Distance between point A and point B =  $85-25(60^{\circ})$

Sped = D/T

Distance =  $400 \times 0.5$

=200Km

Speed= distance /time

$$400\text{km/hr}=200\text{km}/x$$

$$X=200/400$$

$$=0.5\text{hr}$$

### Question 3

An aircraft flies due South from an airfield on latitude  $36^{\circ}\text{N}$ , longitude  $138^{\circ}\text{E}$  to an airfield on latitude  $36^{\circ}\text{S}$ , longitude  $138^{\circ}\text{E}$

- (i) Calculate the distance travelled, correct to three significant figures.
- (ii) If the speed of the aircraft is 800km per hour, calculate the time taken, correct to the nearest hour. (Take  $\pi=22/7$ ;  $R=6400\text{km}$ )

### Solution:

- (i) Sketch the diagram
- (ii) identify the line of latitude and longitude on the globe

$$\begin{aligned}\text{Difference in latitude} &= 36+36 \\ &= 72^{\circ}\end{aligned}$$

$$r = R \cos \theta$$

$$= 6400 \times \cos 72$$

$$= 1977.6$$

$$\text{Distance} = \theta / 360 \times \pi r$$

$$2490(3\text{sf})$$

### Question 4

A ( $60^{\circ}\text{N}$ ,  $30^{\circ}\text{E}$ ) and B ( $60^{\circ}\text{N}$ ,  $42^{\circ}\text{W}$ ) are two towns on the surface of the Earth. Calculate correct to three significant figures, the:

- (i) Radius of the circle of latitude on which A and B lie;
- (ii) Distance on the Earth's surface between A and B along the circle of latitude.

### Solution:

- (i) Sketch the diagram
- (ii) identify the line of latitude and longitude

$$\text{Radius of the circle} = r \cos \alpha$$

$$r = 6400 \times 0.5$$

$$= 3200$$

Distance along the circle of Latitude

$$AB = 42 + 30 = 72$$

$$\text{Distance} = \theta / 360 \times \pi r$$

$$72 / 60 \times 4000$$

$$= 288000 / 360$$

$$800 \text{ Km}$$

### Question 5

An aero plane flies from a town P (lat.  $40^{\circ}\text{N}$ ,  $38^{\circ}\text{E}$ ) to another town Q (lat  $40^{\circ}\text{N}$ ,  $22^{\circ}\text{W}$ ).

It later flies to a third town T ( $28^{\circ}\text{N}$ ,  $22^{\circ}\text{W}$ ). Calculate the:

#### Solution:

(i) Sketch the diagram

(ii) identify the line of latitude and longitude

$$\text{Distance} = \theta / 360 \times \pi r$$

$$\alpha = 38 + 22 = 60$$

$$40 / 360 \times 40000 / 360$$

$$= 7555 \text{ Km}$$

## LANGUAGE EDITOR' S REPORT

### TO WHOM IT MAY CONCERN

This document confirms that I, Dr Jane E M Murray, am a qualified language editor and have edited the following doctoral thesis:

**Effect of computer assisted instruction on students' achievement and attitude towards latitude and longitude in Ogun State, Nigeria**

Submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Mathematics, Science and Technology Education, University of South Africa

Student: **Mr Caleb Ayodele Akintade**

Supervisor: **Prof. L D Mogari**

Co-supervisor: **Dr U I Ogbonnaya**

Editor: **Dr Jane E M Murray**

BA English: Unisa [cum laude]

MA English: Unisa [cum laude]

DLitt et Phil English: University of Johannesburg

Editing Principles and Practices: University of Pretoria [cum laude]

#### **Contact details**

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[jane@4with.co.za](mailto:jane@4with.co.za)

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#### paper text:

EFFECT OF COMPUTER ASSISTED INSTRUCTION ON STUDENTS' ACHIEVEMENT AND ATTITUDE

TOWARDS LATITUDE AND LONGITUDE IN OGUN STATE, NIGERIA by CALEB AYODELE AKINTADE

**2Submitted in accordance with the requirements for the degree of DOCTOR OF PHILOSOPHY IN MATHEMATICS, SCIENCE AND TECHNOLOGY EDUCATION in the subject MATHEMATICS EDUCATION at the UNIVERSITY OF SOUTH AFRICA Supervisor: Prof. L.D. Mogari**

Co-supervisor: Dr. U.I. Ogbonnaya September 2016 DECLARATION I, CALEB AYODELE AKINTADE, declare that the "Effect of computer assisted instruction on students' achievement and attitude towards Latitude and Longitude in Ogun State, Nigeria" is my original work, and has not been submitted for any degree or examination at any other university. All the sources used or quoted in the study are duly acknowledged by means of complete reference MR AKINTADE, CALEB AYODELE .....DATE

DEDICATION. The project is dedicated to my Creator and His Loving Son Jesus, who has preserved, sustained and kept me in the FAITH throughout my programme and enabled me to actualize my lifelong dream. All to you, and none of mine! iii ACKNOWLEDGEMENTS To God be the glory for great things He has done! Praise, honour and adoration are to His name above. Thank you Jesus for this great love and favour you have shown me. I express my

profound gratitude to my dear supervisor, Prof. David L. Mogari, who out his tight schedule took timeto painstakingly go through my thesis2 of 136 05-Apr-17 7:38 PMTurnitin Originality Report [https://www.turnitin.com/newreport\\_printview.asp?eq=1&eb=1&esm=...](https://www.turnitin.com/newreport_printview.asp?eq=1&eb=1&esm=...) word for word, page by page and chapter by chapter. I say a big thank you and my God grant your heart's desire in Jesus' name. I acknowledge the efforts of my co-supervisor, a "God sent brother" Dr Ugorji I.Ogbonnaya, whose support and encouragement saw this research work to a logical and conclusive end. You are a mentor, and God will reward your labours both here on earth and in heaven to come. I appreciate the role played by Prof. Harrison Atagana (former ISTE Head), Prof. Nosisi Feza (present ISTE Head), Prof. Kriek, Dr. C. Ochonogor, Ms Lamola Mathapelo (my younger sister), Eva and other members of staff from ISTE, may God bless you with His grace and abundant life. I want to express my appreciation to the following people who stood by me during my stay in Pretoria. Brother Oluwagbemi Joseph Olaotan (Pretorianson); Pastor and Sister M Kruger; Pastor and Sister Ochonogor; Brother and Sister Jide Adelowotan; Pastor Denis Agbebaku; Pastor (Dr) Peter Sesan Ayodeji; Sister Antoinette; my church members in Kwamlanga; Pretoria church members: Dr Segun Adeyefa; Dr. Faleye; Sister Ogbonnaya (my Pretoria mummy); Emmanuel (my big brother); Daddy and Mummy Desmond and many others. May God bless you.

The West African Examination Council (WAEC) Chief Examiners' reports on students' performance in mathematics have indicated that some topics (e.g. concepts of latitude **and longitude**) have posed **a major problem for students**4 at the senior secondary school level. **This** poor achievement of **students** in understanding the topic may be associated with the traditional "chalk and talk" method that teachers use in teaching the concept. Education reforms in recent years, have advocated for a student-centred method of teaching; a method8 that allows individual **student to work at his** own pace **or** in groups. Various researchers have encouraged the use of different forms of ICT, such as computer-assisted instruction (CAI), in the teaching of mathematics to improve students' learning of topics in mathematics perceived to be difficult. With all the efforts concentrated on improving students' performance in mathematics, no research studies have been conducted on the effectiveness of CAI on students' achievement and attitude towards the learning of the concepts of latitude and longitude in Nigerian secondary schools.

The study employed3 of 136 05-Apr-17 7:38 PMTurnitin Originality Report [https://www.turnitin.com/newreport\\_printview.asp?eq=1&eb=1&esm=...](https://www.turnitin.com/newreport_printview.asp?eq=1&eb=1&esm=...) **3pre-test, post-test non-equivalent control group, quasi-experimental design**

involving two groups: experimental group (162) and control group (158) research design to investigate the effect of the CAI method of teaching on 2nd year senior secondary school students' achievement and attitude to latitude and longitude. Instruments for the research study were Achievement test in latitude and longitude (ATLL); questionnaire on students' attitude to latitude and longitude (QSALL); semi-structured interview and class observations protocol. The instruments were validated, and found reliable via a pilot study before they were employed for the main study. **4 Data collected were analysed using both the descriptive and inferential statistics** to answer the research questions and to test the stated null hypotheses. Results showed a statistically significant difference in the post-test mean scores of the experimental and the control groups, whereas there was no statistically significant difference in the pre-test mean scores of these two groups. In addition, the results revealed non-significant difference between the mean scores of girls and boys in the post-test. Furthermore, there was no significant difference between science students' post-test mean scores and their counterparts in the arts and commercial classes, and there was no interactive effect related to treatment, gender and students' subject area in the post-test. Specifically, the knowledge in this study has added another dimension to everyday experiences of students in vi mathematics when the software was used to teach the perceived difficult topics, and **15 they were actively involved in the learning process** through the use of CAI techniques. The study concludes with recommendations for future research, because even though it is limited to Ogun State, it has potential for future research to be undertaken **1 by expanding its scope to cover many other states** in Nigeria. This study also recommends that efforts **7 be made to integrate the philosophy of** CAI to **the** teaching **curriculum** in Nigerian secondary schools. Furthermore, applications of the recommendations would be appropriate for the improvement to the teaching methodology of mathematics and other science-related subjects in Nigerian secondary schools. Key terms: Computer-assisted instruction, Traditional method, latitude and longitude, students, mathematics, senior secondary school, gender, achievement, attitude

LIST OF ABBREVIATIONS <sup>4</sup> of 136 05-Apr-17 7:38 PM Turnitin Originality Report [https://www.turnitin.com/newreport\\_printview.asp?eq=1&eb=1&esm=...](https://www.turnitin.com/newreport_printview.asp?eq=1&eb=1&esm=...)

**2 ANCOVA ..... Analysis of Covariance**

**ANOVA ..... Analysis of Variance**

CAI ..... Computer Assisted Instruction

CAIP ..... Computer Assisted Instruction Package

NRC ..... National Research Council

QSALL ..... Questionnaire on Students' Attitude to Latitude and Longitude



SSS ..... Senior Secondary School Students  
 TM ..... Traditional Methods  
 UTME ..... Unified Tertiary Matriculation Examination  
 WAEC ..... West Africa Examination Council  
 WASSCE ..... West African Senior Secondary School Certificate Examination

**7 Source: Test Development Division West African Examinations Council**

(WAEC, 2011– 2015), **Yaba, Lagos**. The results indicate that majority of the students failed to obtain a 50% pass in mathematics. For instance, in 2011, 1,587,630 candidates sat for the examination. Of these, only 540,250 representing 34.25 % obtained the 50% pass mark while the remaining 1,040,380 candidates, representing 65.75 % of the total, failed. In 2012, out of a total number of 1,768,923 students examined, 635,634 candidates representing 38.83% of the total failed to obtain a 50% pass. In 2014 out of 1,692,435 candidates examined, only 529,425 representing 31.28% passed with 50% while 1,163,010 representing 68.72% of the students failed to obtain a 50% pass in the subject. This trend has continued with little or no improvement in 2015. Out of the 1,593,442 candidates examined, only 616,370 (38.68%) passed at the 50% credit level while the remaining, 977,072 representing 61.32% candidates failed the subject (The Guardian Nigeria Newspapers, 2012; The Vanguard Newspapers, 2013; This Day Newspaper, August 11, 2015; WAEC, 2011-2015). In addition to students' poor performance in mathematics, the Chief Examiners' reports have also indicated that the concepts of **latitude and longitude** have posed **a major problem area for students**

**12 0 knowledge. Teaching for procedural knowledge, therefore, means that students are taught to solve a problem through the manipulation of mathematical skills such as procedures, rules, formulas, algorithms, and symbols that are used in mathematics.**

However, conceptual knowledge is **16 of 136 05-Apr-17 7:38 PM Turnitin Originality Report [https://www.turnitin.com/newreport\\_printview.asp?eq=1&eb=1&esm=...10](https://www.turnitin.com/newreport_printview.asp?eq=1&eb=1&esm=...10) characterized most clearly as knowledge that is rich in relationships** (Isleyen & Isik, 2003). Hence, conceptual knowledge provides the reason why the formulas work. For example, if a student knows why angle ranges from 0° at the equator to 90° at the North and South Poles of the earth is called latitude, and why longitude is referred to as a distance measured from 0° east and 180° west of the prime meridian, the student has then exhibited conceptual knowledge. Teaching for conceptual knowledge, therefore **10 means to teach students to understand mathematical concepts by making them able to interpret and apply rules and formulas correctly in a variety of situations, as well as to translate these concepts.**