**UNIVERSITY OF EDUCATION, WINNEBA**

# USING COMPUTER ASSISTED INSTRUCTION IN TEACHING AND LEARNING CO-ORDINATE GEOMETRY

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**MASTER OF PHILOSOPHY**

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# USING COMPUTER ASSISTED INSTRUCTION IN TEACHING AND LEARNING CO-ORDINATE GEOMETRY

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# DECLARATION

## STUDENT'S DECLARATION

I, Eric Sakyi, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

Signature......................................

Date..............................................

## SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of thesis as laid down by the University of Education, Winneba.

Name of Supervisor: **Professor Christopher Adjei Okpoti**

Supervisor's Signature................................................

Date.........................................................................

# DEDICATION

To my wife: Mrs Dorcas Sakyi.

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| | |
|---|---|
| UCC | University of Cape Coast |
| NCTM | National Council of Teachers of Mathematics |
| CAI | Computer-Assisted Instruction |
| CBI | Computer Based Instruction |
| CBL | Computer Based Learning |
| CEL | Computer Enhanced Learning |
| CAL | Computer Aided Learning |
| ZPD | Zone of Proximal Development |
| USDOE | United States Department of Education |
| TEPL | Technology-Enhanced Personalized Learning |

## ABSTRACT

This study was undertaken to find out the effect of using Maths Xerte Toolkits (Computer Assisted Instructions) on pre-service teachers' achievement in coordinate geometry, find out the perception of students towards the study of coordinate geometry using Maths Xerte Toolkits and to explore the students' interest in using Maths Xerte Toolkits in teaching and learning Coordinate Geometry. In all, 50 pre-service teachers were involved in the study. The study adopted a quasi-experimental research design. Semi – structured interviews, questionnaire as well as achievement test were the instruments used for data collection. The items in the questionnaire and achievement test were analyzed using statistical tools such as percentages, mean, standard deviation and the paired sample t-test from Excel 2016 Analysis Tools. The result indicated that there was a significant difference between pretest and post test scores. The questionnaire given to the participants to elicit their response on the perceptions of the impact of Xerte toolkits in teaching coordinate geometry revealed a positive response for the opportunities created for them to actively engage themselves as learners. The findings in this study posits that students' interest in using Maths Xerte Toolkits in teaching and learning Coordinate Geometry increased and they were ever ready to use Xerte again in their studies. To support interactivities in teaching and learning process, students must be encouraged to use the Xerte software on their phones and other computing devices in the college so as to arouse their interest in acquiring mathematical concepts.

# CHAPTER ONE

## INTRODUCTION

### 1.0 Overview

This chapter deals with the introductory section of the study which entails the background of the study, statement of the problem, the purpose of the study, the objective of the study, the research questions, hypotheses, the significance of the study, delimitation of the study and the organization of the study.

### 1.1 Background of the Study

The study of geometry contributes to helping students develop the skills of visualisation, critical thinking, intuition, perspective, problem-solving, conjecturing, deductive reasoning, logical argument and proof (Clement, 2001). Geometric representations can be used to help students make sense of other areas of mathematics. The Mathematics curriculum especially Geometry and Trigonometry of Colleges of Education provide pre-service teachers with a background in the theory and application of the content needed to understand the underlying structure and nature of Geometry in Mathematics (UCC, 2018).

In addition, it exposes pre-service teachers to the content knowledge needed in preparing them sufficiently to learn Geometry beyond what they will be expected to teach at the basic education level. Mathematics curriculum in the Colleges of Education is therefore, intended to equip pre-service teachers with the knowledge, skills and values needed to teach mathematics to basic school pupils in everyday life context. Besides, it provides the requisite resource material for preparing pre-service teachers to teach mathematics sufficiently and effectively in our basic schools (Jones, 2002).

Coordinate Geometry in Mathematics for colleges of Education is designed to consolidate and build on students' concepts and skills covered at the senior high school level (UCC, 2018). This includes distance between two points, midpoint of a line segment, length of a line segment, slope (gradient) of a line, equation of a straight line: joining two points; parallel and perpendicular to a given line through a given point; and bisector of a given line segment. There are many interesting, sometimes surprising or counter-intuitive results in geometry that can stimulate students to want to know more and to understand why (UCC, 2018).

Presenting geometry in a way that stimulates curiosity and encourages exploration can enhance student's learning and their attitudes towards mathematics. By encouraging students to discuss problems in geometry, articulate their ideas and develop clearly structured arguments to support their intuitions can lead to enhanced communication skills and recognition of the importance of proof (Jones, 2002).

According to the National Council of Teachers of Mathematics (NCTM, 2008), technology is an essential tool for learning mathematics and all schools must ensure that their students have access to technological innovations such as Instructional televisions, computers and other multimedia technologies. Efficient teaching maximizes the potential of multimedia technology to develop students' understanding, stimulate their interest, and increase their proficiency in mathematics. This is the basis on which this research is being carried out. Cradler, McNabb, Freeman and Burchett (2002) asserted that information and communication tools, as well as the right software can positively impart student learning process and achievement.

Clements (2001) opines that Geometry is a rich source of opportunities for developing notions of proof. It is worth emphasizing that visual images, particularly those, which can be manipulated on the computer screen, invite students to observe and conjecture generalizations. Proving conjectures requires students to understand how the observed images are related to one another and are linked to fundamental ‘building blocks’. To facilitate these learning outcomes, Computer-Assisted Instruction (CAI) is one of the multimedia instructions that has been empirically proven to enhance students’ performance, arouse their interest, and reduce the boring and abstract nature of mathematics (Adegoke, 2010; Gambari, 2010; Kuti, 2006; Mahmood, 2002).

Computer Assisted Instruction (CAI) has been reported to be one of the most effective instructional strategies for developing interest, positive attitude, promoting retention ability of the students and improving the achievements of students which encourages learners to learn devoid of rote learning (Gambari & Adeghenro, 2008; Osemmwinyen, 2009). Gonzalez and Birch (2000) claimed that computer-assisted instruction has the ability to promote active learning in a wide variety of disciplines from literature to the social sciences and beyond. Educators from several countries have expressed similar excitement about the use of computers and the possibilities that this tool can provide. Svensson (2000) conducted a great deal of research into the ability of computers to influence learning in three (3) schools, suggested that computers can influence learning in schools and lead educational practices toward more student-active learning, thus allowing students the ability to develop strategies for learning through interaction.

Beres (2011) points out that learners’ experience difficulties with content due to lack of motivation on the part of the learners to learn Mathematics. However, in order to change learners’ negative views of failure and hatred of Mathematics, it is the teacher’s responsibility to provide instruction and a learning environment that may motivate them (Mansukhani, 2010). Complementing this view point, Hlalele (2012) argues that the creation of conducive learning environment helps learners to feel successful.

There has been enormous investing of huge sums of money to develop, maintain, and upgrade computer labs and computer-assisted instruction (CAI) Mathematics software by colleges and universities. This has come as a result of instructional methodologies changing rapidly from traditional lecture formats in academia. Outside of academia, the push toward CAI originates from publishing houses and educational resource companies claiming to offer innovative and comprehensive solutions to the elementary college mathematics dilemma. As a promising instructional tool for enhancing student learning (Yu, 2001), the use of CAI to teach college mathematics will continue to grow.

In a study conducted by D'Souza (2005) on the effect of incorporating collaborative learning methods in a core first year Mathematics subject, learners pointed out that it was exciting and enjoyable to use computers in class. Therefore, CAI might arouse learners' interest, sustain, and motivate learners which will in turn improve Mathematics performance.

Literature had shown that the advancement of computer has brought great innovation and thus school teachers need to be competent in using computers so that they would maximize its use in teaching and learning (Kumar, Rose, & D'Silva, 2008). In addition, the use of ICT has to be integrated in Mathematics Curriculum in both formal and informal ways and not just make it as an extra component. By integrating ICT into their everyday teaching practice, teachers can provide creative opportunities for supporting students' learning and fostering the acquisition of mathematical knowledge and skills (Hohenwarter & Hohenwarter, 2009).

It seems that the effects of CAI in the teaching and learning of Mathematics is inconclusive with some studies indicating positive effects (Kulik, 2003; Hohenwarter & Hohenwarter, 2009), other studies showing no strong impact (Angrist & Lavy, 2002) and some studies finding negative effects (Spiezia, 2010; Campuzano, Dynarski, Agodini, & Rall, 2009) of using computer software. The mixed results may be caused by the complexity of the relationship between ICT and learning. Other reasons are the wide variety of assumptions that have been made by research studies and the fact that the impact of educational technology has been studied from different perspectives (e.g., pedagogical, sociological, computer sciences and economics), in different teaching and learning environments and using different methodologies. All of these make the findings of one study about the effectiveness of educational technology not generalizable beyond the teaching and learning context in which the study was performed.

Moreover, as remarked by some researchers (Slavin & Cheung, 2008; Cox & Marshall, 2007), a large majority of the past studies suffer from design flaws and methodological or conceptual weaknesses which raise doubt about the validity of their findings. It is based on these findings that the researcher wants to test whether there will be positive or negative effects on the use of CAI (Maths Xerte toolkits) in teaching and learning Coordinate Geometry.

### 1.2 Statement of the Problem

Poor Geometry performance by learners may be attributed to teaching methods that make learners have difficulty in understanding, which in turn leads to negative perception about the mathematics (Siyepu, 2013; Spaull, 2013). It seems Mathematics teachers find it difficult to vary their teaching strategies due to the problem of inadequate teaching and learning resources which affects the number of activities that a teacher can plan for a lesson. This might have made learners to develop negative perception for the study of mathematics. It is the teacher's responsibility to provide instructions and a learning environment that motivate learners (Mansukhani, 2010).

University of Cape Coast (UCC) Chief examiner's report on Geometry one (1) had indicated that most students perform poorly in Geometry due to the abstract nature of the subject (Institute of Education, University of Cape Coast, 2017). I agree with the assertion by National Council of Teachers of Mathematics (NCTM, 2008) that technology is an essential tool for learning mathematics in the 21st century, and all schools must ensure that their students have access to technological innovations such as Instructional televisions, computers and other multimedia technologies. Given this base, there is the need to explore other forms of interactivities in teaching and learning of mathematics, like the Maths Xerte toolkits in teaching and learning of Coordinate Geometry and also find the perception and interest of level 200 students of SDA College of Education.

### 1.3 Purpose of the Study

The purpose of the study is to find out the effect of using Maths Xerte Toolkits (Computer Assisted Instructions) on preservice teachers' achievement in coordinate geometry, find out the perception of students towards the study of coordinate geometry using Maths Xerte Toolkits and to explore the students' interest using Maths Xerte Toolkits in teaching and learning Coordinate Geometry in Mathematics in level 200 of SDA College of Education.

### 1.4 Objectives of the Study

The objectives of the study was to:

1. Examine the effect of Maths Xerte toolkits on the achievement of pre-service teachers on Coordinate geometry.

2. Find out the perception of pre-service teachers towards the study of coordinate geometry using Maths Xerte toolkits.
3. Explore pre-service teachers' interest in using Maths Xerte toolkits to teach coordinate geometry.

### 1.5 Research Questions

The study was directed by the following questions.

1. What is the effect of the use of Maths Xerte Toolkits as an instructional tool on pre-service teachers' achievement in Coordinate Geometry?
2. What is the perception of pre-service teachers towards the study of Coordinate Geometry?
3. How will the use of Maths Xerte Toolkits improve the interest of pre-service teachers in the study of coordinate Geometry?

### 1.6 Hypotheses

Research question one was supported by the following hypothesis

1. **$H_0$**: There is no significant difference between the means scores of the pretest and postests.
2. **$H_1$:** There is a significant difference between the means scores of the pretest and posttests.

### 1.7 Significance of the Study

1. This study will provide some insight into how Maths Xerte Toolkits influence students' achievement in Coordinate Geometry.
2. It will also provide students with practical activities which will enable them to acquire practical skills to solve problems involving Coordinate Geometry in Colleges of Education.

3. It will help students to sharpen their skills in manipulating the computer since students will have the opportunity to operate the computer.
4. The result will serve as a source of reference for other researchers who want to study the same or related problem.
5. It will contribute to the existing body of knowledge for policy makers, curriculum developers and Mathematics Teachers in the college of education.

### 1.8 Delimitation of the Study

The study was delimited to SDA College of Education located in Koforidua Asokore and also to only level 200 students. The study was also delimited to an aspect of Geometry one (1) course focusing on Coordinate Geometry.

### 1.9 Organisation of the Study

This study is organized into five chapters. The chapter one deals with introduction which comprises of the overview of the study, the background of the study and the statement of the problem. The purpose of the study, objectives, research questions that guided the study, and the hypothesis has also been outlined in the chapter one. The chapter one continues with the significance of the study and delimitations. The chapter one ends with the organization of the study. Chapter two deals with the review of related literature. The methodology and the research design as well as the data collection and analysis constitute chapter three of this research work. The chapter four brought to light the results gathered and discussions of the findings. The chapter five which is the last chapter touches on the conclusions, summary, recommendations, limitations and suggested areas for further research.

### 1.10 Definition of Terms

**Computer Assisted Instruction:** Computer-assisted instruction **(CAI)** is an interactive instructional technique whereby a computer is used to present the instructional material and monitor the learning that takes place. CAI uses a combination of text, graphics, sound and video in enhancing the learning process.

**Maths Xerte Toolkits** is an open-source suite interactive content authoring tool that allows you bring together different types of material in order to present information on a topic. You can include text, images, video, audio as well as embed web pages or web widgets and you can add activities which allow the viewer to interact with the content.

**Mathematics curriculum** is the plan for the experiences that learners will encounter, as well as the actual experiences they do encounter, that are designed to help them reach specified mathematics objectives.

**Pre-Service Teachers** An individual or student in a teacher education program receiving training and supervision to obtain certification to teach in the education system.

***Andragogy*** is the art and science of helping adults learn.

# CHAPTER TWO

## LITERATURE REVIEW

### 2.0 Overview

The review of literature focused on work done by researchers in related fields. The topical issues reviewed in this literature include theories behind the study, concept of using Computer Assisted Instruction (CAI) in schools and colleges, impact of Computer Assisted Instruction, Students and Pre-Service Teachers' Perception Towards the Use of Computer-Assisted Instruction in Teaching and Learning, and Students' Interest in the Use of CAI in the Study of Coordinate Geometry.

### 2.1 Theoretical Framework

The theory underlying Computer Assisted Instruction in Coordinate Geometry are many but this study will review the four major theories which are as follows: Theory of Andragogy, Behaviourist learning theory, Cognitivist learning theory and Constructivist learning theory.

### 2.1.1 Theory of Andragogy

Knowles (1980) opine that the theory of *andragogy* is the art and science of helping adults learn. The word Andragogy is derived from the Greek root *agogus* meaning "leading." "*Andra*" translates as the word *adult*, which makes andragogy the art and science of teaching/leading adults.

In this art and science of learning there will be an interest in the individual learner that incorporates unique culture and various ways of learning. Zmeyov (1998, p.106) also define andragogy as the theory of adult learning that sets out the "scientific fundamentals of the activities of learners and teachers in planning, realizing, evaluating, and correcting adult learning.” Andragogy can be referred to as student centered education where the student/learner is placed at the centre of the teaching and learning process. Andragogy also provides a set of assumptions for designing instruction with learners who are more self-directed than teacher-directed (Birzer, 2004; Conner, 2004). An instructor using andragogical principles focuses more on being a facilitator of learning instead of being a transmitter of knowledge and evaluator. Andragogy had been used as a term in Europe for years to identify education with adults (Merriam and Caffarella, 1999). Since most educators are familiar with pedagogy, Knowles defined andragogy in contrast with pedagogy. He lists several hallmarks of andragogy: the learner is self-directed, the vast experiences of an adult adds to knowledge, the learner is at a stage in life where he/she is ready to learn, adult learning is problem centered, and the adult is internally motivated (Knowles, 1985).

In addition, Knowles (1980) feels the facilitator of adult learning should create a climate conducive to learning, the learner will actively participate in every phase of this process, and that each learner would have a learning contract to carry out the process (Merriam & Caffarella, 1999). The facilitator will encourage participatory activities from learners so that one's unique situation and understanding can be incorporated into the learning process. According to Knowles (1980), the goal of adult education should be self-actualization; thus, the learning process should involve the whole emotional, psychological, and intellectual being. The mission of adult educators is to assist adults to develop their full potential, and andragogy is the teaching methodology used to achieve this end. In Knowles’ view, the teacher is a facilitator who aids adults to become self-directed learners (Darkenwald & Merriam, 1982). Andragogy's informality allows the learners to be involved in their own learning experience as well as helping to set the parameters of the experience. Goldberger, et al., (1995) state that the adult educator must move beyond the family and focus on the social, economic, and political system of the world of the learner.

Andragogy emerged in the 1800s and then grew in popularity from 1960 to 2000 when Malcolm Knowles began to synthesize the concept. Alexander Knapp developed the term Andragogy while trying to describe the practice Plato exerted when instructing his pupils who were young adults (Knapp, 1833). The term disappeared until around 1921 when Eugen Rosenback revived it at a Frankfurt conference (Forrest III & Peterson, 2006). As the number of adults who began to return to academia in the early 1920s increased, the concept of adult education became more popular. Two streams of inquiry in the early 1920s developed around adult education. First, the psychological perspective based on the psychologist Edward Thorndike's approach to adult capacity and ability to learn. Second, the social perspective based on the educator Eduard Lindeman's more applied setting of formal adult education (Cartor, 1990). Thorndike tried to inform educators how human nature and human variation impacted the way individuals learned (Thorndike, 1973; Thorndike, Bregman, Tilton, & Woodyard, 1928). Knowles' writings on andragogy and adult learning transformed and energized the profession. It gave adult education a brand name and provided the community something new to discuss. The general criticism of andragogy is that it lacks the fundamental characteristics of a science because of the limited empirical evidence produced (Merriam, Caffarella, & Baumgartner, 2007; Pratt, 1993; Rachal, 2002).

Although Knowles' definition of andragogy focuses on the teacher's role, his andragogical theory is based on characteristics of the adult learner. Knowles summarized six key assumptions about adult learners, which are the foundation of adult learning. Those assumptions are as follows:

*Self-concept*: As a person matures, his/her self-concept moves from one of being a dependent personality towards one of being self-directed. Adults tend to resist situations in which they feel that others are imposing their wills on them.

*Experience*: As a person matures, he/she accumulates a growing reservoir of experience that becomes a resource for learning. Adults tend to come into adult education with a vast amount of prior experiences compared to that of children. If those prior experiences can be used, they become the richest resource available.

*Readiness to learn*: As a person matures, his/her readiness to learn becomes oriented to the development task of his/her social roles. Readiness to learn is dependent on an appreciation of the relevancy of the topic to the student.

*Orientation to learn*: As a person matures, his/her time perspective changes from one of postponed application of knowledge to immediacy of application, and accordingly his/her orientation towards learning shifts from one of subject centeredness to one of problem-centeredness. Adults are motivated to learn to the extent in which they perceive that the knowledge in which they are acquiring will help them perform a task or solve a problem that they may be facing in real life.

*Motivation to learn*: Internal motivation is key as a person matures. Although adults feel the pressure of external events, they are mostly driven by internal motivation and the desire for self esteem and goal attainment.

*The need to know*: Adults need to know the reason for learning something. In adult learning, the first task of the teacher is to help the learner become aware of the need to know. When adults undertake learning something they deem valuable, they will invest a considerable amount of resources (e.g., time and energy). (Forrest III & Peterson, 2006; Kidd, 1973; Knowles, 1984a, 1984b; Knowles et al., 1998; Lindeman, 1926; Ozuah, 2005; Thompson & Deis, 2004)

According to Darkenwald and Merriam (1982), these assumptions epitomize much that is important about adult learning and development. The first two assumptions (that adults are independent beings and have forged their identities from unique personal experiences) are drawn from humanistic philosophy and psychology. The last two assumptions (dealing with an adult's readiness to learn) help us understand adult learning from a psychosocial development perspective. These assumptions, when combined with principles related to the learning process, can offer the adult educator an understanding of the interrelationship between adulthood and learning.

Malcolm Knowles' principles of andragogy have been at the core of adult learning since the theory was put forward over 30 years ago. In that time, both strong detractors and strong supporters have emerged. Detractors often point out the inconsistencies in the model (e.g. Hartree, 1984) as a problem, while supporters recount the utility of the model as an overriding virtue. Knowles discusses andragogy in the context of psychological theory (Knowles, Holton & Swanson, 1998) but relies on older theories, such as ones from Abraham Maslow, Kurt Lewin and B.F. Skinner. Using these models as anchors fuels the detractors from the post-modern camp that claim that Knowles' model is an artifact from a mechanistic intellectual frame (e.g. Grace, 1996). Connecting andragogy to more recent psychological theories can resolve this concern. Recent research in psychology has by necessity been developed with a certain resistance to post-modern critiques. Several factors contribute to this: thorough subject selection to avoid confounding results with race, age, gender or socioeconomic factors; an understanding of the post-modern principles of dialectic discourse and sometimes an application of those principles in development of theory; and a greater reliance on empirical research aided by more sophisticated statistics which enable difficult concepts to be analyzed. Although not making the research immune to criticism, these factors improve the robust nature of more recent psychological findings. Andragogy, with its focus on the individual and a concern about learning, teaching and adult development has many parallels with psychology. These parallels need to be narrowed down in order to discern which theory is relevant. Because andragogy is concerned about learning, cognitive psychology is a relevant field. Given that the context of andragogy is the relationship between a learner and an educator, social psychological theories are relevant. The significance of adult learning contrasted with child- and adolescent learning makes developmental psychology relevant. However, one track of psychological research seems extremely pertinent to the andragogical model.

Adult learn to implement to meet their daily needs and for the future use. How adults learn differ from children and that is how come the use of andragogical approach underpin the study. In designing and using the Computer Assisted Instruction (CAI) using Maths Xerte Toolkits for coordinate Geometry for the college students, the researcher takes into account the readiness of the students to learn at their own pace using the computer and or the internet as a tool to facilitate the learning. Since the learners are adult, they are internally ready to learn at their own. The researcher creates the instruction in a manner that will enable the teacher trainees (adult learners) be independent as well as individualised their learning. This can be achieved as the learner is placed at the centre of the teaching and learning process which benefits learners who are more self-directed and can learn at their own time without supervision or a little guidance.

In addition, the researcher draws from theory of andragogy by Alexander Knapp in 1833 which was revived by Eugen Rosenback in 1921 and Edward Thorndike, the adult learners have a lot of learning experiences from real life situations so if teachers or instructors serve as guides or facilitators of learning instead of being a transmitter of knowledge and evaluator as been asserted by Merriam and cafferella it will help the adult learner learn at their own convenience of which the Maths Xerte Tool will address that. Owing to this, the Computer Assisted Instruction (Maths Xerte Tool) in Coordinate Geometry will be more flexible so that the adult learner will learn at their own pace and time. In this regard, the researcher will use the computer to create a conducive learning environment which will allow the adult learner take active part in every phase of the learning process. This will encourage participatory activities from learners to enable one's unique situation and understanding be incorporated into the learning process which will help the adult learner develop their full potential.

### 2.1.2 Behaviourist Learning Theory

In the behaviorist theory, it is believed that everything can be taught, and learning is a result of teaching that conveys information for student understanding (Skinner, 1958). The behaviourist theory which is considered the most influential on the development of educational technology is the theory of operant conditioning by Skinner with the concept of stimulus-response and reinforcement factors (Heinich & Robert, 1996, Kemp & Dayton, 1985). The fundamental learning principles of Skinner's theory are personalized instruction, controlled operant, immediate feedback, linear sequence of learning, and instructional prompts (Shlechter, 1991). As such, a teacher's role becomes one that provides or assigns essential instruction and support for students to comprehend required information. Behaviorist approaches to learning have been mainstays throughout the history of education, and they support the logistics of delivering specific and sequential standards-based information to students. Several educational practices can be traced to the behavioral type of learning.

The systematic design of instruction, behavioral objectives, notions of the instructor's accountability, programmed instruction, computer-assisted instruction, and competency-based education are all solidly grounded in behavioral learning theory. The concept of behavioral objectives continues to serve as a method for defining the content of instruction. Adult technical and skills training also draws from behaviorism. A behaviorist approach to learning can lend itself to what is known as a *teacher centered* approach; an approach in which the teacher is a classroom leader who directs student learning by imparting expert knowledge through teaching and assigning specific lessons or activities (Edglossary.org, 2014). Wells and Hagman (1989) have demonstrated that objectives have a positive effect on learning at the individual level. In the 1960's and 1970's, as behavioristic learning theory was peaking in its influence on training research and practice, learning theorists were becoming less satisfied with behavioral conceptions of learning and memory and increasingly interested in the study of internal knowledge structures and cognitive processes that underlie task performance (Bosco & Morrison, 2000). The positive effects of behavioral objectives and the learning process are now discussed in cognitive rather than behavioral terms.

With the behaviourist learning theory, the concept of stimulus-response and reinforcement factors by Skinner will be employed which will enable the researcher add the fundamental principles of the theory in the learning package or software. These principles are immediate feedback which the learning package or software will provide, all the necessary information on Coordinate Geometry will be provided in a linear sequence in the learning package. The systematic design of instruction, behavioral objectives, notions of the instructor's accountability, programmed instruction, computer-assisted instruction (Xerte toolkits), and competency-based education are all solidly grounded in behavioral learning theory which the learning package for

Coordinate Geometry in Colleges of Education will employ. This will help the adult learners have in their custody all the necessary information they will need to explore the Xerte Tool and solve problems related to Coordinate Geometry.

### 2.1.3 Cognitivist Learning Theory

Cognitive learning theory is to be used to supplement deficiencies in behaviourist learning theory, because the cognitive learning theory believe that experience is always structured and that we react to a complex pattern of stimuli but not a simple connection of responses to stimuli as proposed by the behaviourist. The learner perceives stimuli in organized wholes, not in disconnected parts. The learner organizes his/her perceptual field according to four laws: the law of proximity, the law of similarity and familiarity, the law of closure, and the law of continuation. Perception, insight and meaning are key contributions to cognitivism. (Merriam & Caffarella, 1999). According Heinich, (1996). Cognitive learning theory is a gradual process in the brain to the acceptance of the material in accordance with learners and learner abilities. A major difference between cognitivists and behaviorists is the locus of control over the learning activity. Cognitivists lies with the individual learner and behaviorists lies with the environment. The shift to the individual and the learner's mental processes is characteristic of cognitivist learning theories. Most contemporary cognitive psychologists hold that learning consists of individual constructions of knowledge. Learning is a personal event that results from sustained and meaningful engagement with one's environment (Bruner, 1961, 1985, 1986).

According to Lewin (1951), learning occurs as a result of a change in cognitive structures produced by changes in two types of forces: change in the structure of the cognitive field itself, or change in the internal needs or motivation of the individual.

Piaget and Bruner focused on the cognition and theory of instruction, which had an impact on learning theories. Piaget (1972) conceptualized behavior of the human organism as starting with the organization of sensory-motor reactions and becoming more intelligent as coordination between reactions to objects becomes progressively more interrelated and complex. A basic assumption of Piaget's theory is that a different type of assimilation and accommodation occurs at each stage of development (Flavell, 1968).

A person must wait until the final stage of development, the formal operational stage, to develop the cognitive structures necessary for dealing with abstract environmental relationships (Shlechter, 1991). Thinking becomes possible after language develops and a new mental organization is created. Piaget's theory of cognitive development influenced many CBI designers. Papert (1980), who helped design the LOGO system (a programming language for children), was greatly influenced by Piaget's theory. While basically agreeing with Piaget about the assimilation and accommodation process, Papert (1980) argues that cognitive development can be expedited by providing the student more formal operational experiences. A student can acquire these needed experiences by programming a computer with the LOGO authoring language (Papert, 1980).

Using and combining different commands to form a coherent computer graphic and debugging a program are examples of formal operational experiences. The cognitive influence became more prevalent as computer technology became more sophisticated (Shlechter, 1991). Bruner's (Knowles, 1984) interest was in the structuring and sequencing of knowledge and translating this into a theory of instruction. He did, however, have a basic theory about the act of learning which he viewed as involving three almost simultaneous processes: acquisition of new information, transformation or manipulating knowledge to make it fit new tasks, and evaluation to see if information is adequate to the task. Bosco & Morrison (2000) reported that cognitive theory is now the dominant theoretical viewpoint in research on learning and memory resulting in two notable trends: the greater use of mental constructs to define task requirements, through the cognitive task analysis method, and the greater willingness to devise training interventions for mentally demanding tasks. This approach offers a predictable system that many teachers appreciate for its creation of order around a central well-defined teacher role (Christenson, 2008). This process is a way the brain constructs information into the learner's memory recall. The final direct learning theory is proposed by Gagne (1985) who produced a 9 step plan of action for teachers. This proposal includes the following issues educators need to consider:

1. *Gaining attention*
2. *Informing learners of objective*
3. *Stimulating recall of prerequisite learning*
4. *Presenting new material*
5. *Providing guidance*
6. *Eliciting performance*
7. *Providing feedback*
8. *Assessing performance*
9. *Enhancing retention and recall*

Changing the focus away from directed learning theories, the focus will now pay attention to Inquiry-Based or Constructivist views. Inquiry Based learning has been considered by Roblyer and Doering, (2010, p.42) they make the following suggestion to including computers in progressive education:

- *Concepts to be learned are abstract and complex; teachers feel that hands-on, visual activities are essential to help students see how concepts apply to real-world problems and issues*
- *Teachers want to encourage collaboration and / or allow alternative ways of learning and showing competence.*
- *There is time to allow unstructured exploration to motivate students and help them discover their own interests.*

Since learning experiences are always structured and that learners react to a complex pattern of stimuli but not a simple connection of responses, it important for the learner to perceive stimuli in organized whole not in disconnected parts. Due this, the learners will engage in the learning package (Xerte tool) through gradual process in the brain to accept the learning materials in the Computer Assisted Instruction (Xerte tool) according to their abilities. To meaningfully engage and sustain the learners in the computer Assisted Instruction using the Xerte tool, individual learning will be employed since learning is a personal event as asserted by Bruner 1961. The cognitive theory have three basic theories which are acquisition of new information, transformation or manipulation knowledge and evaluation to see if information is adequate. The learning package CAI (Xerte tool) will have all these three embedded in the design for learners to acquire new information, transform the information to solve real life situation and to evaluate the information.

### 2.1.4 Constructivist Learning Theory

Constructivism is based on a firm knowledge base of learning theory derived from cognitive psychology (Hausfather, 1996). The nature of constructivism theory is the idea that learners must construct their own knowledge. According to the constructivist theory, knowledge is being actively constructed by the individual and knowing is an adaptive process which organizes the individual's experiential world. Hence, the learner is not considered as a controlled respondent to stimuli as in the behaviourist rubric but as "already a scientist" who actively constructs knowing while striving to make sense of the world on the basis of personal filters: experiences, goals, curiosities and beliefs. Leinhardt has synthesized the cognitive research that supports constructivism and summarized the implications around three fundamental aspects: multiple forms of knowledge, the role of prior knowledge, and the social nature of knowledge and its acquisition. Constructivist theory of learning look continuously checking new information against old rules and improve the rules. Knowledge for constructivism cannot be imposed or transferred intact from the mind of one knower to the mind of another. In this philosophy learners construct knowledge themselves and the learning process is characterized by placing a high responsibility into the hands of the learner instead of the teacher. (Leinhardt, 1992). Learners construct their own knowledge through experiences gained by observing, exploring and performing in the real world. The constructivist approach to education centers on this claim. Essentially, through student-centered instruction, students are able to explore content as teachers act as guides to support learning (Peters, 2010). A variety of tools can support the learner to construct his or her own knowledge in a way that leads to more efficient learning, provides motivation and facilitates innovation. Vygotsky's social constructivism also supports the use of tools, which through scaffolding and providing directed pointers can "enrich and broaden both the scope of activity and the scope of thinking of the learner. Given all of the advances in technology, the personal computer has become a versatile tool through which one can gain a wide variety of learning experiences (Vygotsky, 1978). The integration of simulations, graphics and animation enables users to experience and witness processes and procedures that might not otherwise be readily observable. This makes computer a powerful tool for learning.

This view has deep involvement in teaching, advocating a more active role for learners in their own learning compared to what is currently implemented on the majority class. With constructivist learning, learning is not focused on the teacher or teachers, constructivist help learners internalize and transform new information. The constructivist view, which girds the work of John Dewey, Lev Vygotsky and Maria Montessori, holds that teachers should be facilitators who help students to construct their own understanding and capabilities on carrying out challenging tasks. This view puts the emphasis on the activity of the student rather than of the teacher. Teachers are supposed to develop or provide different teaching materials and strategies for different learners based upon the concept of individualized teaching according to the student's ability. If the teaching method can meet a learner's specific learning style, then it will facilitate his achievement. Computer technology has the potential to provide specific activity based better learning environment.

Vygotsky offers a theory which says that the potential for cognitive development is limited to a certain range and unique for each individual learning. Theory known as the "zone of proximal development/ZPD" can be defined as the range between the actual developmental level of intelligence (without guided instruction) and a potential intelligence (determined by problem solving abilities under the guidance of assistants or more capable peers). The zone of proximal development embodies a concept of readiness to learn that emphasizes upper levels of competence. These upper boundaries are not immutable, however, but constantly changing with the learner's increasing independent competence. What a child can perform today with assistance she will be able to perform tomorrow independently, thus preparing her for entry into a new and more demanding collaboration. These functions could be called the "buds," rather than the fruits of development. The actual developmental level characterizes mental development retrospectively, while the zone of proximal development characterizes mental development prospectively (Vygotsky, 1978:86– 87).

Constructivist theory is grounded in the works of John Dewey, Lev Vygotsky and Maria Montessori who asserted that teachers should be facilitators in order to assist learners construct their own knowledge and understanding. This means that using Maths Xerte tools or application to design Computer Assisted Instruction in Coordinate Geometry will provide or develop different learning materials and strategies to support learners to manipulate and construct their own knowledge. Learners will use the computer assisted instruction (Maths Xerte toolkits) to construct their own knowledge through the use of inquiry or problem solving approach. Learners will be given the learning platform to manipulate, search for the necessary information and solve problems therefore making them to create multiple forms of knowledge and gaining deeper knowledge into Coordinate Geometry using the Maths Xerte Toolkits. The integration of Audio, video, graphics, animations and text in the Maths Xerte Toolkits enable learners to experience, manipulate and witness processes and procedures that might not be readily observable in the normal classroom interaction. This has a more active role for learners in their own as compare to the normal face to face interaction in the classroom. Learners will have the opportunity to move to any aspect of the Coordinate Geometry in the learning package without restrictions, this will enforce individual learning since the rate of absorption differs from individuals.

Maths Xerte Toolkits software is flexible enough so that students can create mental models and images for themselves, something that is emotionally and intellectually stimulating. Maths Xerte Toolkits can allow students to work out their own learning strategies, develop different learning styles, express themselves and not only demonstrate, but also use their new knowledge in many different ways. This also facilitates constructivist practices by providing a medium for discovery and exploring larger worlds and giving students autonomy in using knowledge. Computer Assisted Instructions are an appropriate medium to support active, interactive, and self-directed learning.

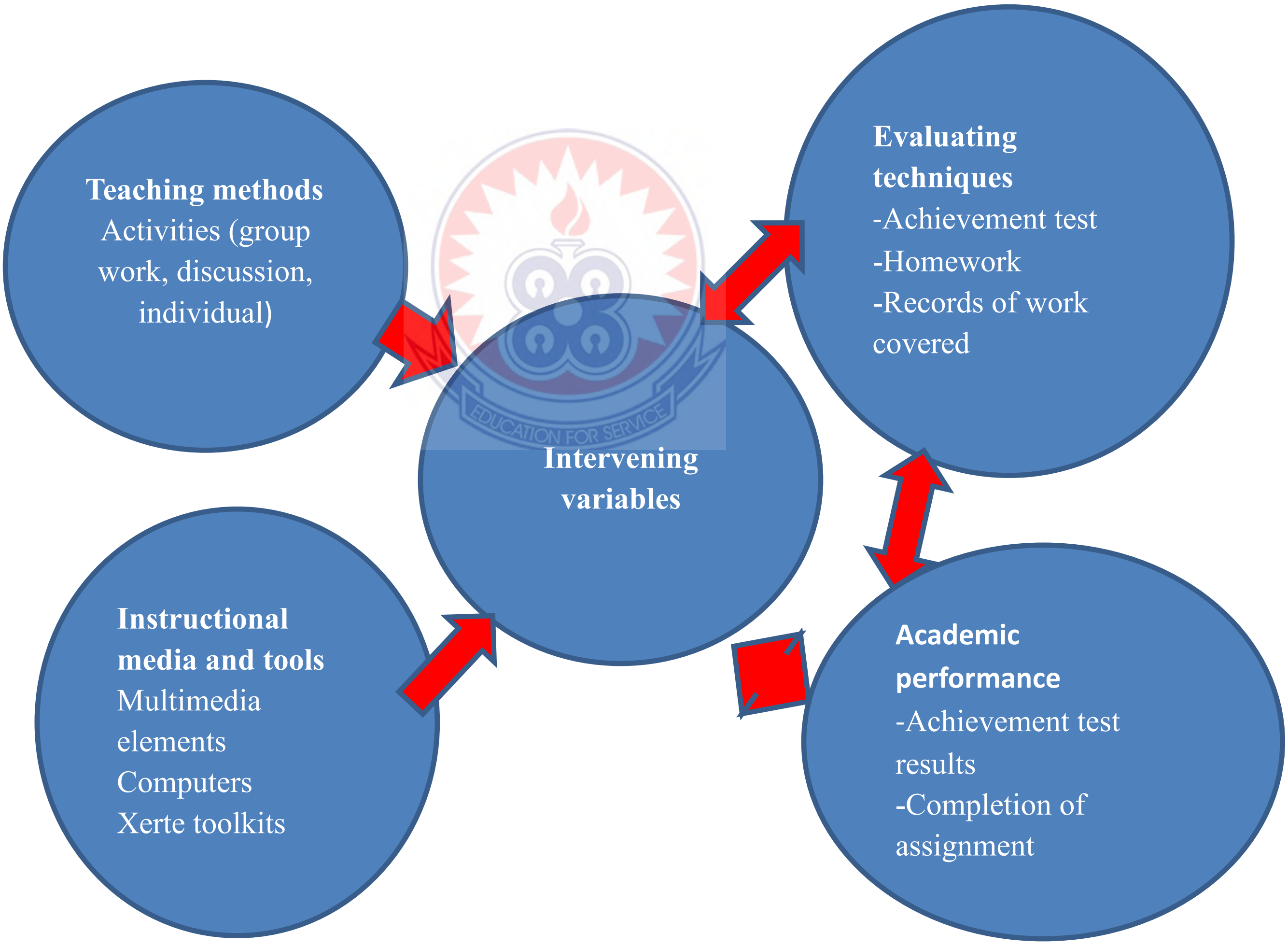
## 2.2 Conceptual Framework

In this conceptual framework, it is conceptualized that students concept acquisition is influenced by instructional media used in the classroom. The independent variable is the use of Maths Xerte Toolkit as CAI whereas the dependent variable is students' concept acquisition of Coordinate Geometry. In this research Xerte tool was used to develop the CAI using all the multimedia elements (text, images, audio and video) and computers. There are also intervening variables caused by theory of Andragogy, Behaviourist, Cognitivist and Constructivist that affect the relationship between independent and dependent variables in the study.

Teachers' instructional methods are used to determine the teaching and learning process of a student: for instance, the use of activities such as group work, discussion and individual work help the students to acquire the concept of coordinate Geometry. This is because an instructional method is a regular and systematic way of facilitating learning. The availability of instructional media and tools also plays a role in a student's learning process. Instructional media and tools such as computers, text, pictures, audio, video, animations, books, writing materials among others are part of the school-required resources that determines the teaching and learning process of students.

Evaluation enables the teacher to know the performance of a student after a period of instruction in order to decide whether he has attained the desired behavioural change or not. Evaluation is a vital activity of instruction because it is a way of observing, collecting of information and making decisions based on that information. The use of examples, test, quizzes, illustration, homework, project work, classwork helped the students to understand the concept acquisition of Coordinate Geometry and also helped the research to support those who were struggling to grasp the concept.

The conceptual framework has been summarized in Figure below:




**Source: Arthur's Construct**

**Figure 2.1: Summary of conceptual framework**

## 2.3 Using Computer Assisted Instruction (CAI) In Schools and Colleges

In Teacher Colleges of Education in Ghana, the teaching and learning process is generally characterized by the traditional lecture, in which the teacher explains to the student rules, principles and concepts. There is a general conviction that this traditional way of expository teaching is not optimal for teaching and training students that the market requires and who need deep, flexible and transferable knowledge. The rapid advances in technology, the need for lifelong learning, and the growth of non-traditional students have encouraged the use of the computer as a means of instructional delivery. This has led to new pedagogical and andragogical philosophies in which the Internet and computer technology are reported to have significantly changed the education landscape (Johnson & Aragon, 2002).

The National Education Technology Plan put out by the United States Department of Education (USDOE) in 2010 makes it clear in their report that technology is a key component of effective teaching methods. Some of the advantages for using the computer as a method of instructional delivery are that it: provides consistency of content delivery; provides training to remote locations; eliminates cost associated with employees' travel; provides means of tracking learner's progress; provides standardized testing; offers learner flexibility in controlling and pacing learning; provides for diverse learning needs; provides opportunities for practice through simulation; provides greater retention and reduces the instructional time by approximately 30 percent. Technology has quickly outpaced the theory that supports its effectiveness, and the application of technology has surpassed the evaluation of that technology. There is no body of research that meaningfully unites training objectives, training content, instructional style, and distance learning media (Wisher & Champagne, 2000). Crawford and Suchan (1996) drew a similar conclusion in their call for systematic selection of "instructional media for specific learning applications that place priority on the desired learning outcome and the media required to support the instructional techniques to attain that outcome"(p. 36). There is a great edge to create personalized learning pathways for every student. This initiative has encouraged placing more advanced technology into classrooms (Bellanca & Brandt, 2010; Silva, 2009). This advanced technology includes computer-adaptive and analytic tools that develop and affect student learning by tracking student response data and adjusting the content, pace, and trajectory of lesson sequences.

Anrig (2013) asserted that effective technology use hinges upon student-teacher relationships because technology should be used in these directions; for greater collaboration, communication, and problem-solving. According to Linke (2013), the borders and connections between humans and technology continue to narrow and point to a relevant starting point of further investigation. Student-teacher relationships have a great impact on teacher philosophy, instructional style and on student performance. (Finn, 1993; Hamre & Pianta, 2006; Marks, 2000); also believe that exploration of student-teacher relationship as it relates to educational technology needs further research. According to (Evans, Harkins, & Young, 2008), Since much of the mounting education technology research is on the effectiveness of blended learning and how, in some cases, the results point toward student gains, it is important to consider how educational technology use is affecting relationships within the classroom.

Redding (2013) suggests that a healthy classroom culture is a foundation on which students' feel a sense of belonging, a sense of being in a good place with good people. With a push for individualization, teachers cannot lose sight of the benefits of attachment to a group and interactions with other students in a whole-class environment, led by a skilled teacher. As Noddings (2015) postulates, "The main aim of education should be to produce competent, caring, loving, and lovable people" (p. 174). If Nodding's statement is understood to be a moral aim for education, then it deserves attention in an educational landscape with increasing numbers of automated and faceless learning encounters. Positive student-teacher relationships are undoubtedly important to the academic, social, and emotional well-being of students (Birch & Ladd, 1997; Carlisle, 2011: Hamre & Pianta, 2001). It is important to understand if CAI programs, with student progress updates, suggestions, and accompanying restructured teacher role, strengthen student-teacher relationships with better information and more one-to-one student-teacher interaction. It is equally important to understand how the use of these programs affects the social aspects of learning and the ways in which teacher and students can communicate and interact within the learning environment. Classroom environment, sometimes referred to as classroom climate or learning environment, can be broadly defined as the quality of the setting in which students learn. It is a dynamic state comprised of many interconnected and substantial components including physical, organizational, and social variables (Adelman & Taylor, 2005). The environment of a classroom can fluctuate over time ranging from dysfunctional to supportive, and a supportive or positive classroom environment is fundamental to effective education in schools (Adelman & Taylor, 2005). It is well documented that classroom environment influences student achievement (Thapa et al., 2013). Classroom environment has been shown to affect student learning, behavior, self-efficacy, engagement, and socio-emotional health (Fraser, 1998; Freiberg, 1999).

The use of Khan Academy in elementary and middle schools in Los Altos, California exemplifies successful implementation of educational technology at the end user level. Khan Academy is a free service that provides over 2,500 short videos, each describing a discrete concept. Students can access lessons at any time with or without proceeding through a sequence of prerequisites (Pugliese, 2016). If teachers direct students to proceed through the recommended sequence, Khan Academy can be considered a rules-based adaptive system based on its linear sequencing and assessment feedback which provides little adaption other than individualized pacing. Teachers using Khan Academy for their digital content have witnessed the motivational effects of immediate feedback and recognition. Khan Academy utilizes gaming features that can act as motivators for students. Students are challenged to complete a series of 10 computer-generated math problems. If a student answers a problem incorrectly, they need to restart the set of problems. After a set of 10 questions has been answered correctly, students earn energy points. Badges are awarded for demonstrating behaviors like working quickly or gaining proficiency with certain concepts such as the Pythagorean Theorem. The instruction was differentiated as students worked on computers independently moving through lessons at their own pace. The seventh graders who used the program including all remedial students, scores of proficient or advanced on the California Standards Test (CAT) rose from 23% to 41%. Ninety-six percent of the fifth-graders achieved a proficiency or mastery rating, compared to a 91% proficiency or mastery rating district-wide. While the advanced analytics in other CAI programs can provide a far more personalized instructional sequence than what Khan has provided, Khan Academy showcases a starting point for the potential of CAI programs to impact today's classrooms.

As educators integrate technology into curricula, it is important to specify the goals for the technology use. Not all students will use technology in the same way. Gasson and Haden (2014) identify four types of technology users:

- A *theoretician* is at the upper end of the computer science field, researching and developing new computer science theories.
- *Practitioners* are hardware or software developers or individuals who maintain computer systems.
- A *power user* is an expert in another field who understands and uses complex computing tools for their needs. To become power users, students must develop the ability to think computationally and utilize these advanced computing tools to solve complex problems.
- An *end user*, on the other hand, simply applies commercial software and hardware for non-specialist use. Examples of end use would include video tutorials, instructional games, word processing, and apps. Technological end use in the classroom typically helps to deliver learning materials and support student learning (Cheung, 2013).

According to Cheung's description and those by Gasson and Haden (2014), users of computer-assisted programs appear to be end users, simply consuming the lessons that are delivered to them. With this in mind, it would be important to know if the students' technology end-user status affects communication and relationships between students and teachers.

To transition students beyond mere end users of technology and allow them to develop more sophisticated skills, many education leaders are embracing policies that develop 21st-century learners. Twenty-first-century learning uses modern technology to create the educational environments that can reflect the ideals that American education pioneer John Dewey long envisioned (Hursh, 2008). These are learning environments where student information is obtained from experience, processed, and reflected upon;

where subject specific disciplines are blended in project and inquiry-based learning situations in real-world contexts. Education in these environments embraces the social and communication components of learning as essential to the formulation of ideas and production of democratic citizens. The Partnership for 21st Century Learning has identified the following primary skill domains that are important for students to develop to be prepared for the complex life and work environments of the 21st century: creativity, critical thinking, communication, and collaboration (HunsingerHoff, 2016). Widely available and immediate access to the internet allows 21st-century learners to use modern technology in blended or virtual environments to obtain, process, and communicate information. While collaboration and communication are pillars of 21st-century learning, a recognized component is also the pursuance of personalization by allowing students to guide their educational trajectory, separate from their classmates. A personalized learning environment recognizes that objectives and content, as well as methods and pace, may all vary with each student. With a 21st-century learning springboard, personalized learning has gained significant momentum in modern educational practices, and technology-enhanced personalized learning (TEPL) environments are now more available than ever.

The concept of personalized learning stems from the fundamental ideas of individualization and differentiation. Individualization, in a progression toward mastery learning, matches the pace and instruction with the unique needs of each student (Bloom, 1971). Similarly, differentiated instruction is adapted to suit the interests and abilities of different groups of learners within a classroom (Tomlinson, Brimijoin, & Narvaez, 2008). Technology-enhanced personalized learning (TEPL) is based on the recognition that individual students learn in different ways and at different rates; therefore, information should be presented in different ways to reach everyone best.

The USDOE (2010) defines personalization as Instruction that is paced to learning needs, tailored to learning preferences, and tailored to the specific interests of different learners. In an environment that is fully personalized, the learning objectives and content, as well as the method and pace, may all vary. (p.12) Along with this definition is the notion that personalization links instruction to student needs and interests, thereby contributing to students' self-direction, enhancing motivation to learn and learning itself (Redding, 2013).

According to the USDOE (2017) website, personalized learning is synonymous with competency-based learning where students' progress through the curriculum by showing mastery of academic content, as opposed to progressing from grade to grade based on classroom seat time. It is important to note that the USDOE website also states that by enabling self-paced skill mastery, competency-based learning programs save time and money by increasing efficiency and productivity. These purported benefits can result from personalized systems that utilize staffing patterns differently, present multiple pathways to graduation, leverage technology more effectively, allow for 24/7 access to learning, and help identify interventions to meet the needs of students best. Personalized instruction is charged with adapting content and learning objectives along with method and pace while remaining focused on the relevant content standards (USDOE, 2017).

For decades, educators have struggled with the tension between personalizing learning for each student and covering mandated curriculum requirements with entire classes. Given typical class sizes and content standards requirements, more often than not the classroom focus trends toward completing the required curriculum, at the expense of true personalization (Kapp, 2017). Customizing instruction to meet the needs of each student in the classroom has shown to be extremely time consuming and commonly unrealistic without the help of technology (Bienkowski, Feng, & Means, 2012). Luckily for supporters of technology-enhanced personalized learning, advancements in learning analytics can increase teacher's abilities to support personalized learning (Atkenson & Will, 2014; Christensen, Horn, & Johnson, 2008).

Michigan and Ohio have passed legislation guaranteeing students an opportunity for competency-based, personalized learning, and New Hampshire is initiating a sweeping high school redesign to utilize competency-based systems for student advancement. (USDOE, 2017). The USDOE (2017) uses competency-based learning synonymously with personalized learning and describes it as Personalized learning is more practical and popular with the increase of computer use and personalizing software, as it allows students to operate at their own pace and communicate with their own computer-assisted learning programs (Roberts-Mahoney, 2015). Educators should be cautious when any mode of learning has the potential to isolate students and impacts the common learning in the social space of the public sphere. It should be recognized that student interactions with computer-assisted learning programs fill a social space that was previously occupied with human social interaction in the classroom (Redding, 2013).

This form of personalized learning, education through computer learning programs, not only shifts the role of the teacher to that of a guide, it can also remove the teacher from the learning environment. As students complete their work online, error messages are sent when needed, and hints can be provided when requested. This automated feedback can redirect the student without the need for social interaction with the teacher (West, 2012).

With increasing sophistication and rapid advances in computer technology, schools can more readily implement computer-assisted, personalized learning (Kapp, 2017). Digital adaptive learning tools have been defined as, "Education technologies that can respond to a student's interactions in real time by automatically providing the student with individual support" (EdSurge, 2016, p. 15). Computer-assisted instruction programs collect and analyze massive amounts of student data to create a personal learning pathway for each student. (Bienkowski, Feng, & Means, 2012). Computer-assisted instruction programs are increasingly popular in tech-enabled classrooms and online learning environments as a way to deliver content and assess mastery. An industry leader in learning analytics, Knewton, gathers hundreds of thousands of student-data points each day and uses this information to personally adapt learning to each student (Cator & Adams, 2013). As students provide program input through clicks, strokes, and type, algorithms process the masses of student data to determine the appropriate next lesson for each student.

Computer assisted instruction programs have been referred to as intelligent tutoring systems, because of their ability to issue feedback to students, prioritize lesson sequences, and provide remedial instruction or advancement when needed (Leong, 2013; Mendicino, Razzaq, & Heffernan, 2009). Replacing teaching and assessment functions traditionally done by classroom teachers, some CAI programs are even designed to imitate human tutors through interactive features using dialogue and immediate feedback (Bennett-Smailis, 2016; Mendicino et al., 2009). The concept of CAI is not new and can be traced back to Sidney Pressey's teaching machine developed in the 1920's. Pressey's teaching machines were used by students to answer multiple choice questions. If the student answered correctly, they advanced to the next question, and if they answered incorrectly, the mistake was noted and the student continued answering until the correct choice was made. Pressey advocated that his teaching machines made teaching and learning more efficient because students would not need to wait hours or days to receive feedback on an assessment. This immediate feedback provided by the machine was similar to a one-to-one tutor (Roberts-Mahoney, 2015). Skinner (1958) also supported the use of teaching machines, explaining that their ability to reinforce small units of desired behavior provided an educational benefit.

Similar to the original learning machines, it is important to recognize the type of information that is being communicated and assessed through computer-assisted learning programs. Many of the programs focus on student acquisition of discrete skills that can easily be recorded and processed from a comprehensive database (Roberts-Mahoney, 2015). Thus, learning is reduced to small components to be analyzed by software to personalize learning for the student (Bienkowski et al., 2012). Educators who utilize these adaptive learning programs should be cognizant of the fragmented competency based structure that the programs utilize. They cannot portray a complete picture of the student's learning, nor can they address complex needs that exist outside of the program structure (Roberts-Mahoney, 2015).

Proponents of assisted learning programs point to a personalized student learning experience with self-controlled pacing, content, and environment. Also, these proponents say that the possibilities for differentiation and personalization allow teachers to connect on a deeper level with students because they know their strengths and needs in a more detailed way (Lemke, 2013). This form of personalized learning, however, does not actually use human decision-making to personalize the learning. Instead, algorithms written by data scientists control the pacing and content instead of the students and teachers. Critics of these systems argue that computerized learning is no more than a behaviorist approach to acute skill building which risks removing students from essential social interaction within the learning environment (McRae, 2010). Other proponents of personalized learning have long suggested that teachers should shift from the role of an actual "teacher of knowledge" to a "guide" for students to create their own knowledge. In reference to teaching, assessment, and planning, claims have been made that technology can do the work more accurately and efficiently than humans (Shechtman, DeBarger, Dornsife, Rosier, & Yarnall, 2013). With technology handling the teaching and assessment, teachers manage the technology by assigning it to students and ensuring student compliance in the classroom so that programs can make the most effective decisions for student learning (Frame, 2013). Despite the ability of these programs to tailor learning situations to each student, they ultimately adapt the educational environment, albeit a virtual environment, to produce the desired behavior of the student (Kohn, 2015).

For personalized learning to be effective, teachers need to be aware of the attributes, needs, and resources of their students (Redding, 2013). With curriculum decisions and instructional practices being reduced to algorithms to personalize learning, the decision making can be taken away from the teacher. Teachers can make fewer pedagogical decisions beyond assisting students with problems initiated by the program; rather, they manage the technology that makes the decisions for them (Roberts-Mahoney, 2015).

The use computers for instructional delivery offer a number of advantages to learners. Some of the advantages being asserted by (USDOE, 2010) are to; provide consistent content, provide content to remote locations if learning package is online, provide training to remote locations, offer opportunity for learners to control and pace their learning according to their ability, promote different leaning styles, provide opportunity for learners to practice and increase retention. These benefits are very essential to teaching and learning hence researchers must research in these areas in order to make teaching and learning more appealing to the learner and also gain all the knowledge they need to move on in the future. To implement the use of computers as a means of instructional delivery, teachers must create good student teacher relationships by creating greater collaboration, communication and problem solving as being supported by (Anrig, 2013) which will enable students achieved their full potential. Although, using computers as a means of instructional delivery tool has a lot of benefits to the learner, however, care must be taken in order not to break student teacher relationship which is the social aspect of learning, teachers must serve as a support base for learners when using computers and also promote one – on – one interaction to maintain good relationship.

Another thing teachers must keep in mind when integrating computers in their lessons is that; most students are end users simply consuming the lessons that are delivered to them, it is important for teachers to create learning environment that can allow students to interact well by providing some problem solving questions or enquiry. This will help students' experience deeper meaning of concepts and understanding and also solve problems better.

**2.4 Impact of Computer Assisted Instruction**

There had been abundance of research studies exploring a limited number of constructs in Computer Assisted Instruction (CAI) but there had been only modest attempts at building a theoretical base for CAI (Williams, 2000). She also found in her research on a framework for online environments for learning that there are several different views of what learning theory best fits learning by means of the computer. Williams advocated for the need for theoretical approaches to learning because of the differences we have in the learning theories. The behaviorist wants the learner to produce desired behaviors by controlling the environment while the constructivist wants to see how learning occurs. Williams found that an integration of behaviorist principles and constructivist principles may be best suited for computer-assisted instruction. Williams also concluded that there are those who believe that the theories and principles that guide practice in traditional face-to-face instruction cannot be directly converted to computer-based instruction. Others also concluded that a single learning theory is not enough, but that a quality learning environment should be based on instructional principles that are derived from multiple learning theories (Johnson and Aragon, 2002). However, there must be attempts at theoretical explanations for learning professionals to make teaching and learning decisions with confidence using this technology.

Johnson and Aragon (2002) have begun developing a framework for instructional strategies for use in the computer learning environment. They also found a lack of evidence that technology significantly influences the learning process. Johnson and Aragon hypothesized that quality learning environments should be based on instructional principles that are derived from multiple learning theories. The challenge is to devise ways to create pedagogically sound content for delivery by the computer. The information to be learned needs to address variability in learning styles, provide motivation, and promote interactivity. Johnson and Aragon suggest that the learning environment should be comprised of the elements in behavioral, cognitive, and social learning theory.

According to Cheung and Slavin (2013), over 20 major reviews of education technology have been conducted over the past 30 years and the majority of these studies have concluded that technology applications show positive effects on student achievement of which Geometry is part. Cavanagh and Mitchelmore (2011) explained that educational technology used for low-level tasks such as drill and practice have shown no significant effect on student learning outcomes. This is attributed to the formats closely resembling printed versions of similar rote learning exercises. The findings of Cavanagh and Mitchelmore contrast a meta-analysis of 254 controlled evaluation studies by Kulik and Kulik (1991) which cover students ranging from kindergarteners to adults and show computer-based instruction usually produces positive effects for students. Lei and Zhao (2007) have shown that both the quantity and quality of technology usage impact student achievement. In a study of 130 middle school students in Ohio, Lei and Zhao found that students who used technology at school for more than three hours per day experienced a decrease in achievement. Conversely, students who utilized technology for one to three hours per day demonstrated an increase in academic achievement. Lei and Zhao suggested that the quality of the technology needed to be ensured before the quantity of time on computers increased, otherwise the increased computer time could cause more harm than benefit. In regards to quality of technology use, students who were involved in higher level tasks such as webpage development and programming had increased achievement compared to students using technology for basic tasks such as taking notes with a word processing program. However, the researchers did not report any interaction effects of quantity and quality on student achievement.

A recent meta-analysis (Cheung, 2013) of 154 studies involving approximately 120,000 K-12 students revealed several important classroom technology usage factors. Programs that required students to use computers 30 minutes or more per week had a larger effect on student achievement than ones that required less. The implementation level was also a contributing factor to student achievement. The average effect size of programs with higher levels of implementation was significant but very small when compared to programs with lower levels of implementation. While Cheung reported these findings as significant, the effect sizes are so small that little effect can be attributed to the level of implementation. Cheung's analysis also suggests that education technology has a more positive effect on secondary students than on elementary students.

Despite the wide range of adaptive system types and modern advances in CAI, no current systems have synchronous capabilities to link students to each other or create communities of learners. Social interaction is a crucial element in the measurement of both cognition and engagement and should be considered an essential element of an adaptive course. Personalized learning should be seen as a piece of a larger educational picture where students collaborate in teams and share resources (Pugliese, 2016).

Although, there are some research studies which indicate little or no effect in the use of Computer Assisted Instruction. However, a greater number of them yielded positive effects. These positive effects can be attributed to how well the CAI interact with students, the preparedness of students to learn on their own using Computers, the availability of quality hardware and software, access to quality internet connectivity if is online, theories underlying the instructions, number of hours a student spent on the computer, teacher support for students and others. These positive attributes will enable the researcher to use all possible means to help students make good use of the Maths Xerte toolkits in Coordinate Geometry to improve upon their performance.

With the integration of multimedia elements such as texts, images, animations, and videos in the Maths Xerte toolkits, will offer unprecedented opportunities to students to learn Coordinate Geometry with less difficulties or no difficulties. It will also help students to interact, create, use and experience the various tools in the Maths Xerte to sketch the behaviour of graph and other computations in Coordinate Geometry. These will boost students' confidents and give them better understanding since students can use all their senses in the learning process and also can cater for different learning styles.

In addition, the Maths Xerte toolkits will increase student interest, reduce anxiety, provide more time on task, and provides instant feedback for the student, self-sufficient learning, independent learning, and the ability to represent content in a variety of media.

### 2.5 Students and Pre Service Teachers' Perception towards the Use of Computer-Assisted Instruction in Teaching and Learning

Perceptions refer to the understanding and attitudes that influence individual construction of reality. Students' perceptions of CAI mean the understanding, knowledge, and skills that influence the constructions of their reality as to whether CAIs are useful tools for Mathematics learning or not. Successful application of Computer-Aided Instruction in the learning of mathematics is strongly influenced by students' perceptions of CAI. Positive perceptions of CAI will enhance the effective integration of CAI into learning and the reverse is true. Globally, the literature on students' perception of CAI has been and will continue to produce varied results. For instance, Kosoko-Oyedeko and Tella (2010) conducted a study to examine teachers' perception of the contribution of ICT to the pupil's performance in Christian religious education (CRE). A population of 200 primary school teachers selected through census from 15 schools in Epe local government, Lagos State, Nigeria was used. A modified questionnaire known as teacher's perception of ICT contribution to pupil's performance was used to gather the data for the study. Data collected was analyzed using percentages and t-test statistical tools. The result indicated that teachers had a strong perception that ICT contributes to the performances of the pupils in CRE.

Moreover, Adekunle (2016) conducted a survey involving 7500 secondary school students in Nigeria to determine their perception of computer education in Abuja. The results show that students had a positive attitude towards the use of computers in education. Male students were found to have a positive attitude towards the use of ICT in education than female students. Finally, there was a significant difference between public and private schools' students' perception of CAI use in education. Tolbert (2015) carried out Quasi-Experimental research to assess the impact of Computer-Aided Instruction on students' performance, and students' perception of CAI. In all, 56 students were sampled and were placed into two categories of equal numbers (n=28). The control group was taught with traditional methods of instruction and 20 minutes daily remedial traditional instruction. The treatment group was taught with a traditional method of instruction and 20 minutes daily remedial Computer-Aided Instruction. The findings revealed no statistically significant difference between the two methods of instruction. The students' perception was no statistically significant different in the feelings about Computer-Aided Instruction (CAI). In contrast, in Ghana, Atta (2015) conducted a Quasi Experimental study involving 40 students in the Central Region to explore the impact of Computer-Based Instruction on basic school students' performance in Mathematics. The findings revealed that students had a positive attitude towards CBI, and students who were taught with CBI scored higher marks than those taught with the traditional methods of instruction. Also, Bariham (2019) carried out a quantitative study to examine the influence of teachers' gender and age on the integration of CBI in Social Studies instructions among basic school teachers in Tamale metropolis, Ghana. In all, 60 teachers were sampled for the study. The results found that the majority of Social Studies teachers had a positive attitude towards CBI, but few were using CBI due to a plethora of challenges. There were no statistically significant differences between young and old teachers' use of CBI during Social Studies instructional processes.

A study was also conducted by Gambari, Shuaibu and Shittu (2013), to examine students' perception towards the use of CAI for learning mathematics in Minna, Niger

State, Nigeria. Gender influence on their perception was also examined. Participants were 540 students (270 male and 270 male) from six secondary schools in Minna, Nigeria. The data were collected through questionnaire and analyzed using percentage, mean, t-test and ANOVA statistics. Findings revealed that majority of the students have positive perception towards the use of CAI. No significant difference among students' perception towards the use of CAI for learning mathematics based on school type. Similarly, no significant difference was established based on gender. The implication is that the student perceived the use of CAI as a mean of improving their performance in mathematics, therefore, it was recommended among others that adequate ICT infrastructure should be provided with relevant mathematics CAI packages in Nigerian schools.

### 2.6 Pre-service Teachers' Interest in the use of CAI in the Study of Coordinate Geometry

Technological advances have provided new concentration for humans. These advances are an enticement for education experts to take advantage of Computer Assisted Instruction (CAI). A lot of activities previously carried out by the teachers are then facilitated by the computer facilities due to efficiency and modernization. This generates the interest for students to use computers in education. Interest is a persisting tendency to pay attention and enjoy some activities. Chukwu (2002) also link interest as emotionally oriented behavioural tract which determines a student's enthusiasm in tackling educational programmes or other activities.

Chen (2017) indicated that computer-aided instruction or computer assisted instruction (CAI), has proven to be effective on the improvement of students' academic achievement, practicable teaching method and students learning interests and attitude. Interest of students are aroused using multimedia elements such as text, graphics, audio, animation and video as supported by Fan and Ma (2018) that CAI utilized the characteristics of computers (texts, pictures, and images). Chalmers et al. (2018) believed that CAI is a tool use to support interactivities in the teaching and learning process which intend help learners learn concepts with ease. Ene and Upton (2018) pointed out "computer-aided instruction" as an interactive teaching method using computer systems for directly helping students' learning, utilizing the characteristics of computer systems for providing teaching situations, presenting course contents, controlling teaching progress according to students' levels, and preceding teaching with tutors, training and practice, tutorial, problem-solving, games, and simulation to achieve instructional objectives. These interactivities create more room for students to explore concepts and also sustain their interest in the lesson. Sharma (2017) understands CAI as an interactive instructional technique whereby a computer is used to present the instructional material and monitor the learning that takes place.

Kellner (2010) and Resnick (2010) argued that the purpose of education is to develop self-actualizing persons. This is important for the teaching of coordinate geometry in mathematics where students should be active knowledge seekers which might be critical to developing analytical thinking and interest. Boling et al. (2002) randomly divided 21 first grade students at a mid-Atlantic elementary school into two groups. The control group used a book and tape to explore stories, while the experimental group used computerized storyboards. Both groups were given a pre and posttest in which the results provided a mean difference that demonstrated a larger gain for students in the experimental group. The researchers concluded that CAI had a positive influence on student interest, motivation, and learning. Eyo (2018) in like manner, sees CAI as a self-learning technique, usually off-line or online using the computer as a tool to facilitate and improve instruction. CAI is simply the type of instruction aided by a computer-controlled display and a response entry device which uses a combination of text, graphics, sound and video to enhance the learning process through interaction, to achieve certain instructional goals and improve educational outcomes.

Ogwo and Oranu (2006) emphasized that unless the teacher stimulates students' interest in learning students" interest in learning students" achievement will be minimal. Hence it is essential chemistry teachers use teaching method which ensures students active involvement in learning, and stimulate interest of student in chemistry. However, several studies have been conducted on computer Assisted Instruction (CAI) in many subjects. These studies indicated very different results. Some of the studies found no significant difference between computer Assisted instruction and conventional teaching methods on students' achievement and interest (Cetin 2007). Some other researchers found computer Assisted Instruction more effective improving students' achievement and interest than the use of conventional teaching methods (Liao, 2007 and Wilder2006). Olakanmi, Gambari, Gdodi and Abalaka (2016) in a study to establish the effects of computer assisted instruction in promoting intrinsic and extrinsic motivation among senior secondary students, found that the students who were taught chemistry with computer assisted instruction had higher extrinsic and intrinsic motivation as well as achievement than those in conventional teaching methods.

# CHAPTER THREE

## METHODOLOGY

### 3.0 Overview

The purpose of the study was to find out the effect of using Maths Xerte Toolkits (Computer Assisted Instructions) on pre-service teachers' achievement in coordinate geometry, find out the perception of students towards the study of coordinate geometry using Maths Xerte Toolkits and to explore the students' interest using Maths Xerte Toolkits in teaching and learning Coordinate Geometry in Mathematics in level 200 of SDA College of Education. This chapter provides detailed description of the methodology employed in the study which includes the research design, population, sample and sampling techniques, research instruments, achievement tests, piloting the study, reliability and validity of the study, data collection procedure and data analysis.

### 3.1 Research Design

A research design indicates the general plan of the research; that is, how the research is set up, what happens to the subjects, and what methods of data collection are used (James & Sally, 2014). The researcher used quasi experimental design. The quasi-experimental, also known as 'field-experiment' is a type of experimental design in which the researcher has limited leverage and control over the selection of study participants. Specifically, in quasi-experiments, the researcher does not have the ability to randomly assign the participants and/or ensure that the sample selected is as homogeneous as desirable. Accordingly, the ability to fully control all the study variables and to the implication of the treatment on the study group(s) maybe limited. Never-the-less, quasi-experiments still provide fruitful information for the advancement of research (Leedy & Ormrod, 2010).

Quasi experimental design was used because the researcher wants to measure the effect of using Xerte Toolkits in the teaching and learning of Coordinate Geometry. The researcher intended to establish the effects of Xerte Toolkits in teaching and learning of Coordinate Geometry by comparing between the students' score before being taught by using Xerte Toolkits and after being taught by using Xerte Toolkits. The researcher used one-group pretest-posttest design. The one-group pretest – posttest design in which there is only an experimental treatment group and no comparison or control at all. Cook & Campbell (1979)

**Table 3.1: Design of One Group Pre-test and Post-test**

| Pre-test | Independent Variable (Treatment) | Post- test |
|---|---|---|
| $O_1$ | X | $O_2$ |

Key of the diagram.

X: Treatment

$O_1$: Pre-test

$O_2$: Post-test

The researcher used the following procedures of pre-experimental design (one group pre-test and post-test design):

1. Administering a pre-test before applying Xerte Toolkits with the purpose of measuring students' achievement in Coordinate Geometry.
2. Applying treatment in teaching and learning Coordinate Geometry by using Xerte Toolkits.
3. Administering a post-test after applying Xerte Toolkits with the purpose of measuring the students' achievement in Coordinate Geometry.
4. Comparing the scores of pre-test and post-test.

This means that the researcher used only one group in this research. It is a design used for comparing the achievements in the pre-test and post-test and also to determine how effective a treatment was. Pre-test and post-test were given to measure if there were significant difference scores before and after the students being taught by using Xerte Toolkits in teaching and learning Coordinate Geometry. This research intended to investigate the effects of Xerte Toolkits in teaching and learning Coordinate Geometry.

### 3.2 Population

The target population for this research work was all level 200 students in SDA College of Education, Asokore totaling four hundred and sixty four (464) students pursuing Bachelor of Education in Early Childhood Development, Primary Education, English and Ghanaian Language and ICT programmes. Table 3.2 illustrates the various classes or programmes and the number of students in the class or programme.

**Table 3.2: Population of the Research**

| COURSE | NUMBER OF STUDENTS |
|---|---|
| Early childhood Development | 64 |
| Primary Education | 277 |
| English and Ghanaian Language | 73 |
| ICT | 50 |
| **Total** | **464** |

### 3.3 Sample and Sampling Technique

The researcher used convenience sampling to select SDA College of Education in the New Juaben North Municipality in the Eastern Region of Ghana. The college was selected because the researcher was part of faculty members, sample group were readily available and willing to partake in the study. The researcher also used purposive sampling technique to select a sample of fifty (50) pre-service teachers for the study because the research does not demand randomization of the participants, the College has a computer lab which can take up to fifty (50) students at a time since the participants manipulate computers and then maintaining intact classes in order not to distract academic programmes. From the above reasons the researcher expediently selected Elective ICT class which consist of a total number of fifty (50) students in the class of which thirty four (34) were male and sixteen (16) are females for the study.

### 3.4 Research Instruments

Creswell (2012) explain that developing an instrument consist of several steps such as identifying the purpose of the instrument, reviewing the literature, writing the questions and testing the questions with individuals similar to those plan to study. Sugiyono (2009) also assert that research instrument is a tool or instrument used to measure nature and social phenomena observed. Diane (2013) opined that instrumentation is a plan that comprises of a number of decisions that need to be made before the beginning of study. Diane (2013) continued that these decisions are made in order to determine what data are needed to answer the research questions. Diane (2013) continued that the researcher has a variety of options that may be used as a data collection instrument, such as interviews, observations, questionnaires and rating instruments. The main instruments used in generating data for this study were the achievement test, questionnaire and interview regarding the usage of Xerte Toolkits. Table 3.3 shows the purpose of this study linked to the data sources.

**Table 3.3: Purpose of the Study linked to the data source**

| Purpose of the Study | Data source(s) |
|---|---|
| 1. Effect of using Maths Xerte Toolkits (Computer Assisted Instructions) in teaching and learning Coordinate Geometry. | • Achievement Test (Pre and Post Test) |
| 2. Perception of students towards the study of coordinate geometry using Maths Xerte Toolkits | • Questionnaire and interview |
| 3. students interest in using Maths Xerte Toolkits in teaching and learning Coordinate Geometry | • Interview Guide |

Table 3.3 depicts the key areas of the study linked to the data source(s) that were used in answering the research questions. For instance, to find out the effect of Xerte Toolkits in teaching and learning coordinate geometry, data sources from pre and post test scores were used. Prospective Teacher questionnaire on Xerte Toolkits was used to find out the perceptions and interview guide was used to find out the interest of prospective teachers using Xerte Toolkits in teaching and learning of coordinate geometry.

### 3.4.1 Achievement Test

The researcher used the achievement test. Achievement test are widely used in educational research, as well as in school system. It is used to measure what an individual have learned. Achievement tests measure mastery and proficiency in different area of knowledge. The tests were constructed by the researcher. According to Isnawati (2014), a test is used to obtain information. The information that we hope to obtain will vary from situation to situation. It is an instrument or procedure designed to measure the student's ability. Test is a procedure for critical evaluation; a means of determining the presence, quality, or truth of something and it is also a series of questions, problems, or physical responses designed to determine knowledge, intelligence, or ability.

The test was made of a pre-test and post-test (See Appendix B and D respectively). Similar questions were used for both the pre-test and posttest. The materials of the test were taken from course outline of the first year second semester Geometry and Trigonometry in which coordinate Geometry is part of the areas in the outline. The pre-test was given to measure their ability before giving the treatment then the post-test was also administered after giving the treatment. The number of items in the test were twenty (20) multiple questions with a stem which is followed by four (4) options lettered (A-D) out of which only "one" was correct.

### 3.4.2 Questionnaire

According to Stefan (2013), questionnaire is simply a 'tool' for collecting and recording information about a particular issue of interest. It is mainly made up of a list of questions, but also include clear instructions and space for answers or administrative details. Structured questionnaires were used to collect the required information from participants.

The questionnaire was structured according to the objectives of the study. Student participants were given questionnaire (See Appendix F) which require them to provide their biographic details and a Likert scale questions mode were used to find out prospective teachers' perceptions and how Xerte Toolkits affected their affective domain as far as coordinate geometry is concerned. To ensure the data acquired was valid and reliable in this study, pre-testing was done to determine whether the questions were acceptable, answerable and well understood. The feedback was used to validate the instruments in readiness for the study.

### 3.4.3 Interview Guide

Semi-structured in-person interviews were granted to students. Interviews provide the researcher opportunity to explore and gather data in a more relaxed context. Semi-structured in-person interviews (See Appendices G) was granted at the end of teaching period, with fifteen (15) students from the class where the treatment was administered. The interview was conducted to seek further clarifications and get deeper insights into the research lesson taught using Xerte toolkits.

## 3.5 Piloting the Study

All the mathematics achievement tests were piloted at Kibi Presbyterian College of Education with a group of students with similar background and same grade level. There were two main reasons for the piloting of achievement tests; first to check the clarity and the understandability of the test items, and secondly to check the reliability coefficient of the tests. The pilot study offered the opportunity to test the instruments on the subjects with similar characteristics as those in the main study (de Vos, 2002). This was important for "refining the wording, ordering, layout, filtering, and so on, and in helping to prune" the instruments (de Vos 2002, p.216).

## 3.6 Validity

Validity determines whether the research truly measures what it was intended to measure or how truthful the research results are (Joppe, 2000). Validity is the extent to which the test actually measures what it is intended to measure (Brown, 2000). It is also the extent to which inferences made from assessment results are meaningful, and useful in term of the purpose of the assessment. Validity can also be defined as the extent to which the instrument measures what it should be measured, so the test should test what the writer or teacher wants to test the students. This means that, the use of valid instrument is very essential to determine the validity of data. To ensure whether the test was valid, the researcher gave them to the Head of Department for Mathematics in the College, to evaluate the questions for content and construct as well as face validity. In addition to confirming that the content was valid, the Department inspected each item and determined that the items did indeed represent the skills that was being assessed. After the feedback was received from the department; Out of the forty (40) multiple choice questions, twenty (20) questions were selected as pre-test and post-test. Again, the researcher prepared a different one based on the objectives of Coordinate Geometry syllabus in the Colleges of Education so that it was not out of contents. The final questions were piloted in the same College with Primary Education Students to ensure that the instrument was clearly understood by respondents.

### 3.7 Reliability

According to (Apaw, 2009) reliability refers to the extent to which research findings can be replicated. Golafshani (2003) cited that reliability is the extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability and if the results of the study can be reproduced under a similar methodology, then the research instrument is considered to be reliable. In other words, it is such that if a later researcher follows the same procedure as described by an earlier researcher and then conducts the same research all over again, the later researcher should arrive at similar findings and conclusions. Apaw (2009) opined that for the mere fact that a number of people have experienced the same occurrence does not make data more reliable, particularly in educational studies. Then, their view on reliability should be altered from whether findings will be found again to whether the results are consistent with the data collected. However, the internal consistency for the achievement test instrument using the Cronbach alpha was 0.74. This value indicates a high degree of reliability of the instrument. Furthermore, triangulation approach was employed to address the issue of reliability. Apaw (2009) advocated that the use of triangulation strengthens a study by combining various methods. This means using several methods or data, including using both quantitative and qualitative approaches. Triangulation is using two or more instruments to collect data in a study. The researcher fully described how the data was collected, how categories were derived, and how decisions were made throughout the study. Data collected using interviews, questionnaire, pre-test and post-test helped readers' get holistic understanding of the situation.

### 3.8 Data Collection Procedure

The computer assisted instructional package was developed by the researcher using the lesson notes prepared for the conventional (talk and chalk method). The Xerte Toolkits was used to design the instruction on Coordinate Geometry (See Appendix A). Xerte tool was used to develop the CAI by the researcher using all the multimedia elements (text, images, audio and video). The topic treated was selected based on Colleges of Education mathematics course outline for first year second semester. The development of CAI followed a systematic approach of instructional development model put forward by Dick and Carey (1996). However, three trials were made before the package became successful. It was then tested with selected students in the SDA college of Education in New Juaben Municipality. These students used for testing the package falls within the population of the study but not part of the sample selected. The Xerte toolkits was used as the major teaching and learning aid through the computers at the ICT lab. The same software was used for learning, and practicing by the pre-service teachers with the researcher as the facilitator.

The time allocated was one hour a day for nine (9) days. However, pre-service teachers at SDA College of Education were given one hour thirty (1:30) minutes orientation for a day on how the software works and how to navigate through the lessons.

Some pre-service teachers also practiced on their own at their own convenience. Participants were educated on the properties and use of Xerte toolkits in the context of learning coordinate geometry. The course was taught for three (3) weeks. The researcher engaged pre-service teachers three times within each week. The first day was used for administration of Pre-Test, the second day was orientation on the use of Xerte toolkits, the third day was used to introduce coordinate geometry concept via the use of Xerte software, the fourth day was used to find the distance between two points, the fifth day was used for finding the gradient of a line joining two points, the sixth day was used for finding equation of a straight line, the seventh day was intersection of lines, the eighth day was perpendicular lines and the last day was used for post-test.

**Table 3.4: Summary of the schedules for the treatment.**

| Day | Activities |
|---|---|
| 1 | Pre-test |
| 2 | Orientation on the use of Xerte toolkits |
| 3 | Introduction of coordinate geometry concept |
| 4 | Distance between two points |
| 5 | Gradient of a line joining two points |
| 6 | Equation of a straight line |
| 7 | Intersection of lines |
| 8 | Perpendicular lines |
| 9 | Post-test |

### 3.9 Data Analysis

The items in the questionnaire were analyzed using percentages and the achievement test items were also analysed using statistical tools such as mean, standard deviation and paired sample t test from Microsoft Excel 2016 software analysis tool pack. Moreover, the interview data were analyzed using qualitative content analysis which led to common themes about the use of Xerte toolkits. In line with this, quotations of the participants were used to support the emerging themes and to provide a rich description of these themes.

### 3.10 Limitation of the study

The findings in this study could only be generalized within the sampled school, but could not generalize for all students in the Colleges of Education in Ghana because of the convenience sampling techniques used for selecting the school and class.

# CHAPTER FOUR

## RESULTS, DATA ANALYSIS AND DISCUSSIONS

### 4.0 Overview

This chapter focuses on the results of the analyses of the data and discussion of the findings. The data were organized and presented using tables, charts and descriptive statistics. The sequence of the presentation and the discussion of the results obtained in this study were discussed in accordance with three predetermined themes derived from the research questions. These themes are:

1. Effect of Maths Xerte toolkits on the achievement of pre-service teachers in Coordinate geometry.
2. Perception of pre-service teachers towards the study of coordinate geometry using Maths Xerte toolkits.
3. Pre-service teachers' interest in using Maths Xerte toolkits to teach coordinate geometry.

### 4.1 Effect of Maths Xerte toolkits on the achievement of pre-service teachers in Coordinate geometry

The major research question raised for the study was to examine how the use of Computer Assisted Instruction applications such as Xerte toolkits could affect pre-service teachers' concept acquisition in questions involving coordinate geometry at the SDA College of Education, Koforidua. In order to accomplish this, pre-service teachers were given pre and posttest on coordinate geometry.

### 4.1.1 Pre-test Scores

Pre – service teachers were first given a pre-test and then exposed to a series of instructional teaching after which they were given a post-test. In all 50 pre – service teachers took the pre – test and the marks obtained out of 20 in the pre-test were as seen in Table 4.1

**Table 4.1: Pre-test Scores of Pre – Service Teachers**

| Marks | Number of Students | Percentage (%) |
|---|---|---|
| 5 and below | 14 | 28% |
| Between 5 and 10 | 23 | 46% |
| 10 and above | 13 | 26% |
| **Total** | **50** | **100%** |

From Table 4.1, fourteen (14) pre – service teachers representing 28% scored a mark of 5 or below and 23 of them scored a mark between 5 and 10 representing 46% of the pre – service teachers who took the pre – test. Moreover, only 13 of them representing 26% of the pre – service teachers scored a mark of 10 or above indicating that less than one third of the participants had a pass mark.

### 4.1.2 Post-test score

The post-test was administered after students were introduced to the treatment with regard to the use of the Xerte toolkits. The post-test questions were similar to the pre-test questions and this assisted the researcher to assess the effectiveness of the treatment employed and also the student's mastery over the concept, coordinate geometry. The marks obtained out of 20 after the post-test were as follows:

**Table 4.2: Post-test Scores of Pre – Service Teachers**

| Marks | Number of Students | Percentage (%) |
|---|---|---|
| 5 and below | 0 | 0% |
| Between 5 and 10 | 1 | 2% |
| 10 and above | 49 | 98% |
| **Total** | **50** | **100%** |

From Table 4.2 it could be seen that no pre – service teacher had a mark of 5 or below and only one had a mark between 5 and 10. Moreover, 49 pre – service teachers representing 98% had a pass mark of 10 and above. Also, 4 pre – service teachers had a perfect mark of 20 as a result of the treatment given them.

Figure 4.1 is a bar chart showing the pre – test and post test score of pre – service teachers.

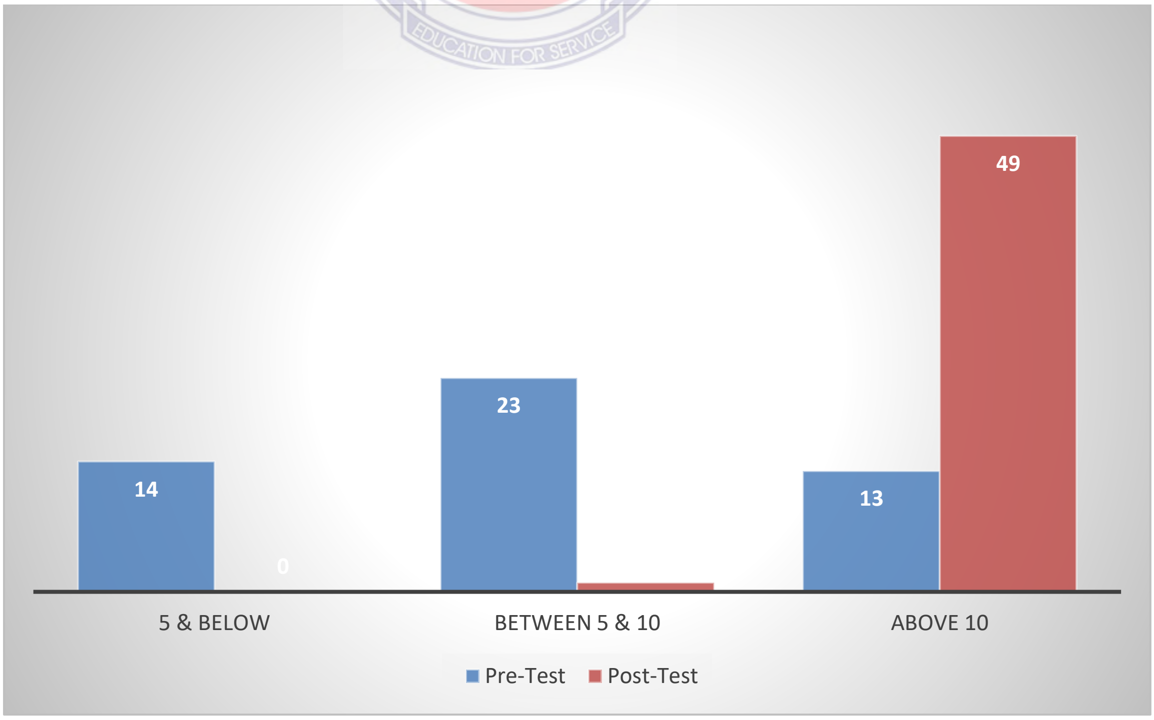



**Figure 4.1: Bar Chart of Pre – test and Post – Test score**

From Figure 4.1, unlike the pre – test where 14 pre – service teachers had a mark of 5 and below, no pre – service teacher had a mark below 5 in the post – test. Whereas 23 pre – service teachers had a mark below the average pass mark of 10 in the pre – test, the post – test recorded just a mark within this range. Also, more than 90% of the pre – service teachers had a pass mark in the post test.

Table 4.3 shows the descriptive statistics of pretest and post test results of students on coordinate geometry.

**Table 4. 3: Descriptive statistics on pre-service teachers' pre-test and post-test scores**

| | N | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Pre – test scores | 50 | 7.4 | 2.7 | 2 | 13 |
| Post - test scores | 50 | 14.6 | 3.4 | 9 | 20 |

Table 4.3 indicates that there was a difference in pre-test and post-test scores with respect to the minimum, maximum, mean and standard deviation with the post test score being better than pretest scores. (ie. with pre-test mean and SD 7.4 and 2.7 and post-test mean and SD 14.6 and 3.4).

Further analysis was conducted to find out whether the difference in means was statistically significant. A paired-sample t-test was used to test the null hypothesis that there is difference in means of the pre – test and post – test scores. The t-test was used because the researcher had only one group of people and collected data from them under two different conditions or occasions. Table 4.4 shows the paired sample statistic of pre – test and post – test scores.

**Table 4.4:Paired Sample t test for Pre – test and Post – test scores**

| | N | Mean | Std. Deviation | df | T | Sig (2 - tailed) |
|---|---|---|---|---|---|---|
| **Pre – Test** | 50 | 7.4 | 2.7 | | | |
| **Post – Test** | 50 | 14.6 | 3.4 | 49 | -11.2250 | 0.0000 |

The statistical test was set at $\alpha = 0.05$. The results of the t-test (49df, t = -11.2250, and p = 0.00) indicates that the difference in means was significant at p = 0.00. Since P is less than 0.05, level of significant; the null hypothesis that there is no difference in means of pre – test and post scores is rejected in favor of the alternative hypothesis. It can be argued that there was statistically significant difference between the post-test and pre-test in favour of the post test.

### 4.2 Perception of students towards the study of coordinate geometry using Maths Xerte toolkits.

The second research question was to find out how Maths Xerte Toolkits has influenced the perception of students toward the study of Coordinate Geometry. In order to accomplish this, a questionnaire was given to participants to illicit their response after partaking in the intervention activities. Table 4.3 show the participants' responses to each of the fourteen statements on their perception towards the study of Coordinate Geometry using Maths Xerte Toolkits.

**Table 4.5: Students Perception on Xerte Toolkits in teaching and learning coordinate Geometry**

| | Statement | SD | D | NS | A | SA |
|---|---|---|---|---|---|---|
| 1 | I would like to use Xerte toolkits to learn coordinate geometry always. | | | | 35 (70%) | 15 (30%) |
| 2. | Using Xerte toolkits does not make the learning of coordinate geometry interesting. | 25 (50%) | 25 (50%) | | | |
| 3. | Xerte toolkits helps to learn coordinate geometry concepts. | | | | 20 (40%) | 30 (60%) |
| 4. | Xerte toolkits did not help me to understand coordinate geometry concept. | 40 (80%) | 10 (20%) | | | |
| 5. | Xerte Toolkits helps to think creatively. | | | | 5 (10%) | 45 (90%) |
| 6. | Critical thinking is enhanced by using Xerte toolkits in learning coordinate geometry. | | | | 5 (10%) | 45 (90%) |
| 7. | Xerte toolkits assists me to learn coordinate geometry without the guide of my tutor. | | | 10 (20%) | 40 (80%) | |
| 8. | Xerte toolkits does not support interaction of students and tutors. | 40 (80%) | 5 (10%) | 5 (10%) | | |
| 9. | My attention span is enhanced when I use xerte toolkits to study coordinate geometry. | | | | 5 (10%) | 45 (90%) |
| 10. | Xerte toolkits does not demystify difficult concept in coordinate geometry. | | 50 (100%) | | | |
| 11. | I prefer to learn coordinate geometry without the use of Xerte toolkits | 5 (10%) | 45 (90%) | | | |
| 12. | I am happy with my tutor when he/she uses Xerte toolkits to teach coordinate geometry. | | | | 50 (100%) | |

| | | |
|---|---|---|
| 13. | The use of Xerte toolkits in teaching coordinate geometry is a waste of time. | 50 (100%) |
| 14. | Xerte toolkits creates more difficulty in studying coordinate geometry. | 50 (100%) |

*SD* strongly disagree, *D* disagree, *NS* not sure, *A* agree, *SA* strongly agree

Table 4.5 contains responses from pre – service teachers on the views to research question two which indicates that 75% (35) agreed and 25% (15) strongly agreed that they will use Xerte toolkits in learning coordinate geometry. On the other hand, all the participants disagreed to the statement that Xerte toolkits does not make learning of coordinate geometry interesting. This can be confirmed when the 15 students were interviewed. All the 15 students confirmed that they will use Xerte toolkits again because of its user friendly and multimedia nature.

Statement 3 and 4 was to ascertain whether Xerte toolkits helps in learning the concept of coordinate geometry. The pre-service teacher participants affirmed that it helps in learning the concept of coordinate geometry because 40 of the participants representing 80% strongly disagreed whereas 10 of the participants representing 20% disagreed that Xerte toolkits did not help them understand coordinate geometry concept. When student B was asked whether the use of Xerte toolkits made understanding of the coordinate geometry easier, she said "*Of course! Some concepts that were not clear to me were made easier by the software. For instance, the step-by-step procedure on how the equation of a straight line was obtained when two points are given*".

On the issue of creativity, critical thinking and attention span, 10% of the pre-service teachers agreed and 90% strongly agreed that Xerte toolkits enhanced their critical thinking, creativity and attention span.

10 of the participants were not sure whether Xerte toolkits could assist them learn coordinate geometry without the guide of their tutor whereas 40 of the participants agreed that they can learn coordinate geometry with Xerte toolkits without the help of a tutor. This is affirmed by participant E when he was interviewed. He was of the view that *"if the tutor creates the content with text, videos and creatively designed questions using flip charts and among others, we can learn concepts without his presence".* This was further confirmed when all the students accepted that Xerte toolkits demystify difficult concepts in coordinate geometry.

## 4.3 Pre – Service Teachers Interest in using Maths Xerte Toolkits in teaching and learning Coordinate Geometry

The researcher conducted interview for fifteen (15) pre – service teachers to elicit their response on how xerte toolkit has aroused their interest in understanding the concept of coordinate geometry. The responses from the interview posits that interest in understanding of coordinate geometry concept have been aroused after using the Xerte toolkits. For instance, student A was of the view that *"I can now work independently and Xerte toolkits has increased my interest and motivational level in learning coordinate geometry".* Student C also added "*my confidence level has improved and I can now solve coordinate geometry questions with little or no help*". This shows that Xerte toolkits has actually stimulated their interest in coordinate geometry. Also, all the interviewee responded that their competence level has improved and Xerte toolkits interface is user friendly therefore they intend to use the tool again in their studies.

### 4.4 Discussions of Finding

This part of the chapter discusses the results from the Xerte toolkits intervention based on the research questions. Research question one seeks to find out the effect of Xerte toolkits on student performance in coordinate geometry. The results reveal a tremendous improvement in scores after the treatment. That is with pretest mean score of 7.4, there was a posttest mean of 14.6 indicating an increased in score in favour of the post test. Also, in pretest the scores were far from the mean mark, however in posttest the standard deviation of 3.4 indicates that the scores of the posttest are not too far from the mean. Moreover, in the paired t - test the probability of 0.0000 is less than alpha level of 0.05 indicating that the initial assumption that there is no effect on using computer as instructional tools in teaching and learning coordinate geometry in the S.D.A college of education is rejected in favour of the alternate hypothesis and can be argued that there was significant difference between posttest and pretest scores in favour of the posttest. This result is in line with Cheung and Slavin (2013) study. They conducted over 20 major reviews of education technology over the past 30 years and the majority of these studies have concluded that technology applications show positive effects on student achievement of which Geometry is part. Also, many studies have indicated that the Computer Assisted Instructions have positive impacts on learning outcomes. For instance, Hung (2007), Liu (2010), Wang and Yu (2012), and Wiginton (2013) have found that the Computer Assisted Instruction is more effective in terms of academic achievement than traditional methods. The reason may be that in teacher-based learning, students cannot progress at their own pace, and if they become distracted, it is difficult to catch up on what they have missed. When each student has their own computer with access to teaching resources, they can control their learning progress and they can learn without being interrupted. Students can browse learning materials as much as they need and repeat exercises to understand the content. Online assessment and immediate feedback can help to improve learning effectiveness. However, Cavanagh and Mitchelmore (2011) explained that educational technology used for low-level tasks such as drill and practice have shown no significant effect on student learning outcomes. This is attributed to the formats closely resembling printed versions of similar rote learning exercises. The findings of Cavanagh and Mitchelmore contrast a meta-analysis of 254 controlled evaluation studies by Kulik and Kulik (1991) which cover students ranging from kindergarteners to adults and show computer-based instruction usually produces positive effects for students. Lei and Zhao (2007) have shown that both the quantity and quality of technology usage impact student achievement. In a study of 130 middle school students in Ohio, Lei and Zhao found that students who used technology at school for more than three hours per day experienced a decrease in achievement. Conversely, students who utilized technology for one to three hours per day demonstrated an increase in academic achievement.

On the participants' perceptions of the impact of Xerte toolkits in teaching coordinate geometry, the results indicated that, pre-service teacher participants made positive response about the impact of Computer Assisted Instruction (CAI). All the pre-service teacher participants agreed to use the software over and over again because of its ease and multipurpose nature. The finding in this study is in line with findings of study conducted by Gambari, Shuaibu and Shittu (2013), to examine students' perception towards the use of CAI for learning mathematics in Minna, Niger State, Nigeria. Findings revealed that majority of the students have positive perception towards the use of CAI. The implication is that the student perceived the use of CAI as a means of improving their performance in mathematics, therefore, it was recommended among others that adequate ICT infrastructure should be provided with relevant mathematics

CAI packages in Nigerian schools. The findings of the study conducted by Adekunle (2016) also revealed that students had a positive perception towards the use of computers in education. The findings in this study also validates that of Kosoko-Oyedeko and Tella (2010) who conducted a study to examine teachers' perception of the contribution of ICT to the pupil's performance in Christian religious education (CRE). The result indicated that teachers had a strong perception that ICT contributes to the performances of the pupils in CRE. Belal (2011) also conducted a study to find out Students' Perceptions of Computer Assisted Learning. The study attempts to redress the imbalance by illuminating some neglected, but important, student voices and concerns in the context of computer assisted learning. The findings suggest that students are in favour of using Computer Assisted Learning in a supportive role only. However, interviewees in this study rejected the idea of replacing human tutors with machine tutors and they believed that most of their learning occurs in tutorials and ranked these as the most important component of the module.

Finally, the findings in this study supports that of Atta (2015) who conducted a Quasi Experimental study involving 40 students in the Central Region of Ghana to explore the impact of Computer-Based Instruction on basic school students' performance in Mathematics. The findings revealed that students had a positive attitude towards CBI, and students who were taught with CBI scored higher marks than those taught with the traditional methods of instruction.

The results on students' interest using Maths Xerte Toolkits in teaching and learning Coordinate Geometry indicates that, their interest has increased and are ever ready to use Xerte interface again in their studies. This is in conformity with the findings of Chen (2017) which indicated that computer-aided instruction has proven to be effective on the improvement of students' academic achievement, practicable teaching method and students learning interests and attitude. It also supports Chalmers et al. (2018) assertion that CAI is a tool used to support interactivities in the teaching and learning process which intend help learners learn concepts with ease.

# CHAPTER FIVE

# SUMMARY, CONCLUSION, AND RECOMMENDATIONS

## 5.0 Overview

This chapter presents the summary of the research findings, conclusion as well as recommendations and suggestions for further research works.

## 5.1 Summary of the Findings

The purpose of the study was to find out the effects of using Maths Xerte Toolkits (Computer Assisted Instructions), perception of students towards the study of coordinate geometry using Maths Xerte Toolkits and to explore the students' interest using Maths Xerte Toolkits in teaching and learning Coordinate Geometry in SDA College of Education.

Three research questions guided the study:

1. To what extent will the use of Maths Xerte Toolkits as an instructional tool affect pre-service teachers' achievement in Coordinate Geometry?
2. What is the perception of pre-service teachers towards the study of Coordinate Geometry?
3. How will the use of Maths Xerte Toolkits improve the interest of pre-service teachers in the study of coordinate Geometry?

The researcher expediently selected Elective ICT class which consist of a total number of fifty (50) students in the class of which thirty-four (34) are male and sixteen (16) are females for the study. Semi – structured interviews, questionnaire, pretest and posttest were the instrument used for the collection of data. The items in the questionnaire as well as pretest and post test scores were analyzed using statistical tools such as percentages, mean, standard deviation and paired sample t -test from Excel 2016 Analysis Tools.

To find out the effect of Xerte toolkits on student performance in coordinate geometry, scores of pretest and posttest were compared and the results of the descriptive statistics revealed a significant difference in scores of participants in favour of posttest (M = 14.6 and SD = 3.4) as against pretest (M = 7.4 and SD = 2.7). The results reveal a tremendous improvement in scores after the treatment. Moreover, in the paired t-test the probability of 0.0000 is less than alpha level of 0.05 indicating that the initial assumption that there is no effect on using computer as instructional tools in teaching and learning coordinate geometry in the S.D.A college of education is rejected in favour of the alternate hypothesis and can be argued that there was significant difference between posttest and pretest scores in favour of the posttest.

The questionnaire given to the participants to elicit their response on the perceptions of the impact of Xerte toolkits in teaching coordinate geometry revealed a positive response for the opportunities created for them to actively engage themselves as learners. The results indicated that, pre-service teacher participants made positive response about the impact of Computer Assisted Instruction (CAI) and agreed to use the software over and over again because of its ease and multipurpose nature. Excerpt from the interview data also revealed that students' interest in using Maths Xerte Toolkits in teaching and learning Coordinate Geometry has increased and are ever ready to use Xerte interface again in their studies

## 5.2 Conclusion

Based on the findings of the study, the researcher concludes that for this group of pre-service teachers, Xerte toolkits has effectively enhanced their performance in coordinate geometry and promoted their professional development. Pre-service Teachers positively perceive Xerte toolkits to be beneficial for them to become better teachers. Similar studies may be conducted to a wider scope using different population to promote the generalizability of the results.

### 5.3 Recommendation for Practice

The following recommendations were made based on the findings and the conclusions of the study:

i. Looking at the positive impact of the study, the government should support the integration of ICT in teaching and learning of mathematics by supplying ICT facilities such as internet, computers, and software and among others to S.D.A College of Education, Asokore – Koforidua.

ii. To be abreast with xerte software in teaching and learning mathematics, management of S.D.A College of Education should organize workshop and training for mathematics tutors periodically.

iii. Management of S.D.A College of Education should encourage the use of computers and xerte software in teaching and learning of mathematics.

iv. To support interactivities in teaching and learning process, students must be encouraged to use the Xerte software on their phones and other computing devices in the college so as to arouse their interest in acquiring mathematical concepts.

v. Mathematics teacher should acquire knowledge of variety method of teaching to enable them vary their teaching method.

vi. Mathematics tutors in the College should use part of their instructional period and give a brief tutorial on how to use Xerte Software in order for students to increase their interest and enhance their academic achievements.

## 5.4 Direction for future research

Further research can be carried out on different CAI such as SciLab, Microsoft Excel, Mathematical, Maple, MATLAB, Octave, Geometer Sketch Pad and the like to ascertain whether CAI brings about relational understanding of concept or not.

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# APPENDICES

## APPENDIX A: TREATMENT

### Steps in Installing and setting up the Xerte Online Toolkits

1. Download and install a Xampp package from this URL (http://www.apachefriends.org/en/xampp.html) and follow the instructions.

**Note**: The Xampp software is part of the resources on the USB flash drive provided at the training, hence no need downloading it.

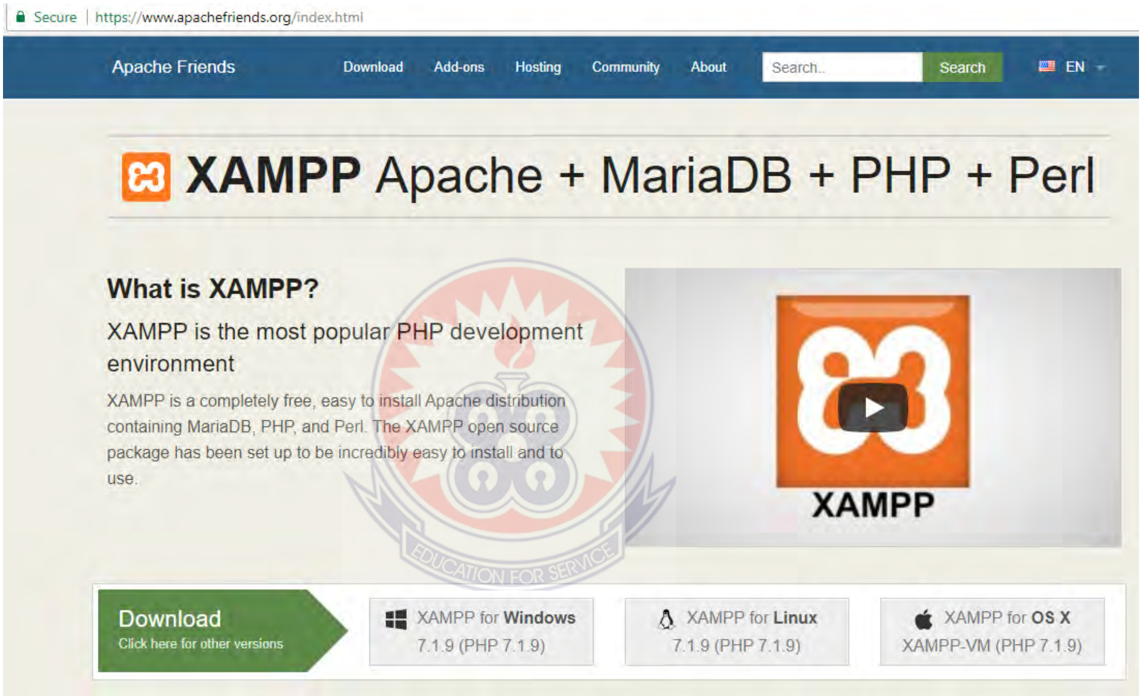



**Figure 1: Apache website**

After the download, double click on the installation file to begin the installation. Click on 'next' to proceed at every stage to finish the installation as shown below;

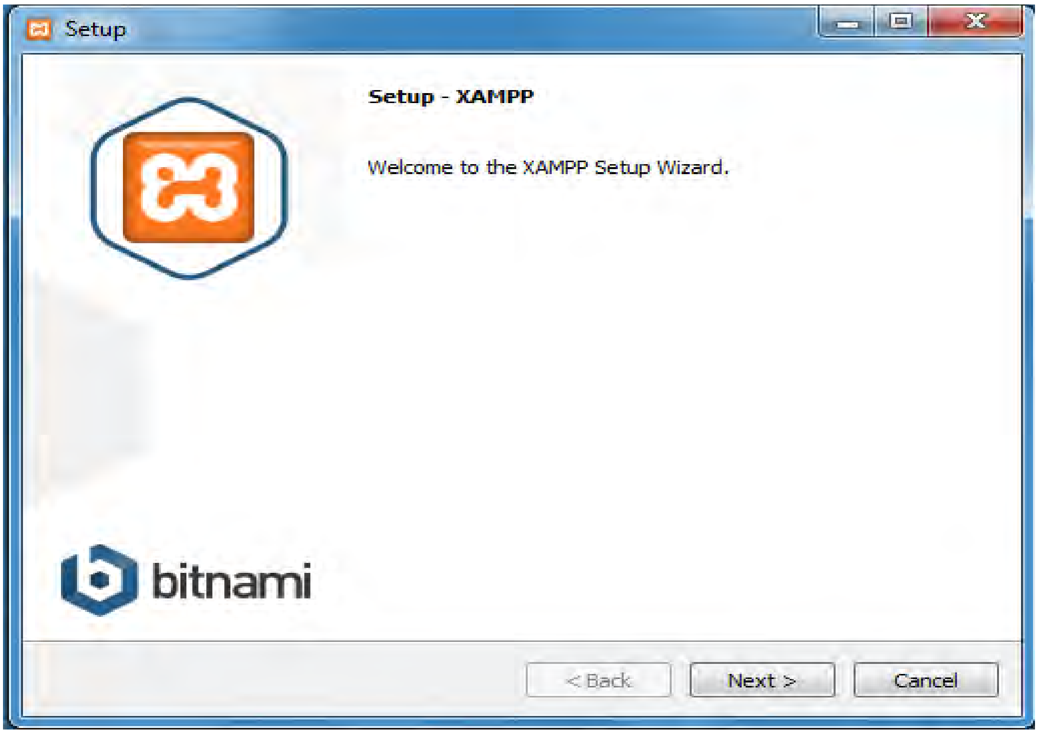



Figure 2: XAMPP Setup

2. Start the Apache server and the MySQL database as shown in the figure below.

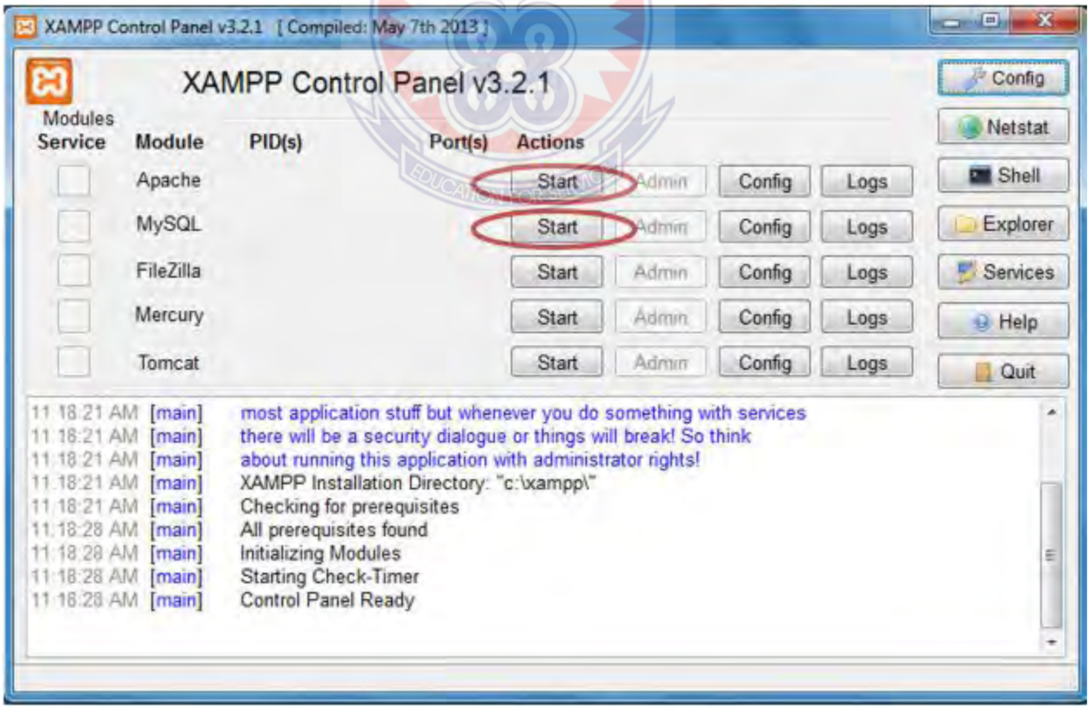



Figure 3: Start Apache and MySQL

3. Enter this url (http://www.nottingham.ac.uk/xerte/) in the address bar and download
xertetoolkits.zip

**Note**: The xerte toolkit is part of the resources on the USB.

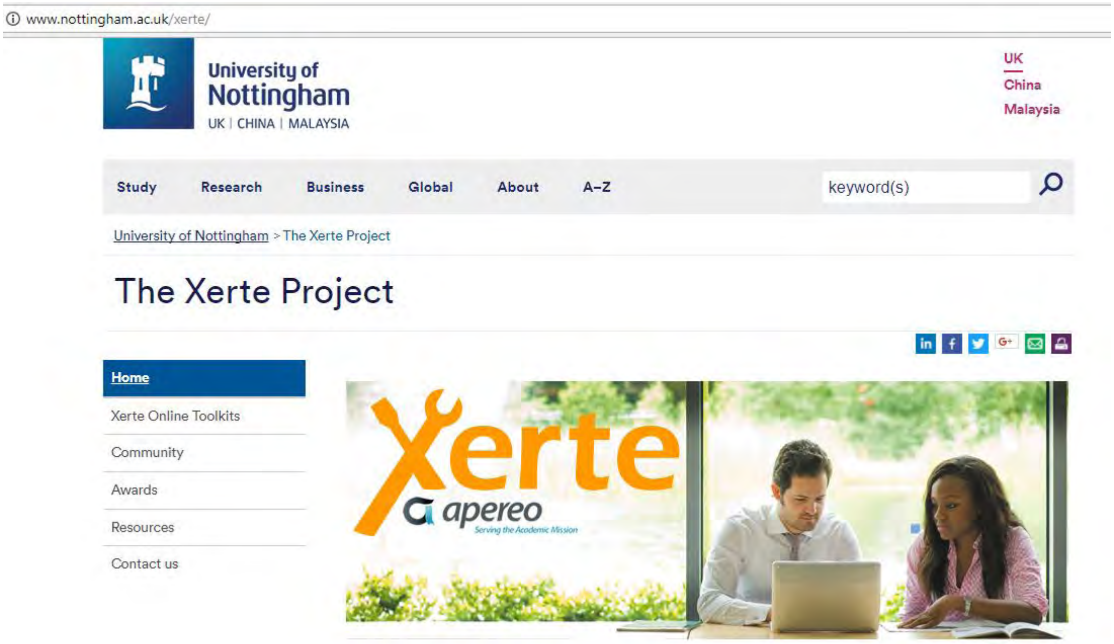



**Figure 4: Xerte Project website**

4. Create a folder on the desktop and name it 'toolkits' . Extract the zip folder downloaded from the Xerte website into the toolkit folder created.

5. Access the XAMPP folder on the drive *C:/* and access the *'htdocs'* folder within the Xampp folder as indicated below

6. Copy the toolkits folder from the desktop and paste in the htdocs folder.

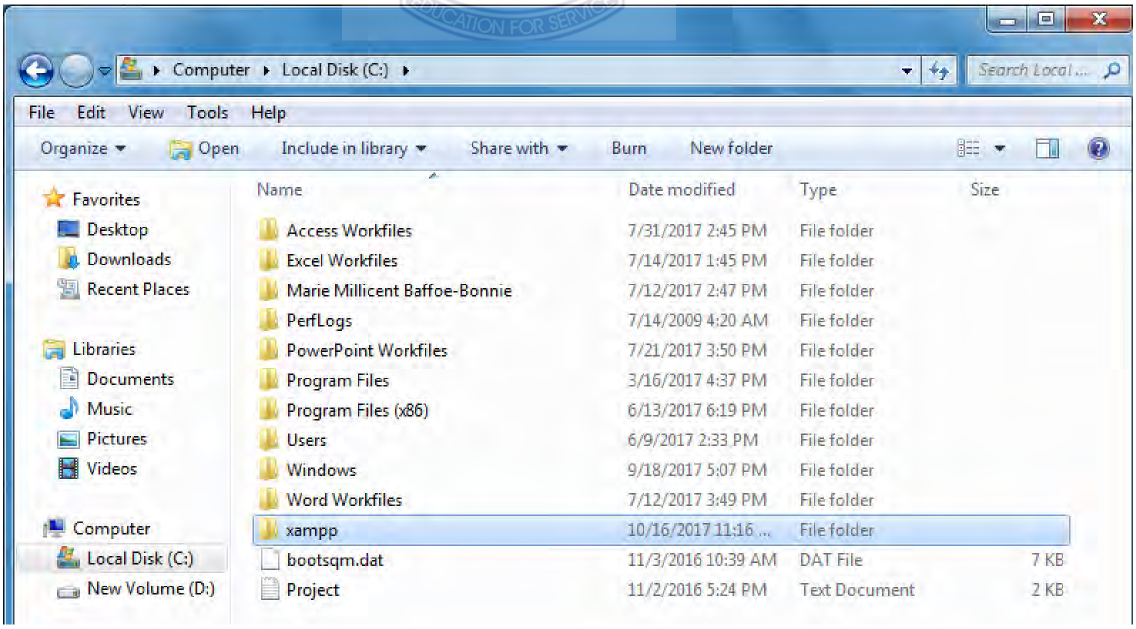



**Figure 5: Local Disk (C:)**

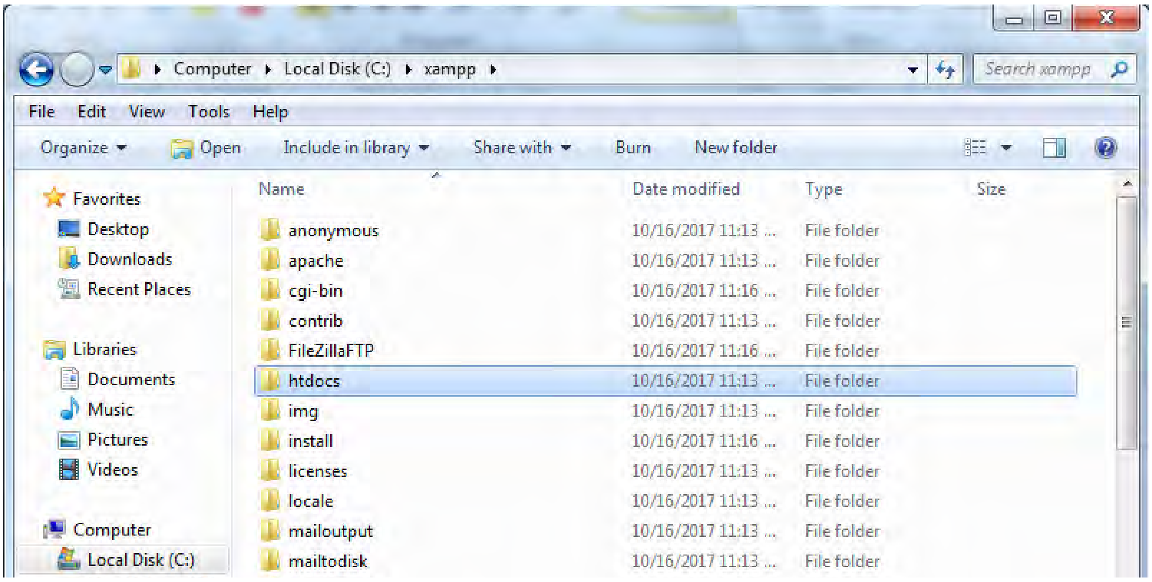



Figure 6: htdocs in the xampp folder

6. Copy the toolkits folder from the desktop and paste in the htdocs folder.

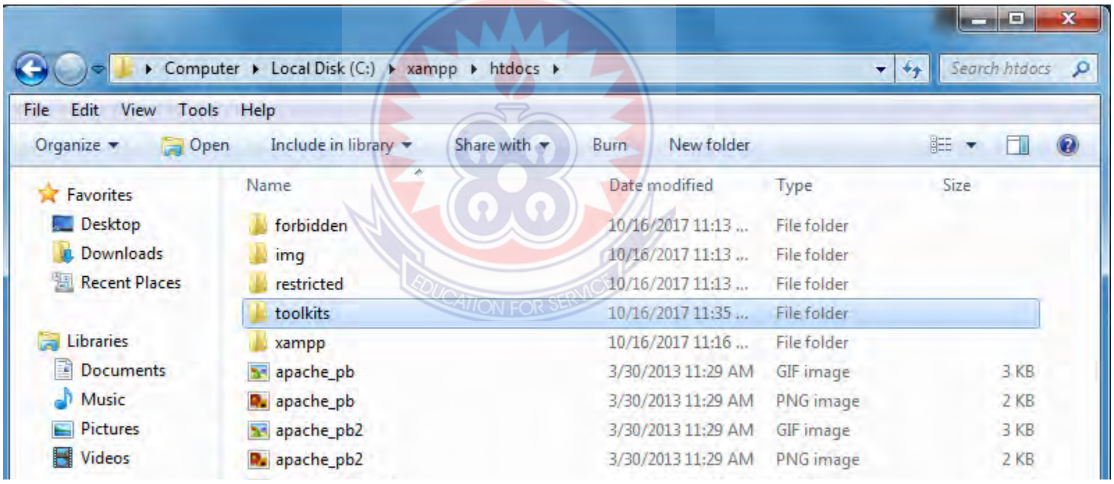



Figure 7: Paste toolkits folder in htdocs

7. In any web browser, type this URL : http://localhost/toolkits/setup and press the enter key on the keyboard.

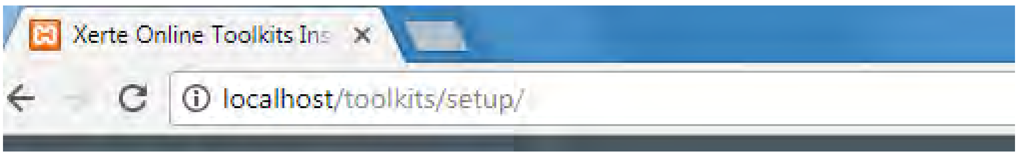



Figure 8: URL for Xerte setup

8. Follow through with the steps to install XERTE.

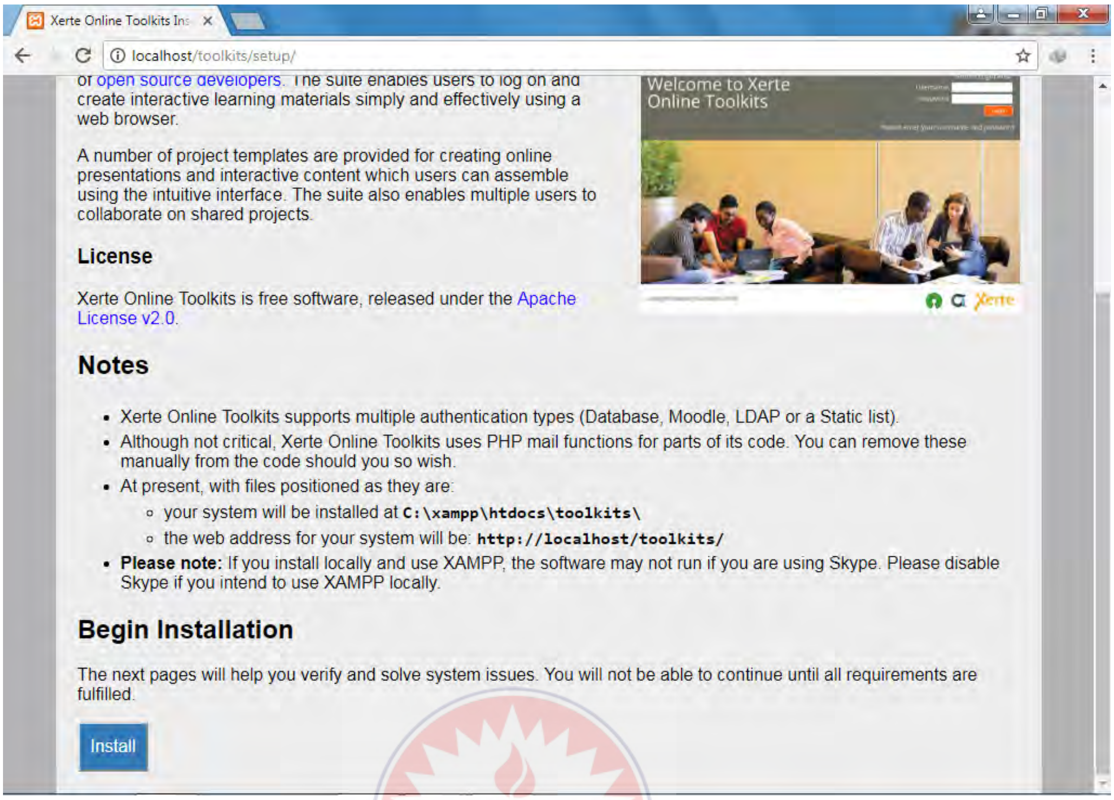
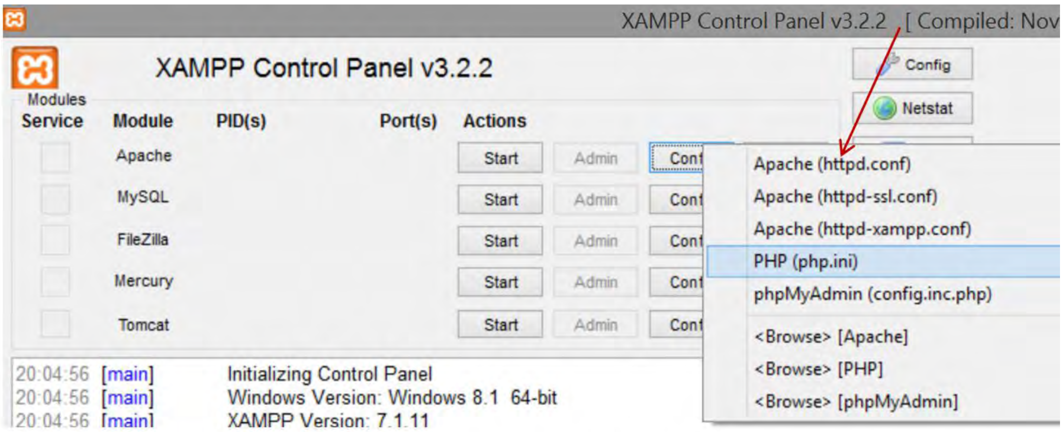



**Figure 9: Installing XERTE**

9. In order to add videos and images, two settings in the php.ini configuration file has to be changed. Retrieve the php.ini configuration file from the xampp control panel by clicking on config of apache and select PHP(php.ini) as shown in the figure below.




Obtaining PHP(php.ini) config file from XAMPP control panel

**Figure 10: Obtaining PHP(php.ini) config file from XAMPP control panel**

10. Click to open the php.ini, which is the apache configuration file. Do the following settings:

-Press CTRL + F and search for *upload_max* in the find what textbox as shown below and increase the value to *1028M*.

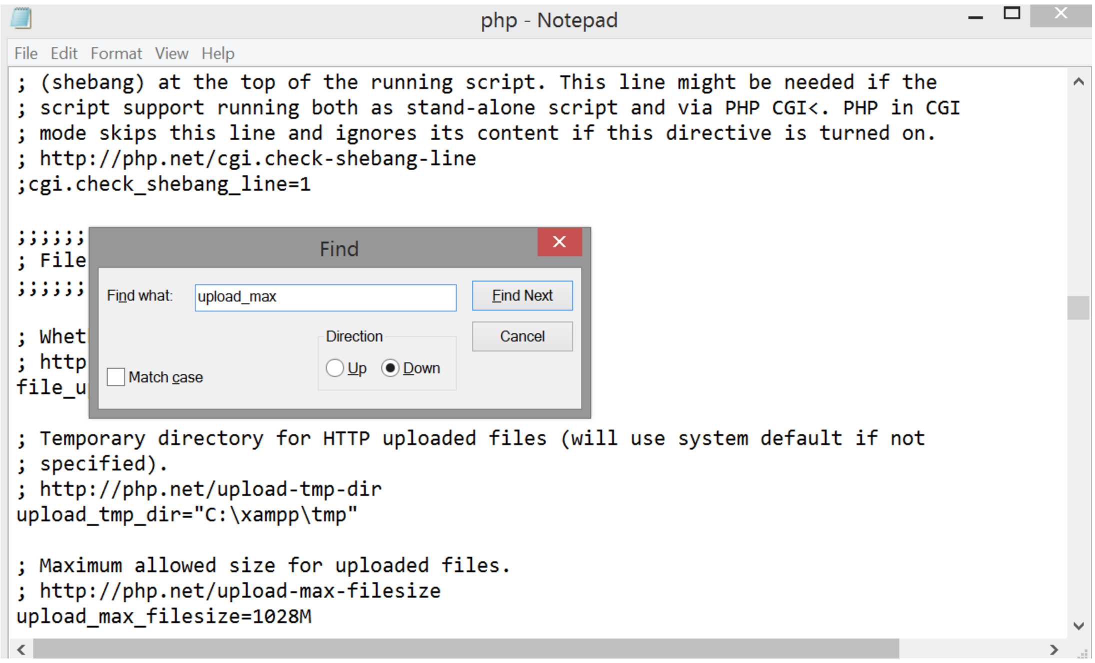



**Figure 11: Changing the value of upload_max_filesize to 1028M**

-Likewise search for *post_max* and increase the value to *200M* as shown below.

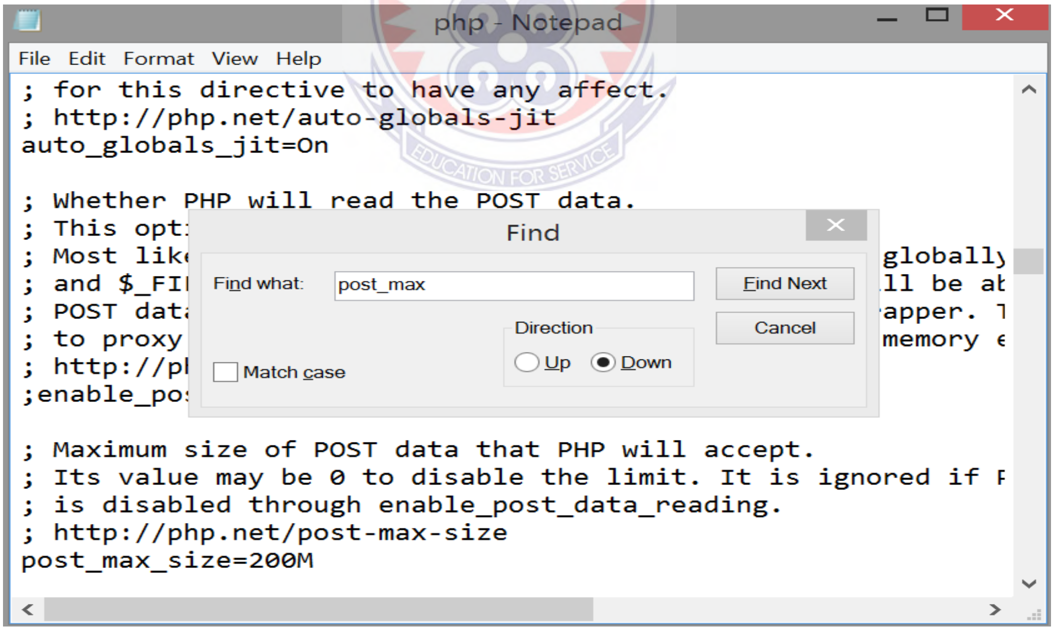
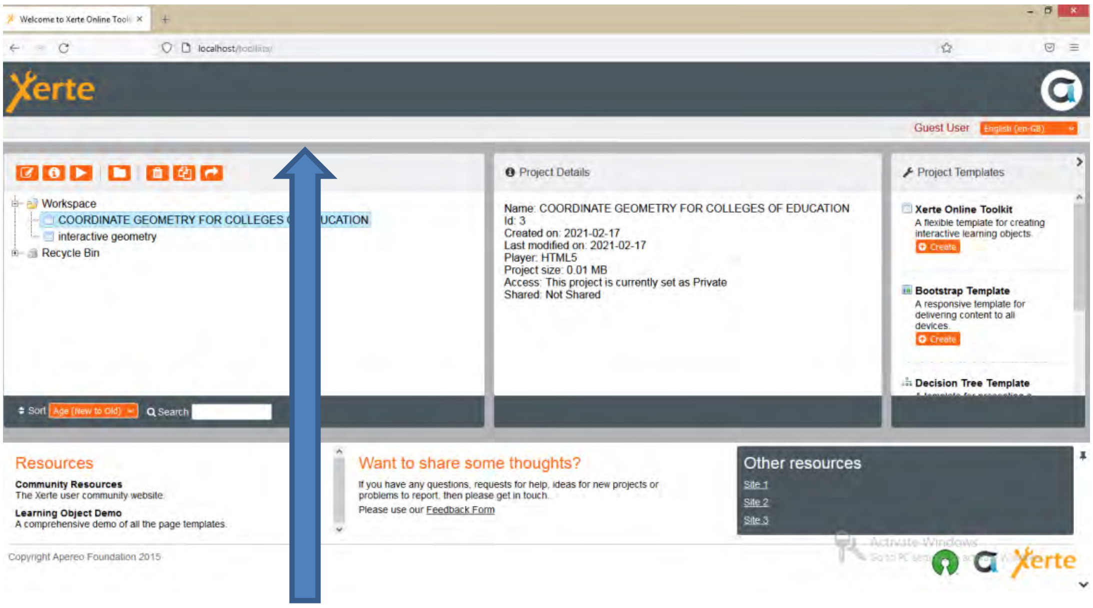


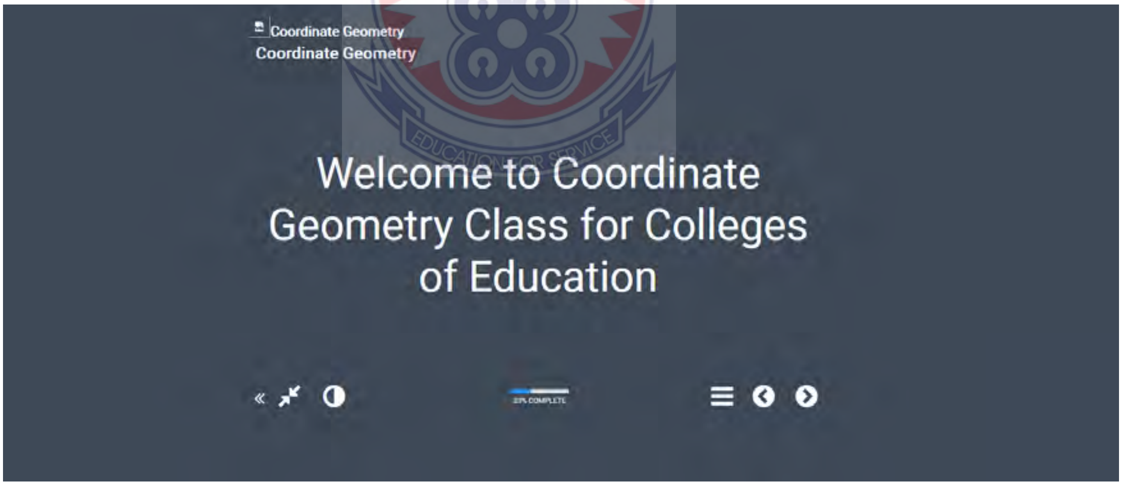

**Figure 12: Changing the value of post_max_size to 200M**

11. Save the file with CTRL + S
12. In the address bar of a browser, type in the URL to access the XERTE online toolkit. E.g. http://localhost/toolkits/. The URL could vary depending on the port that Apache Server responds to. This will

display a page as displayed below. At this stage XERTE is ready for use in creating content.

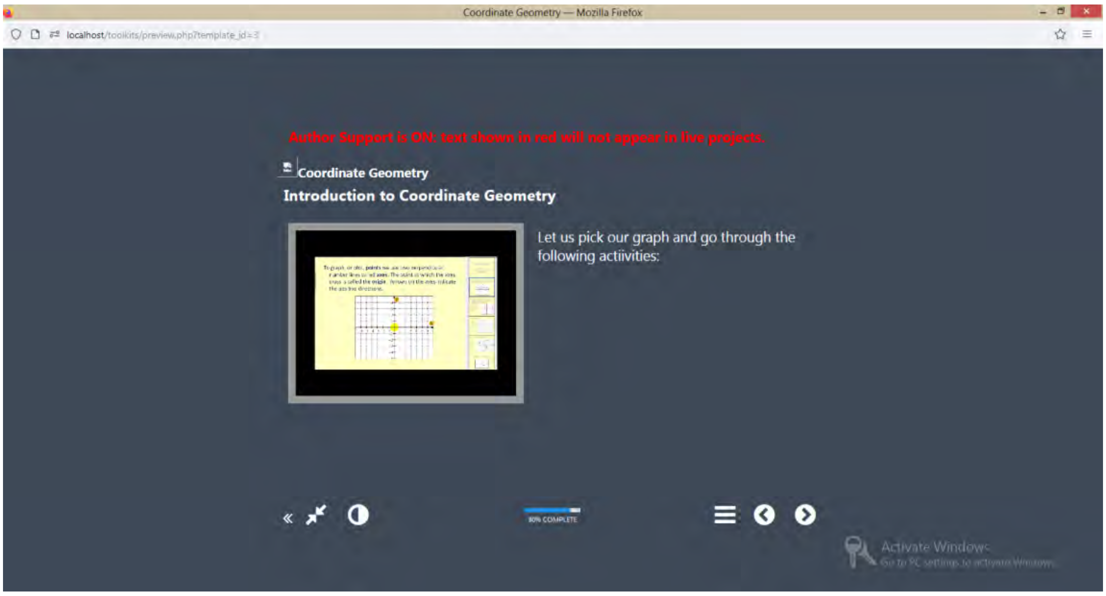



13. Click on **Coordinate Geometry for Colleges of Education** to begin.




## Plotting Points on a Cartesian Plane

A Cartesian plane (named after French mathematician Rene Descartes, who formalized its use in mathematics) is defined by two perpendicular number lines: the $x$-**axis**, which is horizontal, and the $y$-**axis**, which is vertical. Using these axes, we can describe any point in the plane using an ordered pair of numbers. The Cartesian plane extends infinitely in all directions.




https://www.varsitytutors.com/hotmath/hotmath_help/topics/cartesian-plane

Ordered Pair

An ordered pair is a composition of the x coordinate (abscissa) and the y coordinate (ordinate), having two values written in a fixed order within parentheses.

It helps to locate a point on the Cartesian plane for better visual comprehension.

The numeric values in an ordered pair can be integers or fractions.

| |
|---|
| Ordered Pair = (x,y)<br><br>Where, x = abscissa, the distance measure of a point from the primary axis “x”<br><br>And, y = ordinate, the distance measure of a point from the secondary axis “y” |

In the Cartesian plane, we define a two-dimensional space with two perpendicular reference lines, namely x-axis and y-axis. The point where the two lines meet at “0” is the origin.

**To comprehend it better, let’s take an example. Plot the point “P” with coordinates 6, 4.**

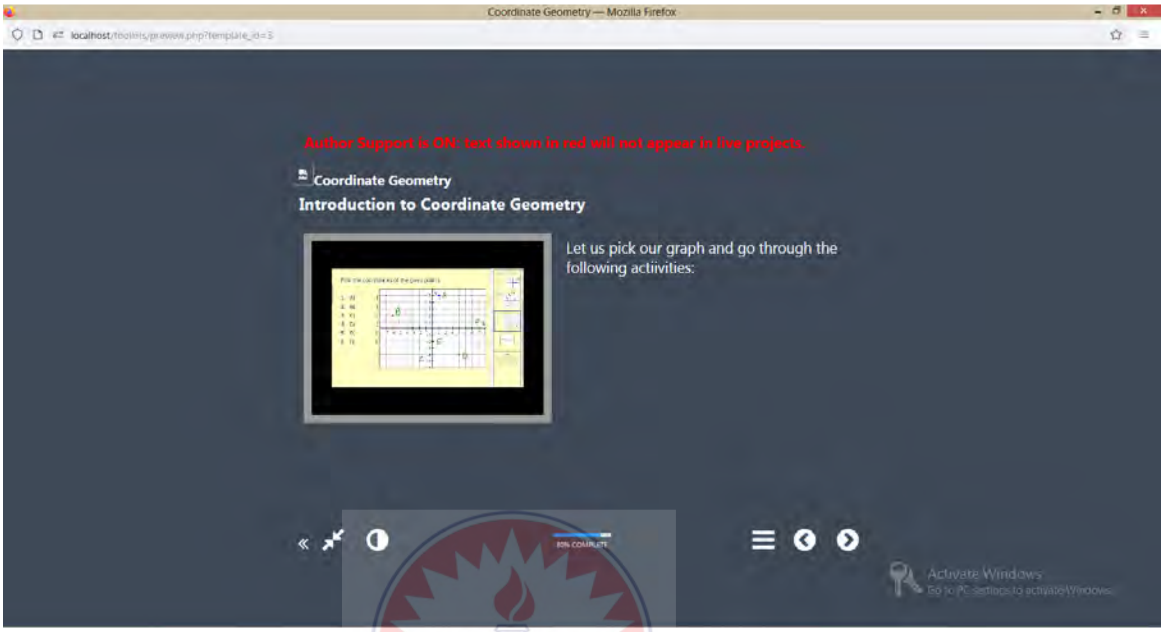
As per the definition of ordered pair, the point P will be written as:

- P = (6, 4)
- The first number in the ordered pair shows the distance from “x" axis which is 6

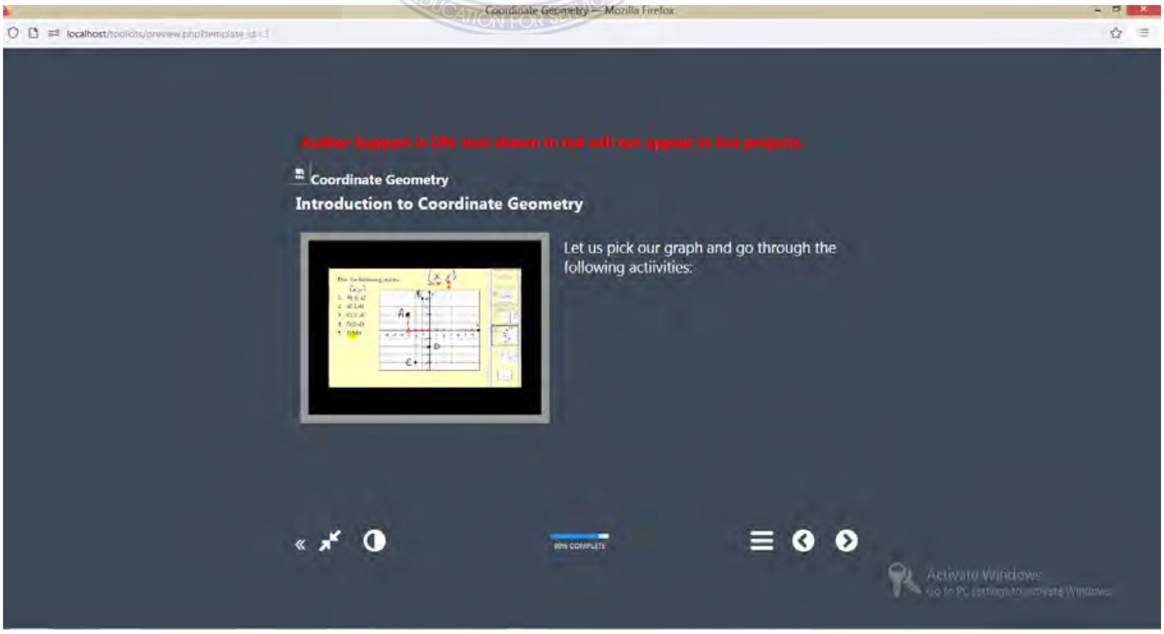
- The second number in the ordered pair shows the distance from "y" axis which is 4

https://www.splashlearn.com/math-vocabulary/geometry/ordered-pair

**Identify the following ordered pair on the Cartesian plane.**



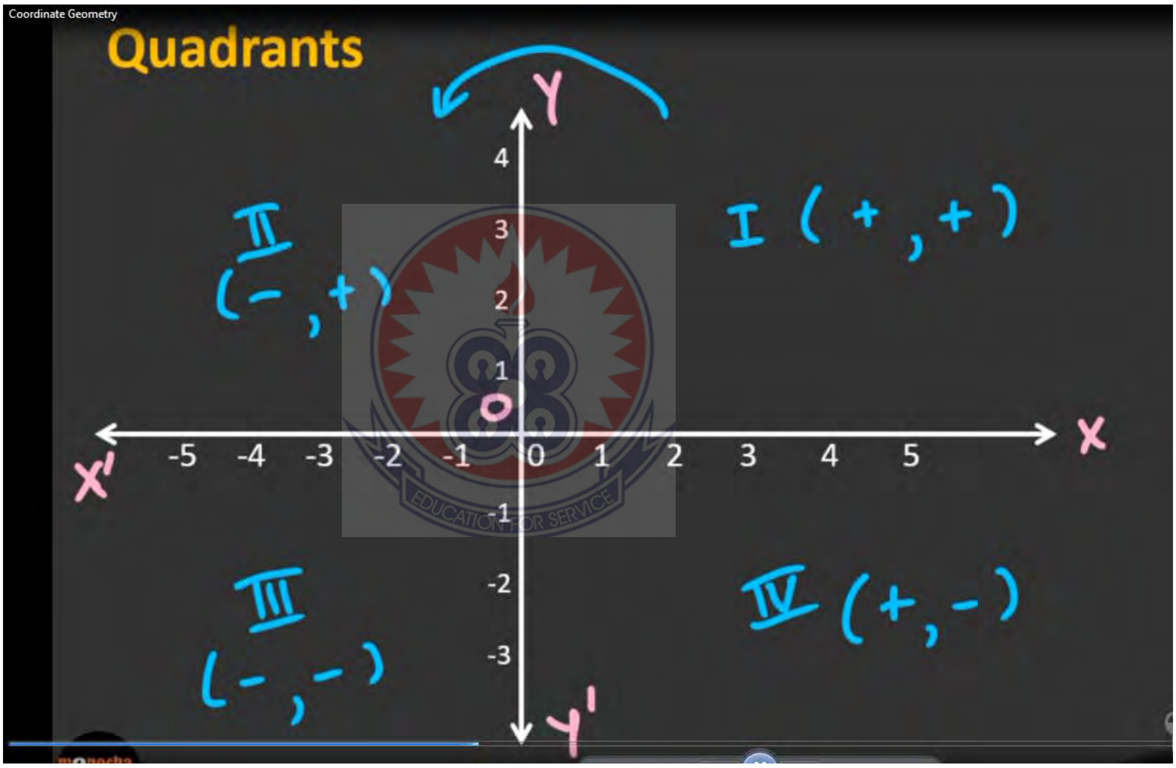

**Locate the following points on the Cartesian plane**



## Quadrants

A quadrant can be defined as a region/part of a cartesian plane which is obtained when the two axes intersect each other creating four regions. It is used to determine the position of a point in a plane.

- The first quadrant is on the upper right-hand corner of the plane. In this quadrant, both x and y-coordinates are positive.
- The second quadrant is on the upper left-hand corner of the plane. In this quadrant, the x-coordinate is negative and the y-coordinate is positive.
- The third quadrant is on the lower left-hand corner of the plane. In this quadrant, both x and y-coordinates are negative.
- The fourth quadrant is on the lower right-hand corner of the plane. In this quadrant, the x-coordinate is positive and the y-coordinate is negative.




## Deriving the distance formula

Guide students to find the formula for finding the distance of two points using Pythagoras theorem.

Let A($x_1$, $y_1$) and B($x_2$, $y_2$) be the coordinates of two points on the coordinate plane.

Draw two lines parallel to both x-axis and y-axis (as shown in the figure) through P and Q.

The parallel line through P will meet the perpendicular drawn to the x-axis from Q at T.

Thus, ΔABD is right-angled at T.

AD = Base, BD = Perpendicular and AB = Hypotenuse

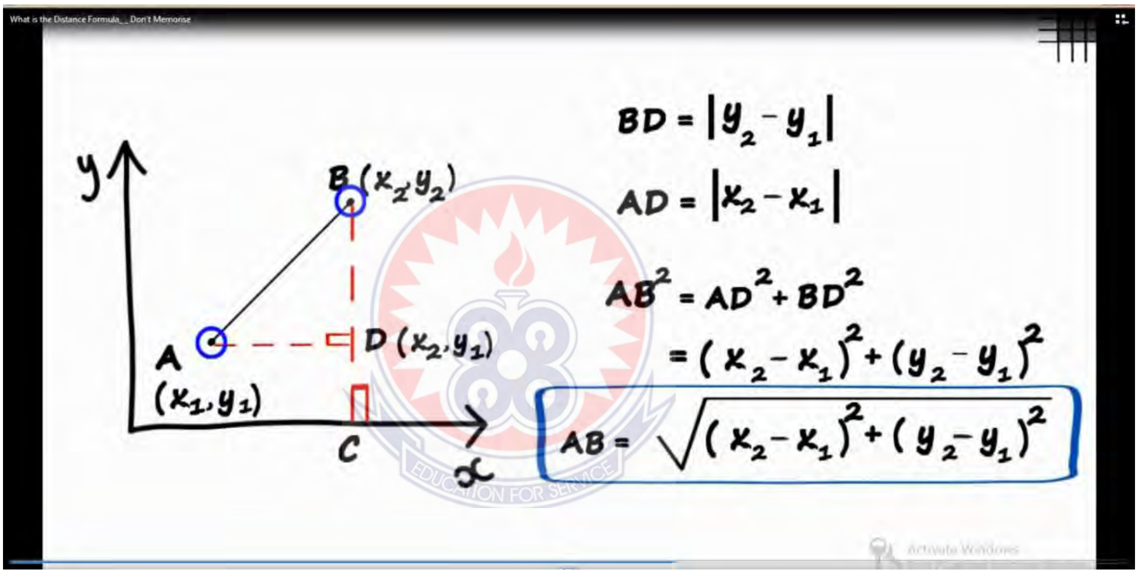
By Pythagoras Theorem,

$AB^2 = AD^2 + BD^2$

$= (x_2 - x_1)^2 + (y_2 - y_1)^2$

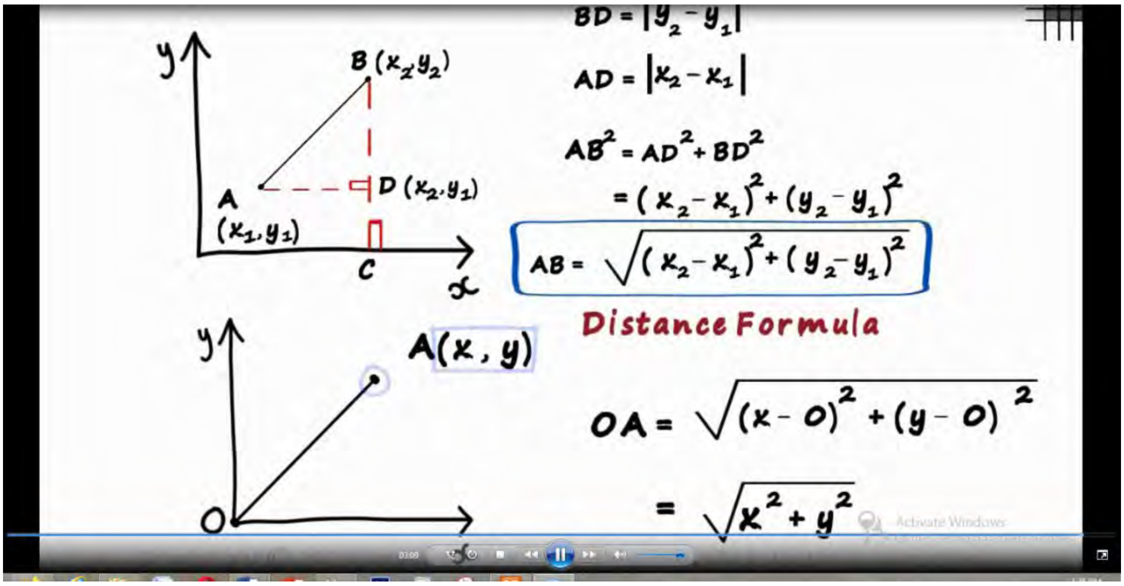
$PQ = \sqrt{[(x_2 - x_1)^2 + (y_2 - y_1)^2]}$

Hence, the distance between two points $(x_1, y_1)$ and $(x_2, y_2)$ is $\sqrt{[(x_2 - x_1)^2 + (y_2 - y_1)^2]}$

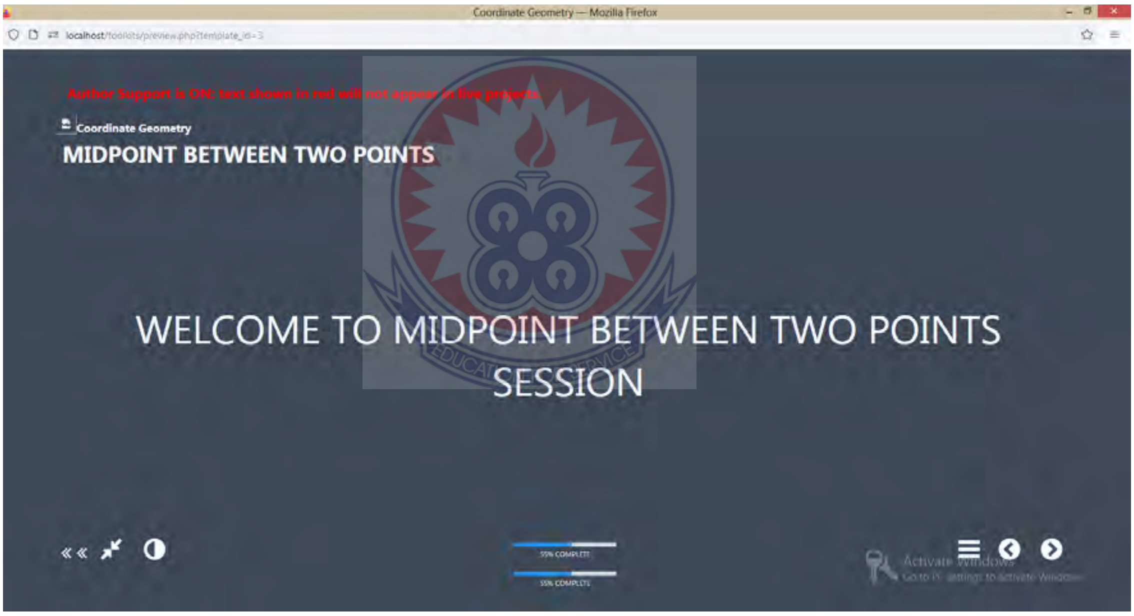


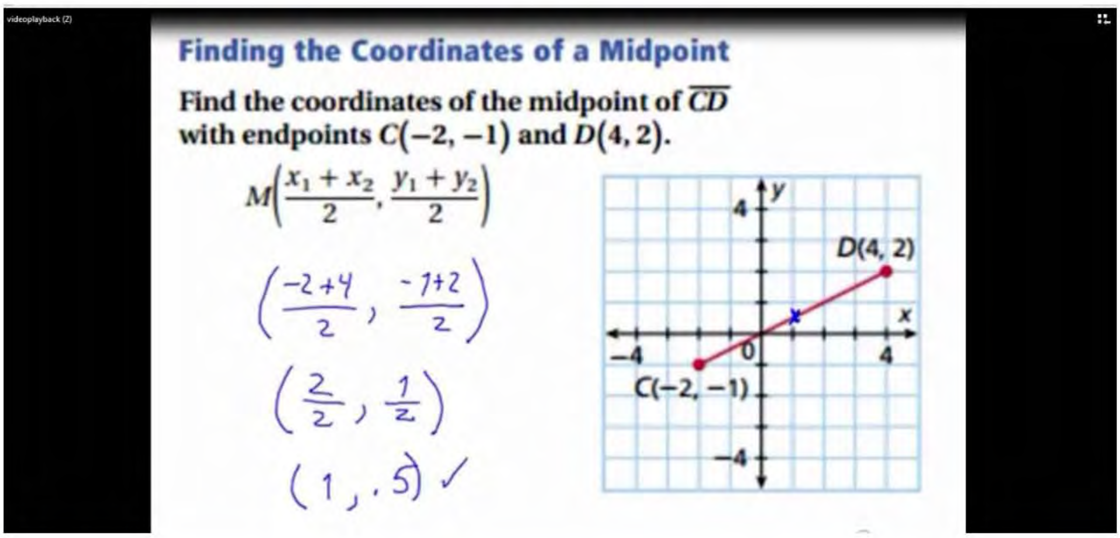

Similarly, the distance of a point P(x, y) from the origin O(0, 0) in the Cartesian plane is given by the formula:

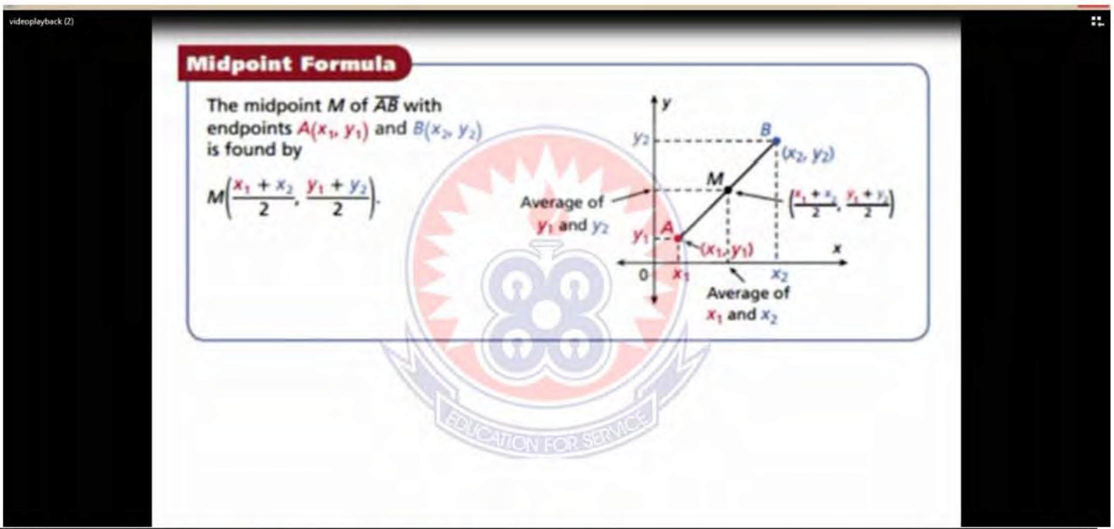
$OA = \sqrt{(x^2 + y^2)}$

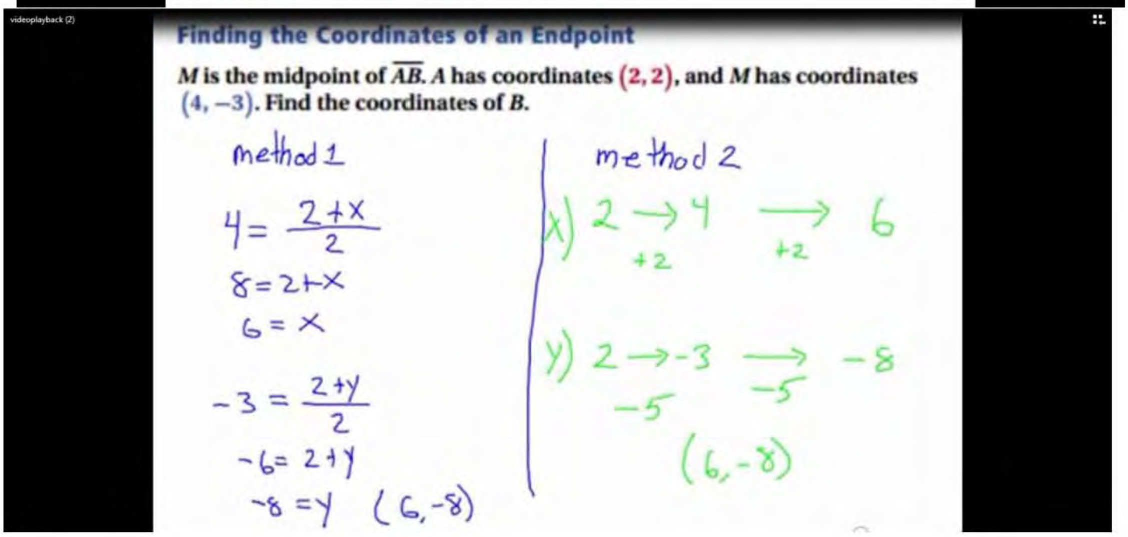


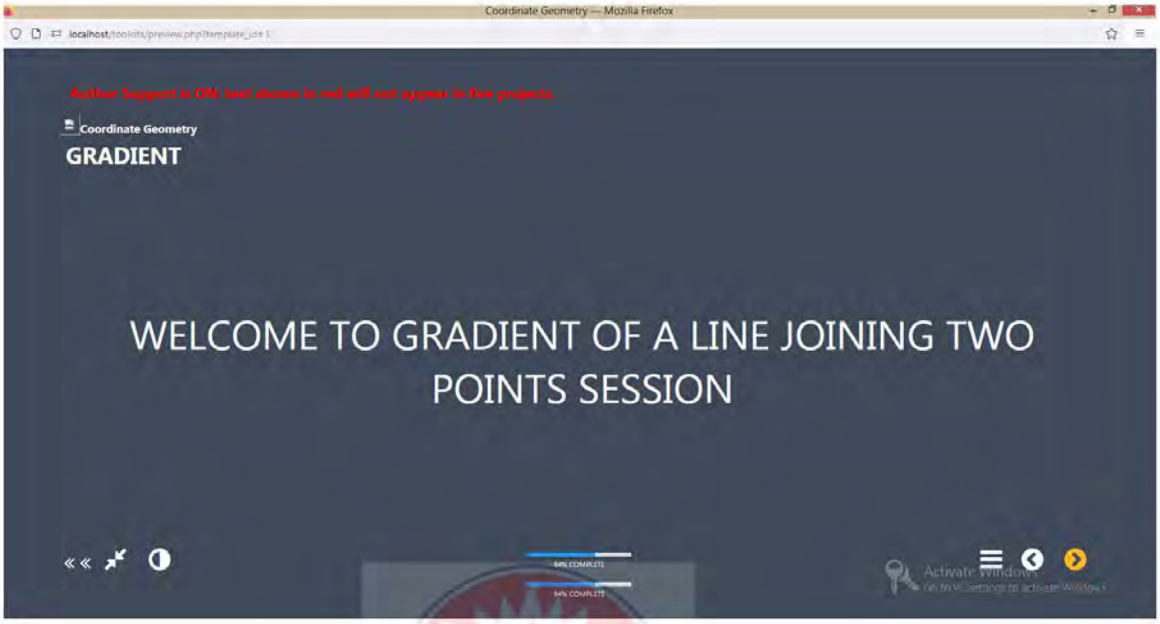

Snapshots of some activities

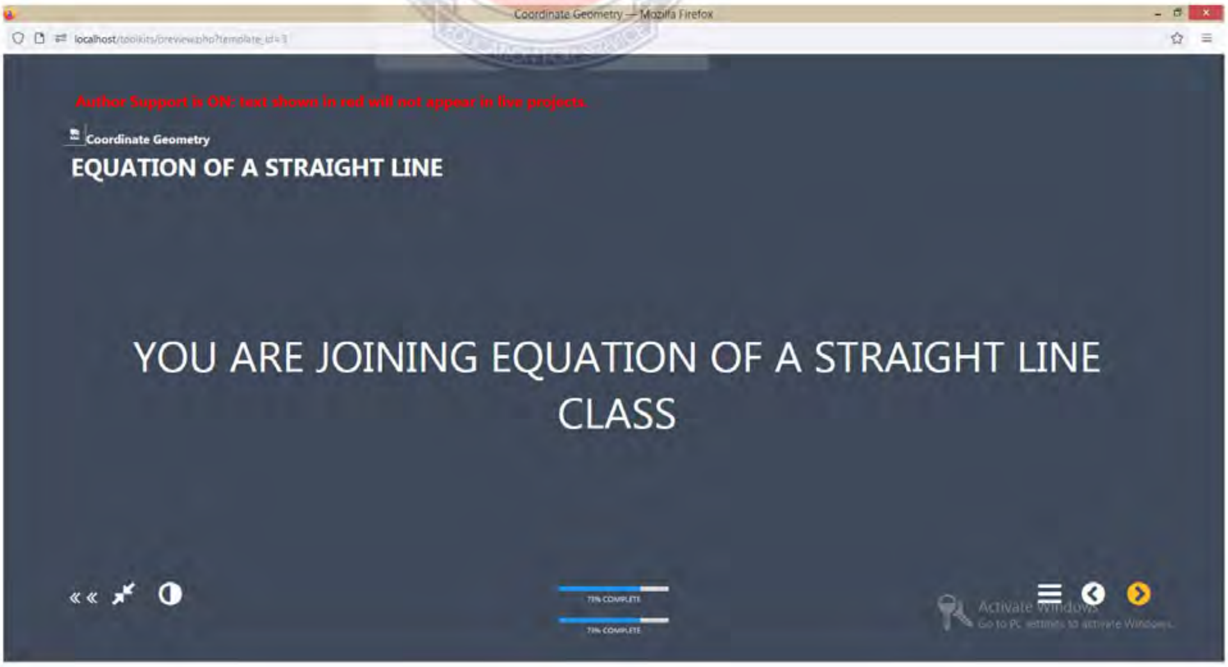


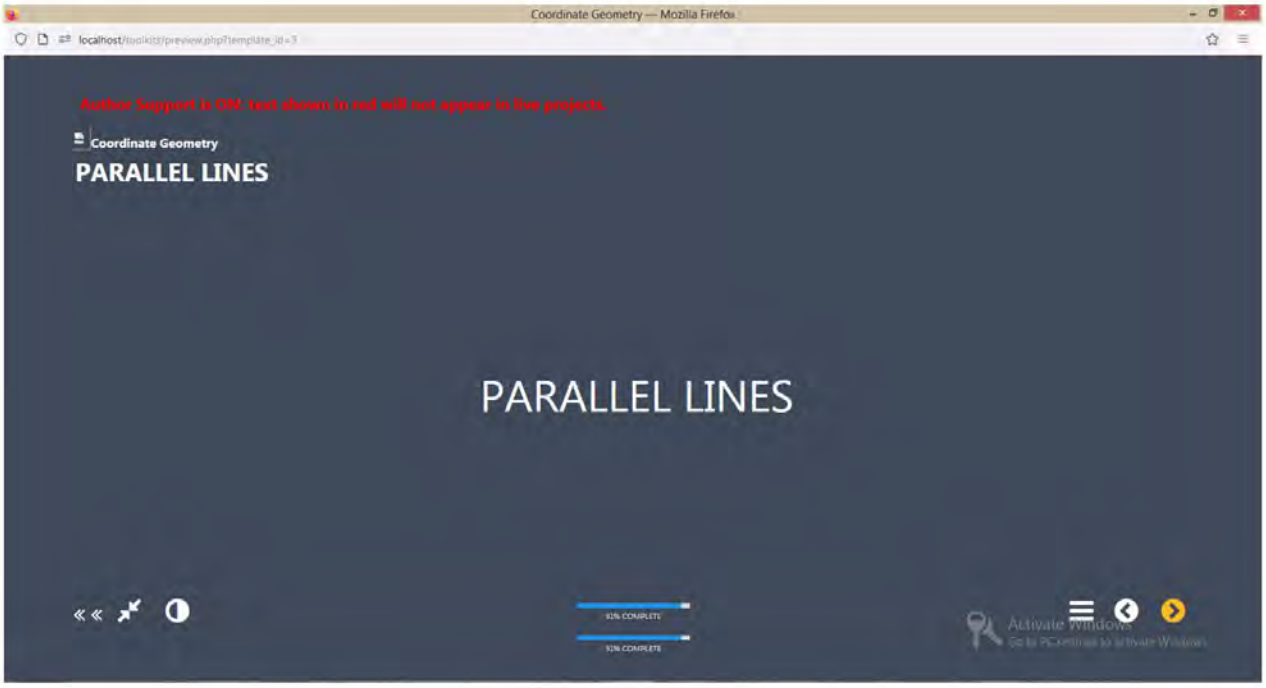

videoplayback (2)
Finding the Coordinates of a Midpoint
Find the coordinates of the midpoint of $\overline{CD}$ with endpoints $C(-2, -1)$ and $D(4, 2)$.
$M\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$
$\left(\frac{-2+4}{2}, \frac{-1+2}{2}\right)$
$\left(\frac{2}{2}, \frac{1}{2}\right)$
(1, .5) ✓
y
4
D(4, 2)
x
−4
0
4
C(−2, −1)
−4


videoplayback (2)
Midpoint Formula
The midpoint $M$ of $\overline{AB}$ with endpoints $A(x_1, y_1)$ and $B(x_2, y_2)$ is found by
$M\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$.
y
$y_2$
B
$(x_2, y_2)$
M
Average of $y_1$ and $y_2$
$\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$
$y_1$
A
$(x_1, y_1)$
x
0
$x_1$
$x_2$
Average of $x_1$ and $x_2$
EDUCATION FOR SERVICE

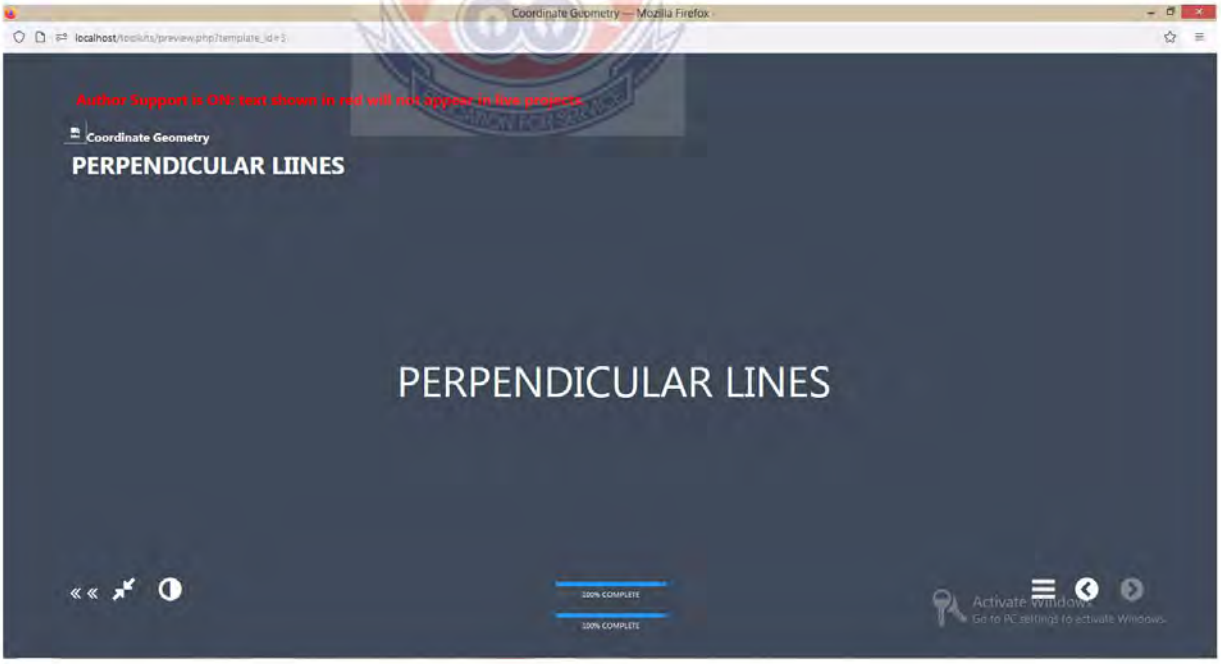

videoplayback (2)
Finding the Coordinates of an Endpoint
$M$ is the midpoint of $\overline{AB}$. $A$ has coordinates (2, 2), and $M$ has coordinates (4, −3). Find the coordinates of $B$.
method 1
$4 = \frac{2+x}{2}$
$8 = 2+x$
$6 = x$
$-3 = \frac{2+y}{2}$
$-6 = 2+y$
$-8 = y$
(6, -8)
method 2
x) 2 → 4 → 6
+2 +2
y) 2 → -3 → -8
-5 -5
(6, -8)


Coordinate Geometry — Mozilla Firefox
Author Support is ON: text shown in red will not appear in live projects.
Coordinate Geometry
GRADIENT
WELCOME TO GRADIENT OF A LINE JOINING TWO POINTS SESSION

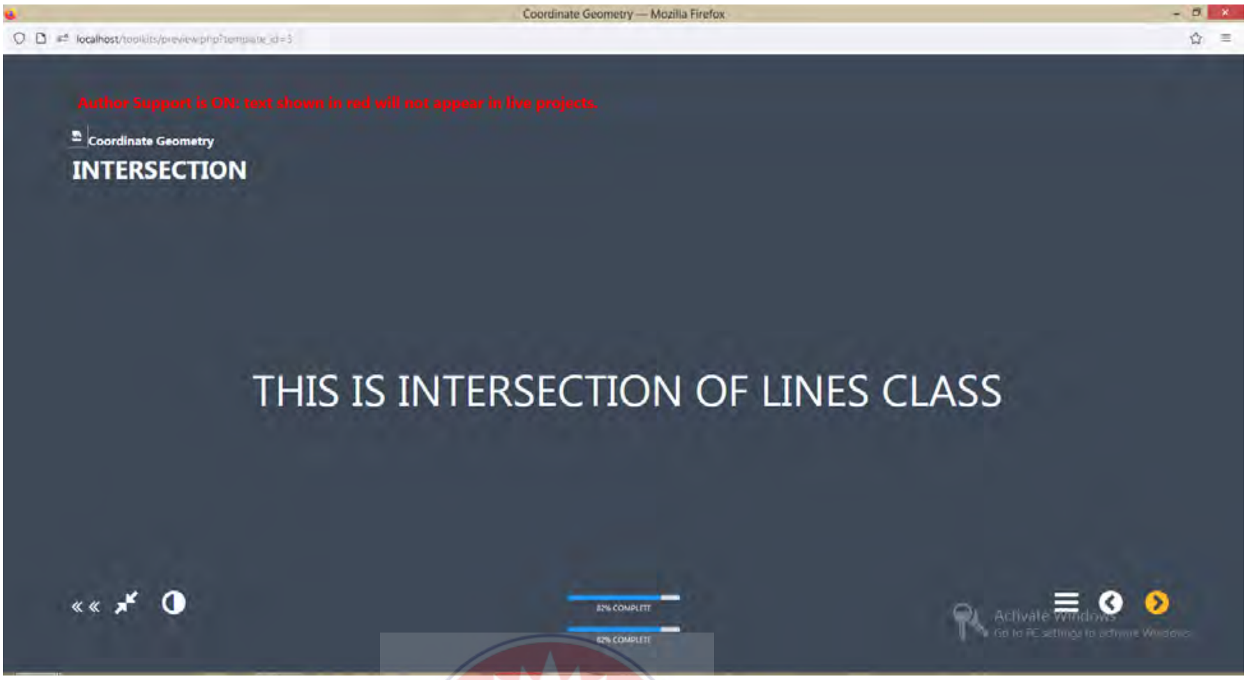

Coordinate Geometry — Mozilla Firefox
Author Support is ON: text shown in red will not appear in live projects.
Coordinate Geometry
EQUATION OF A STRAIGHT LINE
YOU ARE JOINING EQUATION OF A STRAIGHT LINE CLASS



Coordinate Geometry — Mozilla Firefox
Author Support is ON: text shown in red will not appear in live projects.
Coordinate Geometry
PARALLEL LINES
PARALLEL LINES

Coordinate Geometry — Mozilla Firefox
Author Support is ON: text shown in red will not appear in live projects.
Coordinate Geometry
PERPENDICULAR LIINES
PERPENDICULAR LINES
100% COMPLETE


Coordinate Geometry — Mozilla Firefox
Author Support is ON: text shown in red will not appear in live projects.
Coordinate Geometry
INTERSECTION
THIS IS INTERSECTION OF LINES CLASS

# APPENDIX B: PRE-TEST

**Duration: 60 Minutes**

Pretest data collecting instrument – is to test student's knowledge in Coordinate Geom etry

Class/Form of participant; ………………………………………………….....

School of participant; ……………………………………………………....

Please answer ALL questions

This test contains twenty (20) multiple choice questions. Each question is followed by four options lettered A to D. Read each statement carefully and circle the letter of the c orrect or best option. Each question carries 1 mark.

1. Find the distance between the points P(-2, 3) and Q(1, -4).

A. 58units
B. 57units
C. $\sqrt{58}$ units
D. $\sqrt{57}$units

2. The midpoint of line segment AB is (5, 10). If point A is (-5, 8), find the co-ordinates of point B.

A. (12, 15)
B. (15, 12)
C. (-12, 15)
D. (-15, 12)

3. The gradient of a straight line PQ is $\frac{3}{2}$. Determine x so that the line through C(x, 2) and D(0, 2) is parallel to PQ. x = 4

A. x = -4
B. x = 3
C. x = -3

4. Find the equation of the straight line passing through the point (-3, 4) and with gradient $-\frac{3}{5}$. Give the equation in the form ax + by = c.

A. 3x – 5y = 11
B. 3x + 5y = -11
C. 3x + 5y = 12
D. 3x + 5y = 11

5. Find the distance between the points A(1, 2) and B(4, 6).

A. 5.4
B. 5.0
C. 4.0
D. 3.5

6. What are the coordinates of the midpoint of the line joining A(6, -4) and B(8, 2)?

A. (1, 2)
B. (2, -3)
C. (7, -1)
D. (7, -3)

7. Find the equation of the line joining the points A(5, 7) and B(4, 5).

A. $2x - y - 3 = 0$
B. $2x - y + 3 = 0$
C. $2x + y - 3 = 0$
D. $2x + y + 3 = 0$

8. Find the gradient of the line that joins the points A(2, 1) and B(-4, -2).

A. $-\frac{2}{3}$
B. $-\frac{1}{2}$
C. $\frac{1}{2}$
D. 2

9. Find the equation of a line segment joining the points (7, 4) and (-3, 2).

A. $x - 5y - 13 = 0$
B. $x + 5y - 13 = 0$
C. $x - 5y + 13 = 0$
D. $x + 5y + 13 = 0$

10. The gradient of a straight line passing through (8, -12) is $\frac{1}{2}$. Find the equation of the line.

A. $x - 2y + 32 = 0$
B. $x + 2y - 32 = 0$
C. $x + 2y + 32 = 0$
D. $x - 2y - 32 = 0$

11. Find the midpoint M of the line joining the points (8, 4) and (-2, 6).

A. (-3, 5)
B. (3, -5)

C. (5, 3)
D. (3, 5)

12. Find the equation of the line joining the point A(1, 9) and M(3, 5).

A. $2x + y + 11 = 0$
B. $2x - y + 11 = 0$
C. $2x + y - 11 = 0$
D. $2x - y - 11 = 0$

13. What is the shortest distance between the points P(2, 3) and Q(5, 7).

A. 3
B. 4
C. 5
D. 6

14. The coordinates of the end points of a line segment are A(7, -8) and B(5, 7). The midpoint of line AB is ............

A. (12, -4)
B. (6, -4)
C. (6, -2)
D. (1, -6)

15. Find the gradients of the line that joins the points A(2, 3) and B(5, 4).

A. $\frac{1}{3}$
B. $\frac{1}{2}$
C. 1
D. 2

16. Find the equation of a line that passes through the points A(2, 3) and B(6, 8).

A. $5x - 4y + 2 = 0$
B. $5x - 4y - 2 = 0$
C. $5x + 4y - 2 = 0$
D. $5x + 4y + 2 = 0$

17. Find the equation of the perpendicular bisector of the line joining A(2, 4) and B(4, 10).

A. $x + 3y - 24 = 0$
B. $x - 3y + 24 = 0$
C. $x - 3y - 24 = 0$
D. $x + 3y + 24 = 0$

**Use the information below to answer the question 18 - 20**

A line passing through A(-3, 8) and P(x, 0) is parallel to the line joining (2, 7) and (6, 5).

18. Find the equation of line AP.

  A. $x - 2y - 13 = 0$
  B. $x + 2y - 13 = 0$
  C. $x + 2y + 13 = 0$
  D. $x - 2y + 13 = 0$

19. Determine the value of x.

  A. $x = 12$
  B. $x = 11$
  C. $x = 14$
  D. $x = 13$

20. Calculate, correct to one decimal place, the magnitude of line segment AP.

  A. 17.9units
  B. 17.7units
  C. 18units
  D. 17.8units

## APPENDIX C: PRE-TEST MARKING SCHEME

1. C
2. B
3. B
4. D
5. B
6. C
7. A
8. C
9. C
10. D
11. D
12. C
13. C
14. C
15. A
16. A
17. A
18. B
19. D
20. A

## APPENDIX D: POST-TEST

**Duration: 60 Minutes**

Pretest data collecting instrument – is to test student's knowledge in Coordinate Geom etry

Class/Form of participant; …………………………………………………....

School of participant; ……………………………………………………...

**Please answer ALL questions**

**This test contains twenty (20) multiple choice questions. Each question is followed by four options lettered A to D. Read each statement carefully and circle the lette r of the correct or best option. Each question carries 1 mark.**

1. Find the gradient of the straight line 2x+3y=7
   A. $-\frac{3}{2}$
   B. $-\frac{2}{3}$
   C. $\frac{2}{3}$
   D. $\frac{3}{2}$

2. A(8, 3) and B(4, 7) are points on a plane. Find the midpoint of the line segment AB.
   A. (6, 5)
   B. (4, 10)
   C. (6, 10)
   D. (12, 5)

3. Find the equation of a line segment joining the points (6, 9) and (2, 7).
   A. x + 2y – 12 = 0
   B. x + 2y + 12 = 0
   C. x - 2y – 12 = 0
   D. x - 2y + 12 = 0

4. Find the distance between the points A(5, 2) and B(-1, -5) to the nearest whole number.
   A. 8units
   B. 7units
   C. 10units
   D. 9units

5. Find the equation of the straight line that passes through the points (0, 5) and (5, 7).
   A. 5y – 2x = 25
   B. 5y + 2x = 25
   C. 5y – 2x = -25

D. 5y + 2x = -25

6. Find the equation of the line that passes through the points ($3\frac{1}{2}$, -5) and (-$-4\frac{1}{2}$, -7).

A. 2x + 8y – 47 = 0
B. 2x - 8y + 47 = 0
C. 2x - 8y – 47 = 0
D. 2x + 8y + 47 = 0

7. The coordinates of the midpoint of the line joining A(-1, 6) and B(p, q) is (-2, $9\frac{1}{2}$). Find the values of p and q.

A. (3, 13)
B. (3, -13)
C. (-3, 13)
D. (-3, -13)

8. Find the gradient of the line joining the points (4,-3) and (-2, 7).

A. $-\frac{5}{3}$
B. $\frac{5}{3}$
C. $-\frac{3}{5}$
D. $\frac{3}{5}$

9. Find the magnitude of the line segment joining the points P(-3, 8) and Q(-4, -2).

A. 9.00
B. 10.00
C. 9.05
D. 10.05

10. Find the equation of a straight line having gradient $\frac{2}{3}$ and passing through (-8, 11).

A. 2x - 3y - 49 = 0
B. 2x - 3y + 49 = 0
C. 2x + 3y + 49 = 0
D. 2x + 3y - 49 = 0

11. Find the equation of the line joining the point A(1, 9) to the midpoint of PQ where P(-4, 3) and Q(2, 5).

A. 5x - 2y + 13 = 0
B. 5x + 2y + 13 = 0
C. 5x - 2y - 13 = 0
D. 5x + 2y - 13 = 0

12. Find the equation of the perpendicular bisector of the joining (-2, 9) and (6, -7).
    A. y = -2x
    B. x = -2y
    C. y = 2x
    D. x = 2y

13. Find the intersection of lines 2y+3x=16 and 7y=2x+6.
    A. (2, 4)
    B. (4, 2)
    C. (-4, 2)
    D. (4, -2)

14. Find the equation of the line which passes through the point (2, 3) and parallel to the line 2y – x = 3
    A. 2y + x – 4 = 0
    B. 2y – x + 4 = 0
    C. 2y – x – 4 = 0
    D. 2y + x + 4 = 0

15. Determine the distance between points (3, 5) and (6, 9).
    A. 4
    B. 5
    C. 6
    D. 7

16. State the gradient and y-intercept of the line 3y - 6x = 9.
    A. 2 and 3
    B. -2 and 3
    C. 2 and -3
    D. -2 and -3

17. Find the gradient of the line passing through the points (1, 2) and (3, 6).
    A. 1
    B. 3
    C. 4
    D. 2

**Use the information below to answer questions 18 – 20**
**M(4,7) is the midpoint of A(x, y) and B(6, 11)**

18. Determine the values of x and y.
    A. (3, 2)
    B. (-3, 2)
    C. (-2, 3)
    D. (2, 3)

19. Find the equation of the line which passes through the point A and perpendicular to the line 9x-12y-11=0.

   A. $3y + 4x - 17 = 0$
   B. $3y - 4x - 17 = 0$
   C. $3y + 4x + 17 = 0$
   D. $3y - 4x + 17 = 0$

20. Determine the magnitude of AB, leaving your answer in surd form.

   A. $2\sqrt{5}$
   B. $3\sqrt{5}$
   C. $4\sqrt{5}$
   D. $5\sqrt{5}$

## APPENDIX E: POST-TEST

## POST TEST MARKING SCHEME

1. B
2. A
3. D
4. D
5. A
6. C
7. C
8. A
9. D
10. B
11. A
12. C
13. B
14. C
15. B
16. A
17. D
18. D
19. A
20. C

## APPENDIX F: QUESTIONNAIRE

**Introduction**

Dear Respondent,

This exercise is purely for academic purposes only and your confidentiality is assured. Thank you

**SECTION A: Biographical Information**

1. What is your age (years)?................

2. Indicate your gender…………………………

**SECTION B:**

**Direction:** Please tick (√ ) and rate yourself honestly based on what you actually do give the statements using the following scales

**SD** = Strongly Disagree; **D** = Disagree; **NS** = Not Sure; **A** = Agree; **SA** =Strongly Agree

**Students Perception on Xerte Tool Kit in teaching coordinate Geometry**

| No. | **Statement** | **SD** | **D** | **NS** | **A** | **SA** |
|---|---|---|---|---|---|---|
| 3 | I would like to use Xerte tool kit to learn coordinate geometry always. | | | | | |
| 4. | Using Xerte tool kit does not make the learning of coordinate geometry interesting. | | | | | |
| 5. | Xerte tool kit helps to learn coordinate geometry concepts. | | | | | |
| 6. | Xerte tool kit did not help me to understand coordinate geometry concept. | | | | | |
| 7. | Xerte Tool kit helps to think creatively. | | | | | |
| 8. | Critical thinking is enhanced by using Xerte tool kit in learning coordinate geometry. | | | | | |
| 9. | Xerte tool kit assists me to learn coordinate geometry without the guide of my tutor. | | | | | |
| 10. | Xerte tool kit does not support interaction of students and tutors. | | | | | |

| No. | Statement | SD | D | NS | A | SA |
|---|---|---|---|---|---|---|
| 11. | My attention span is enhanced when I use xerte tool kit to study coordinate geometry. | | | | | |
| 12. | Xerte tool kit does not demystify difficult concept in coordinate geometry. | | | | | |
| 13. | I prefer to learn coordinate geometry without the use of Xerte tool kit | | | | | |
| 14. | I am happy with my tutor when he/she uses Xerte tool kit to teach coordinate geometry. | | | | | |
| 15. | The use of Xerte tool kit in teaching coordinate geometry is a waste of time. | | | | | |
| 16. | Xerte tool kit creates more difficulty in studying coordinate geometry. | | | | | |

## APPENDIX G: INTERVIEW GUIDE

1. How has xerte toolkit aroused your interest in understanding the concept of coordinate geometry?
2. How do you rate your competence with the use of xerte toolkit?
3. Was xerte toolkit interface user friendly?
4. Do you ever intend to use xerte toolkit again in your studies?