# EFFECTS OF GEOGEBRA AND WEB-BASED PRACTICE ON ATTITUDE AND PERFORMANCE IN COORDINATE GEOMETRY AMONG STUDENTS OF COLLEGES OF EDUCATION IN NORTH WEST ZONE, NIGERIA

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JUNE, 2019

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## DECLARATION

I Sani SAIDU (P14EDSC9010) declare that this thesis titled “Effects of GeoGebra and Web-Based Practice on Attitude and Performance in Coordinate Geometry among Students of Colleges of Education in North West Zone, Nigeria” was carried out by me in the Department of Science Education, Ahmadu Bello University, and Zaria.

This thesis as a whole or part was not previously presented to any institution for the award of degree or diploma. The information derived from literature has been duly acknowledged in the text and the list of references provided.

Sani, SA’IDU ……. …….
Signature Date

**CERTIFICATION**

This thesis titled "Effects of GeoGebra and Web-Based Practice on Attitude And Performance in Coordinate Geometry Among Students of Colleges of Education in North West" by Sani SAIDU has been read and approved in meeting the regulations governing the award of the degree of Doctor of Philosophy (Ph.D.) in Mathematics Education of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

| | | |
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## DEDICATION

This study is dedicated to my parents: Late Alhaji Saidu Saleh (May his soul continues to rest in peace) and my mother Hajiya Hamamatu Saidu Abdullahi (May Allah continues to give her good health, long life that is full of happiness and obedience to Allah).

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**ABBREVIATIONS USED**

| | |
|---|---|
| ANCOVA: | Analyses of Covariance |
| ANOVA: | Analyses of Variance |
| CAS: | Computer Algebraic System |
| CG: | Control Group |
| CGAT: | Coordinate Geometry Attitude Test |
| CGPT: | Coordinate Geometry Performance Test |
| CK: | Content Knowledge |
| DGS: | Dynamic Geometric Software |
| EDC: | Educational Broadcasting Cooperation |
| EG: | Experimental Group |
| E-Learning: | Electronic Learning |
| FRN: | Federal Republic of Nigeria |
| FSMAS: | Fennema – Sharma Attitude Scale |
| GAT: | Geometry Achievement Test |
| GII: | Geometry Interest Inventory |
| GSP: | Geometric Sketch Pad |
| HV: | High Visual |
| ICT: | Information and Communication Technology |
| KFUPMR: | King Fahd University of Petroleum and Mineral Resources |
| LV: | Low Visual |
| MAN: | Mathematical Association of Nigeria |
| MLA: | Mastery Learning Approval |
| NCCE: | National Commission for Colleges of Education |
| NCTM: | National Council of Teachers of Mathematics |
| NMC: | National Mathematical Centre |
| OECD: | Organization for Economic Cooperation and Development |
| OSS: | Open Source Software |

| | |
|---|---|
| PCK: | Pedagogical Content Knowledge |
| PISA: | Programme for International Student Assessment |
| SDG: | Sustainable Development Goal |
| TALP: | Traditional Assisted Learning Practice |
| TCK: | Technological Content Knowledge |
| TIMSS: | Trend in International Mathematics and Science Study |
| TK: | Technological Knowledge |
| TPACK: | Technology Pedagogical Content Knowledge |
| UTME: | Unified Tertiary Matriculation Examination |
| WALA: | Web based Assisted Learning and Practice |

## OPERATIONAL DEFINATION OF TERMS

**Academic Performance**: Use of the knowledge students have acquired to earn scores or marks in a given test or examination

**Attitude:** refers to feelings and behavioral tendencies towards a subject.

**Coordinate Geometry**: Is a branch of Mathematics that bridges the gap between Algebra and Geometry.

**GeoGebra**: Is a dynamic computer software for teaching and learning Mathematics and other related subjects.

**Web- Based Practice**: Is a method of solving Mathematics exercises/problems through the use of internet. It's also known as electronic practice. Solutions, immediate feedback and hints are usually available

## ABSTRACT

This research investigated the effects of GeoGebra and Web - Based Practice on attitude and performance in Coordinate Geometry among Students of Colleges of Education in North West Zone, Nigeria. A pretest -posttest, quasi experimental design was used to carry out the study. A sample of 210 students out of 1465 NCE1 Mathematics students from three out of twelve colleges of education in the zone was randomly selected. In this study, six research objectives were stated; six research questions were asked and six hypotheses were formulated and tested at 0.05 level of significance. Two research instruments were used in the work, namely: Coordinate Geometry Performance Test (CGPT) and Coordinate Geometry Attitude Test (CGAT). The two instruments were validated by experts from the rank of Senior Lecturers and above. The reliability coefficients of CGPT and CGAT were calculated to be 0.79 and 0.80 respectively. In addition to these, lesson plans were written by the researcher and were used in teaching the experimental and control groups. Mean, mean rank, standard deviations were used to describe the data; while t-test, ANOVA, Mann Whitney U- test, Krukal Wallis - H test were used in testing the hypotheses. Some of the findings of the study were: there is significant difference in academic performance between NCE 1 Mathematics students taught Coordinate Geometry using GeoGebra and those taught using lecture method in favour of the former. More so, significant change in attitude towards Coordinate Geometry was found among the students taught using GeoGebra. However no significant difference in academic performance was found between NCE 1 students taught using Web - Based Practice and those taught using lecture method. Similarly no significant change in attitude was found between Web- based Practice Students and those taught using lecture method. Likewise, no significant difference in gender performance in, and attitudinal change towards Coordinate Geometry was recorded among all the three instructional methods. Based on these findings, it was recommended among others that lecturers in colleges of education should use GeoGebra in teaching Coordinate Geometry and other courses.

**APTER ONE**

# THE PROBLEM

## 1.1 Introduction

Geometry according to Sarracco (2005) is a branch of Mathematics that involves properties, measurement and relationship of points, lines, angles, surface and solids. Geometry is one of the main branches of Mathematics in primary and secondary schools in Nigeria. It is taught as a subject of its own in some countries like Turkey. One of the main reasons for teaching Geometry is that it enables us interpret our environment. The environment we live in is full of geometrical figures. Another reason is that the knowledge of Geometry has a lot of applications in other fields such as survey, architecture, building, structural engineering and industrial arts to mention a few. More so the National Council of Mathematics Teachers (NCTM, 2000) described Geometry as natural place for the development of students reasoning and justification of skills where students should understand that part of the beauty of Mathematics is when interesting thing happen is usually for good reason. Some of the major types of Geometry include: Euclidean Geometry, Projective Geometry, Differential Geometry, Coordinate Geometry (Analytic Geometry) and Topology.

Coordinate Geometry is a field of study which bridges the gap between Algebra and Geometry. It makes it possible for one to solve geometrical problems algebraically and allows one to solve algebraic problem geometrically (Odili, 2006). In addition to this, Coordinate Geometry facilitates the learning of many other topics in School Mathematics. Brown, Evans, Hunt, McIntosh, Pender and Ramagge (2011) explained that the techniques of Coordinate Geometry are used in Calculus, Graph Theory, Statistics and many other areas of Mathematics. The development of Coordinate Geometry as stated by Brown at el

was done in three facets: the invention of coordinate system; the recognition of correspondence between Geometry and Algebra and the graphic representations of relations and functions. Some of the topics that are taught under Coordinate Geometry are Equation of Lines and Circles; Parabola, Ellipse and Hyperbola.

Despite the usefulness of Coordinate Geometry, many students find it abstract, difficult, uninteresting, and uncomprehending (Avcu; Dimakos, and Zoraniis 2010); consequently they perform poorly on it. More so, the WAEC Chief Examiner Reports (2014) stated that students exhibited lack of understanding in solving geometrical questions. The situation is similar at higher level Mathematics, because it's common to see students carrying over Coordinate Geometry course from NCE I up to NCE III. One of the reasons for poor performance in Geometry is the use of lecture method and lecture method has been proved to be ineffective, unsuitable and unproductive (Odili, 1997; Baker, Jansen and Kolb, 2002).

In an attempt to tackle the problem of poor performance in Coordinate Geometry, researchers such as Li and Ma (2010); Funkhouser (2014); Enyyam and Yaratan (2018) suggested the use of Computer Technology. In recent times modern technology has changed the life of people positively all over the world especially in the area of communication. Similarly, Computer Technology has changed how Mathematics is taught in many countries. Ayub, Semble & Luan (2010) asserted that computers can transform the classroom from a boring place to an exciting learning environment because students are very much interested in computers. As a result of this, computers and other modern technologies such as smart phones, interactive whiteboard could also be used in Nigeria to facilitate the teaching and learning of Coordinate Geometry by making the concept easier and livelier. Computers can play dual roles in the classroom: first to raise students' interest

in learning Secondly to teach Geometry effectively and hence to improve students' performance in it. Chyrsanthou (2008) stated schools without computers are as disadvantaged as schools without text books. Computer technology is considered as a powerful tool that could enhance visual and effective learning environments. In her contribution Sandra (2008) maintained that computer technology can enhance mathematical teaching; help in conceptual development; enrich visualization of Coordinate Geometry; lay foundation for careful analysis and deductive proof and create opportunities for careful thinking. Generally computers can be regarded as assistant to both the teacher and the learner.

Similarly on the importance of Computer Technology integration in the classroom NCTM (2011:p23) made this declaration:-

*"It is essential that teachers and students have regular access to technology that support and advance mathematical sense making, reasoning, problem solving and communication. Effective teachers optimize the potential of technology to develop students understanding, stimulate their interest and increase their proficiency in Mathematics when teachers use technology strategically they can provide greater access to Mathematics for all students'*

In addition to that the Nigerian National Policy on Information Technology (FRN, 2001), stated the objectives of the use of technology in teaching and learning which include: (i) to empower the youth with technological skills and prepare them for global competitiveness (ii) integrate technology into the mainstream of education and training and (iii) establish new multifaceted technology institution as center of excellence to ensure Nigerian competitiveness in international market.

The most recent computer technological approaches in the teaching and learning of Geometry are the use of computer soft wares and e-learning environments. The most widely used computer soft wares in the teaching and learning of Geometry include: Cabri maths, Geometer Sketchpad and GeoGebra.

GeoGebra (derived from Geometry and Algebra) was described by Dikovic (2009) as innovative open code Mathematics software that can be downloaded freely from www.geogebra org. It offers Geometry, Algebra &Calculus features fully connected and it is easy to use. GeoGebra supports construction of lines, points and functions. It is a software that encourages students' projects in multiple representations. GeoGebra gives visualization of many geometrical concepts for example the concept of touching circles in Coordinate Geometry. Once you type the equations of the circles in the input bar the circles appear on the geometrical view and the corresponding equations on the Algebraic view with the center and the radius clearly represented. Unlike the traditional method which one has to analyze the circles; find the radii and the center; before arriving at how the circles touch each other.

Visualization does not only make Coordinate Geometry more meaningful but it also motivates students to learn and master it in particular and learn Mathematics in general. In addition to these, GeoGebra is user friendly and it encourages cooperative learning. Akanmu (2015) described GeoGebra as dynamic, interactive open-source, student- centered and user friendly software. It has played great role in integrating ICT into Mathematics Education. GeoGebra Community Newsletter (2014) reported that millions of teachers use GeoGebra all over the world for teaching Mathematics .GeoGebra has been translated into 55 different languages and its being used in more than 150 countries. GeoGebra is more versatile than Coordinate Geometry because GeoGebra connects Algebra, Geometry, Calculus, spreadsheet and Statistics; while Coordinate Geometry connects Algebra and Geometry only. GeoGebra was initially used for secondary school Mathematics instruction only but now it is certainly being used in higher institutions worldwide. GeoGebra interface according to Stols (2009) is divided into three

sections: Input bar; Algebraic View and Graphic view. Algebraic View shows and edits all the created objects and functions. The Graphic View shows and constructs objects while the Input Bar enables one to create new objects, equations and objects by just typing the function you want to create in the Input Bar.

The advantages of GeoGebra over other soft wares are: it allows students to save configuration and sequence of action; it also allows students and teachers to create and solve their problems; it encourages easy alteration of scale and arrangement; ;it goes beyond what can be done with physical manipulative; it demands increasingly complete and precise specification; it has uncomplicated changing, repeating and undoing action; it dynamically link different representations and it maintains tight connections between computer soft wares and web based learning. (Briscoe, 2010).

Web-Based Practice is one out of many Web-Based education features that enables one to learn mathematics through practice anytime, anywhere as long as there is internet connection .Web-Based Practice is another innovation that is provided by computer. Irish (2002) opined that Web- Based Practice has helped students and teachers to meet curriculum standard and reach greater height in many countries. Students that use Web Based instructions and practice benefit most by taking classes not offered in their schools .Similarly, Rebova (2013) reported that Web-Based Practice increases students' motivation and performance in Mathematics. In addition to this, Esucuder and Furner (2008) asserted that Web- Based Practice change students' attitude and increase students confidence towards Mathematics. In the same vein, Nguyen (2006) opined that Web-Based Practice has become a powerful and innovative teaching and assessment tool. It serves as a central part of the virtual teaching and learning effort. Furthermore, according to NCTM (2001) Web-Based Instruction and Practice enable teacher to monitor students'

progress; it also enable students' asses themselves, regulate their learning and become self-directed learners. In addition to these, Wong (2001) stated that Web Based Instructions and Practice increase flexibility in accepting students' ways of solving problems. It can also increases positive attitude towards learning Geometry in particular and Mathematics in general. Indeed Web Based Instruction and Practice can create different learning environments and produce flexible approach to instructions. In conclusion, Loannis (2010) listed ten advantages of using web based learning as: classroom readiness and accessibility; adaptable and customizable; teacher support, convenience and control; open, portable and interoperable; integrated, dynamic, and interactive; instant assessment and feedback; sharing of expertise and educational method finally aiding parents and home students.

Denama and Waits (2010) defined attitude as multi-faceted psychological construct based on individual feelings, beliefs and values. Likewise, Graf and Fraser (2010) defined attitude as a learned pattern of manners that is developed through ones environment. Attitude plays an important role on students learning outcome. It is generally believed that students learn more effectively when they have interest in what they learn. If they students have positive attitude towards Coordinate Geometry they will be expected to love it, take part fully in its lessons and become high achievers in it (Bindak, 2004). Researchers such as Yushau (2006) lamented that Coordinate Geometry in particular and Mathematics in general remained mysteriously difficult and unpopular to students despite the fact that no one is in doubt of their importance in almost all careers. The researcher of this work hopes that the use of computer technology might change male and female students' attitude towards Coordinate Geometry.

Gender performance in Mathematics has been discussed extensively by many researchers. American Psychological Association (2010) stated that females are not worse than male in Mathematics even though male are more confident in their Mathematics abilities than females. Furthermore Amelik (2016) reported an extensive research conducted by University of Wisconsin in 2015 that examined students in more than 50 countries recently did not find significant difference between male and female performance in Mathematics. The research further reported that the percentage of women awarded doctoral degree in Mathematics all over the world has increased six fold in the past fifty years. More so, nearly half of bachelor's degrees in Mathematics in the U.S were earned by females. It is the researcher's principal interest to find out if the use of GeoGebra and Web-Based Practice could improve male and female Mathematics students' attitude and performance in Coordinate Geometry.

## 1.2 Statement of the Problem

Coordinate Geometry is an important branch of Mathematics which is very vital to many other professions and useful for our daily lives. However the researcher observed for many years that Coordinate Geometry continued to record poorer performance among NCE students compare to other branches of Mathematics. Learning Coordinate Geometry has not been easy for many students due the use of lecture method by most teachers and so students fail to develop adequate understanding of geometrical concepts and geometrical reasoning (Idris, 2006). Consequently, many students avoid geometrical questions in internal and external examinations. Similarly many teachers skip geometrical topics in their teaching. These reasons made geometrical questions become unpopular among the students and their performance in it has been described as unsatisfactory by WAEC Chief Examiner (2014). Students bring the problem of lack of understanding of geometrical

concepts to higher institutions. As a result of that, the performance of colleges of education students in Coordinate Geometry (MAT 122) has continued to be poorer than their performance in other courses. From the researcher's experience, Nigerian Certificate in Education (NCE) students complain of so many formulae in Coordinate Geometry and lack of visualization of geometrical concepts in the traditional method of teaching (Lecture Method) among others

In an attempt to salvage the situation; the researcher investigated whether GeoGebra software, and Web-Based Practice could improve students' performance and change their attitude towards Coordinate Geometry in colleges of education in the North west Zone.

### 1.3 Objectives of the study

The main objective of this study is to investigate the effects of GeoGebra and Web-Based practice on students' attitude and performance among colleges of education Mathematics students in the North -West Zone. Based on the main objective the following specific objectives were outlined as to:

1) investigate the effect of GeoGebra software on Mathematics students' academic performance in Coordinate Geometry at NCE I level.
2) investigate the effect of Web-Based Practice on NCE1 Mathematics students' academic performance in Coordinate Geometry in the colleges of education.
3) determine the influence of Web-Based Practice on Mathematics students' attitudinal change towards Coordinate Geometry at NCE I.
4) examine whether the use of GeoGebra will enhance NCE1 Mathematics students attitude towards learning Coordinate Geometry.
5) determine if the use of GeoGebra and Web-Based Practice can change male and female Mathematics students attitude towards Coordinate Geometry at NCE I
6) determine, if GeoGebra and Web-Based Practice can improve male and female students' academic performance in Coordinate Geometry

## 1.4 Research Questions:

The following research questions were raised in order to guide the conduct of the study:

1) Is there any significant difference in the academic performance between NCE1 Mathematics students taught Coordinate Geometry using GeoGebra and those taught using lecture method?
2) Is there any significant difference in academic performance between NCE1 Mathematics students taught Coordinate Geometry using Web-Based Practice and those taught lecture method?.
3) What is the effect of Web-Based Practice in changing the attitude of NCE1 Mathematics students towards learning Coordinate Geometry?
4) What is the effect of GeoGebra in changing the attitude of NCE1 Mathematics students towards learning Coordinate Geometry in Colleges of Education?
5) Is there any difference in attitude change between male and female NCE1 Mathematics students taught Coordinate Geometry using GeoGebra and Web-Based Practice and those taught using lecture method?
6) Is there any significant difference in academic performance between male and female NCE 1 students taught Coordinate Geometry using GeoGebra and Web-Based practice and taught using lecture method?

## 1.5 Null Hypotheses

The following hypotheses were formulated based on the research questions and were tested at $p \leq 0.05$ level of significance.

$H0_1$: There is no significant difference in the mean academic performances between NCE1 Mathematics students taught Coordinate Geometry using GeoGebra and those taught using lecture method.

$H0_2$ There is no significant difference in the mean academic performances of NCE1 Mathematics students taught Coordinate Geometry through Web-Based Practice and those that learned using conventional method.

$H0_3$: There is no significant difference in attitude change between NCE 1 Mathematics Students that learned Coordinate Geometry using Web-Based Practice and those that learned Coordinate Geometry through lecture method.

$H0_4$: There is no significant difference in attitude change between NCE1 Mathematics Students taught Coordinate Geometry using GeoGebra and those taught using lecture method.

$H0_5$: There is no significant difference in attitudinal change between male and female NCE1 Mathematics students taught Coordinate Geometry using GeoGebra, Web-Based Practice and lecture method.

$H0_6$: There is no significant difference in academic performance between male and female NCE1 Mathematics students taught Coordinate Geometry using GeoGebra and Web-Based and lecture method.

### 1.6 Significance of the Study

The study "Effects of GeoGebra and Web-Based Practice on Colleges of Education Students Attitude and Performance in Coordinate Geometry" would hopefully move the teaching and learning of Coordinate Geometry forward in the following ways:

This study may help in sensitizing Mathematics students in the North West zone of Nigeria with the new development in the use of GeoGebra and Web-Based Practice in learning Coordinate Geometry. It would also facilitate the reduction of abstraction in Coordinate Geometry through visualization. Students would remember more what they do than what they hear or read. Teaching and learning Coordinate Geometry with the aid of

technology (GeoGebra and Web-Based Practice) may be of great help for students who are deficient in the language of instruction (English language) as they can comprehend better through images and models than words. It could also assist the students to be abreast with the applications of Geometry in real life situations. Furthermore the use of GeoGebra and Web- Based Practice would enable students create and solve problems by themselves. Consequently, these would hopefully increase interest in learning Coordinate Geometry.

Moreover, the study may encourage NCE students in Nigerian Colleges of Education in using internet resources positively through Web- Based Practice. Students would be engaged in solving problem rather than chatting. In addition to this Web-Based Practice could encourage students' autonomy, discipline and self-control in learning as students have the liberty to practice at their own time as long as there is an internet connection.

Furthermore, the study would assist in making Mathematics teachers' up-to-date in the use of technology in the teaching of Mathematics. It may also be useful in reducing teachers' task of explaining and demonstrating the content of Coordinate Geometry to the students as computers can do that. Furthermore, the use of GeoGebra and Web-Based Practice may enable the teacher to cover more ground in lesser time than when teaching using the lecture method. More so the effective use of technology in teaching of Coordinate Geometry may enable the teacher give proper and sufficient examples and exercises to his students because the use of computer technology reduces the time used in teaching .This in turn may arouse and maintain students' interest throughout the lesson.

Not only that, the study would hopefully help in demonstrating the use of Technological Pedagogical Content Knowledge (TPACK) which is a theoretical frame work for backing the use of technology in education in general and Mathematics education

in particular. In addition to this, this study would help in highlighting the use of constructivism as another theory that supports the use of technology in Mathematics education .Constructivism is a strategy that makes the learner an active participant in creating his own knowledge rather than a passive receiver of knowledge.

The in-cooperation of GeoGebra and Web-Based Practice into Mathematics curriculum at both secondary school and post-secondary school levels made the students learn many topics by themselves. Furthermore this can make Mathematics curriculum in Nigeria be more feasible, more realistic and more interesting. This could5 be achieved by removing from the curriculum those topics that are not pre-requisite of learning future topics which students can also learn by themselves.

Also, the authors of Mathematics textbooks in Nigeria would find this study useful because it will help them infuse appropriate technological approaches in their textbook. Since teaching of Mathematics in general and Coordinate Geometry in particular using paper and pencil only is becoming inadequate in many countries; there is a need for the textbooks in the country to reflect the changes in learning of Coordinate Geometry.

Likewise, research bodies and associations such as Science Teachers Association (STAN); Mathematical Association of Nigeria (MAN); National Teachers Institute (NTI); National Mathematics' Center (NMC); whose duty is to re-train teachers, carry out researches, and disseminate innovation will benefit from this work through those that will read the reports of this work. They will in turn organize workshops and seminars on the uses of various computer soft wares especially GeoGebra and Web-Based instructions; with the hope that it will enhance the teaching and learning of Coordinate Geometry. The researcher will personally make sure that the findings of this work are disseminated to all stake holders through publication of the results of the findings in reputable Journals

Researchers and Post graduate students of higher institutions will use the findings of this study as a basis for further research in Mathematics, science education and other fields of study.

## 1.7 Scope /Delimitations of the study

The research work on the effects of GeoGebra and Web-Based Practice on Student Attitude and Performance in Colleges of Education in Nigeria has the following delimitations:

The study was carried out in the North West Zone of Nigeria because the duration of the study did not allow the researcher to look at all the six political zones. The study was delimited to three Federal Colleges of Education in the North West. A sample of 210 out of 1465 NCE1 Mathematics students were selected for the study. The instrument for the data collections was a 40 item Coordinate Geometry Performance Test (CGPT) and a 20 item Coordinate Geometry Attitude Test (CGAT).

The study was also delimited to the following Coordinate Geometry topics: distance between two points; midpoint; division of a line in a given ratio; angle between two straight lines; equation of a straight line; equation of a circle and tangent to a circle

## 1.8 Basic Assumptions

The study was conducted based on the following assumptions:

- NCE Mathematics students are not significantly different from one another as they all have same minimum entry qualification.
- All colleges of education in the North West Zone have computer department and computer laboratories.
- The methods (Lecture Method, Web-Based Method and GeoGebra) used in the research work are appropriate for teaching Coordinate Geometry.

## CHAPTER TWO

## REVIEW OF REALTED LITERATURE

### 2.01 Introduction

The study investigated the effects of GeoGebra and Web-Based Practice on attitude and performance among Students of Colleges of Education in the North West Zone, Nigeria. Literatures were searched under the following main headings: GeoGebra, Web-Based learning, Lecture method and Coordinate Geometry. The literature review was done under the following sub-headings:

- Theoretical Frame Work
- Conceptual Frame Work
- Geometry as Branch of Mathematics
- Students Performance in Geometry
- Students Attitude Towards Geometry
- Computer Software in Mathematics Education
- GeoGebra Software
- E-Learning in Mathematics Education
- Lecture Method of Teaching
- Gender and Technology in Mathematics Education
- Review of Related Studies
- Implication of Reviewed Literature on the Present Study.

### 2.02 Theoretical Frame Work

The use of technology (GeoGebra and Web-Based Practice) in teaching and learning of Coordinate Geometry can be supported by many theories of learning which include: Technological pedagogical Content Knowledge (TPACK) and Constructivism Theory among others.

### 2.02.1 Technological Pedagogical Content Knowledge

Pedagogical Content Knowledge (PCK) was first proposed by Shulman (1986) which according to him refers to as unique knowledge for the teaching profession. Shulman (1986) categorized teachers' knowledge into seven categories which include: General pedagogical knowledge; knowledge of learners and their characteristics, knowledge of educational context; knowledge of educational ends; content knowledge; Curriculum- Knowledge and pedagogical content knowledge. Based on this notion Koehler and Mishra (2009) developed TPACK which is an interaction among three terms viz "content", "pedagogy" and "technology". TPACK provides a theoretical frame work for integrating technology in the classroom. The terms that form TPACK are explained as follows:

i. **Content Knowledge (CK):** This consist the knowledge of the subject matter to be taught and its organizing structure. In Shulman's words CK refers to knowledge of concepts, ideas, organizational frame works. Knowledge of evidence; proof as well as established practice and approaches towards developing such knowledge.(Koehler and Mishra,2009). Content knowledge differs from subject to subject and from one level to another. The content of Mathematics is different from that of biology. Similarly within the same subject area the content of Elementary School Geometry is different from the content of Advanced Level Geometry. Teacher's knowledge of his subject area and related fields is the most fundamental issue in teacher profession. The other two domains will not stand if the content is not there. Yet possession of content knowledge alone is not enough to make one a teacher (Ball, 2008).

Comment [AA2]:

ii. **Pedagogical Knowledge (PK).** This refers to teachers' knowledge on principles of teaching, psychological and sociological needs of the learners, educational and learning

theories as well as educational goals. According to Koehler and Mishra (2009), PK applies to understanding how students learn, general classroom management skills, lesson planning, and student assessment among others.

iii. **Technology knowledge (TK):** This means that teacher having knowledge of how to operate technological tools such as computers, smart boards, computer soft wares etc. This also include understanding information technology broadly enough to apply it productively at work and in everyday life; being able to recognize when information technology can assist the development of goal and being able continually adapt to changes in information technology (Koehler &Mishra,2009). In addition to this NCTM (2010) stated that electronic technologies such as computers and Calculators are essential tools for teaching, learning and doing Mathematics. They furnish visual images of mathematical ideas, they facilitate, organize, analyses ideas and they compute accurately. NCTM further stated that when technologies are available, students can focus on decision making, reflection, reasoning and problem solving. In addition to this technology plays vital roles in Mathematics classroom, helps the teachers to capture students interest, provide students with better understanding and assist the students in mastering concepts (Khoyibaba, 2010).

iv. **Pedagogical Content Knowledge (PCK):** This is the combination of content knowledge and pedagogical knowledge. PCK is teachers understanding of how to guide students learn specific subject matter. It include knowledge of how particular subject matter, topic and issue can be organized, represented adapted to the diverse interest and abilities of learners and then presented to the learners. PCK in Shulman's (1986) words is the most useful way of representing and formulating the concept in order to make it comprehensive for others. It also consists of the understanding of misconception and preconception learners of diverse background bring to the classroom. It also comprises

what makes the learning of a concept easy or difficult. PCK according to Ball (2008) includes teachers ability to answer students "Why" question in the classroom. For example teacher should be able to give reason why pi is always equal to 22/7 if a student asks him.

v. **Technological Content Knowledge (TCK):** This is made by teachers' thorough understanding of the manner in which the subject matter can be modified or changed by the application of particular technology. Teachers need to understand which specific technology are best suited for addressing subject matter learning in their domain and how the content dictates or perhaps even changes the technology or vice-versa (Koehler & Mishra, 2009).

vi. **Technological Pedagogical Knowledge (TPK**): An understanding of how teaching and learning can change when technologies are used in particular ways. This also includes the type of technology (computer soft wares, internets, calculators, interactive white boards…) and how and when to use them in the classroom. Koehler and Mishra (2009) stated that knowing pedagogical affordances and constrains of range of technological tools as they relate to disciplinarily and developmentally appropriate pedagogical designs and strategies are parts of TPK.

vii. **Technological Pedagogical Content Knowledge (TPACK)**. Underlying truly meaningful and deeply skilled teaching with technology, TPACK is different from knowledge of all three concepts individually (TK, PK, CK); instead, TPACK is the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students prior knowledge and theories of epistemology and knowledge of how

technologies can be used on existing knowledge to develop new epistemologies or strengthen old one (Koehler & Mishra, 2009).

For a teacher to effectively teach Coordinate Geometry; he/she should first possess the knowledge of the subject matter (CK). He/she also be familiar with the appropriate methodologies of teaching (PK). He/she should be up to date with the technologies that are used in the classroom (TK). As stated earlier this three domains should not be in isolation which means that an effective teacher requires the blended form of the three domains to enable him/her teach Coordinate Geometry using GeoGebra and Web-Based Practice as well as other technological tools.Figure 2.1 illustrates the modified TPACK diagram

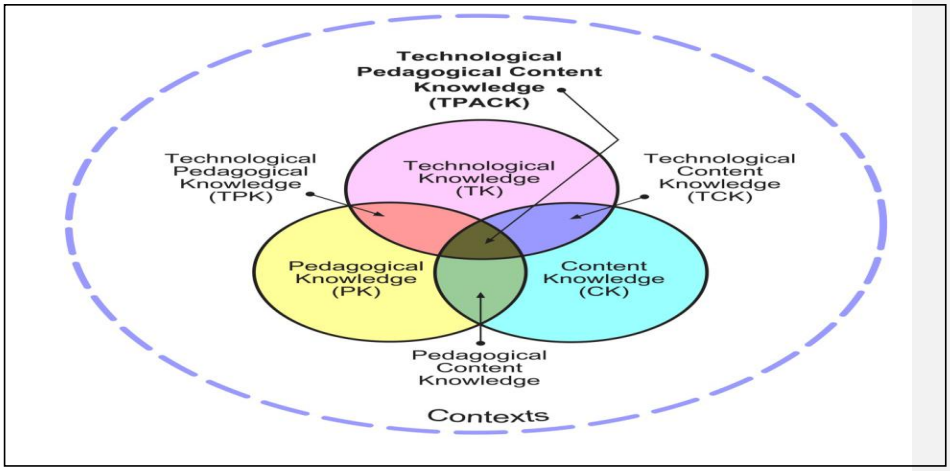



**Figure 2.1 Modified TPACK Diagram (**Adopted from Koehler & Mishra)

None of three components that form TPACK is viewed in isolation from the other but they rather exit in a dynamic transactional relationship (Bruce, 1997). In Harris, Mishra and Koehler words (2009) "There is no pure content, no pure pedagogy no pure technology but its important for teachers to understand the complex manner in which the three domain are continually form, coexist and co create each other. Barbara (2009) sees

TPACK as the rich understanding of how Mathematics teaching and learning can be transformed as a result of authentic, meaningful application of appropriate technology. A teacher capable of integrating these domains of knowledge in his classroom can be regarded as a resourceful teacher Martina (2011)

TPACK according to Messina and Talbore (2012) allows understanding of how technological, pedagogical and content interact with each other. They further stated that this type of knowledge include an understanding on how to represent concepts with technology, pedagogical techniques and the use of technology in constructive ways to teach content, knowledge of what makes the content easy to learn and how technology can help students to learn and how technology can be used to build new knowledge on prior knowledge. In their contribution, TPACK according to Koehler and Heineken (2011) is a brand of knowledge that constitutes dynamic relationship between content, pedagogy and technology. The teacher needs the blended knowledge of seven sub domain illustrated in figure 2.1 to teach effectively. More so Harris, Mishra and Koehler (2008) stated that the development and demonstration of TPACK knowledge requires flexibility and fluency not just in curriculum based content but also with pedagogy, technology and context because each influence the other a pervasive way. Furthermore, Guerrero (2010) is of the opinion that an understanding of the knowledge teacher must possess in various instructional settings has the potential to impact both teacher training and instructional practice. In order to use TPACK effectively in Mathematics class room, the teacher should ask himself the following questions:

Table 2.1 Questions Guiding the use of TPACK

| Component | Questions |
|---|---|
| Instruction | Is technology the most appropriate tool for teaching and learning this topic?<br>How does technology affect collaborative nature of my classroom?<br>Will I adjust my instruction and use of technology to meet individual needs? |
| Managements | How will I manage the physical logistic of technology?<br>Where will we use technology?<br>How many students per computer?<br>How do I manage students' engagement with technology based lesson? |
| Depth and Breadth of Content | Do I have the mathematical Knowledge to handle students' inquiry that may be beyond the Intent of this lesson?<br>Am I willing to acknowledge my content-related short comings and invest time and energy to investigate student generated trait? |
| Conception and use of technology | Is the topic best addressed through the use of technology?<br>How does technology improve the teaching and<br>Learning of this topic?<br>Is the use of technology in this topic most appropriate?<br>Is technology fully integrated in this lesson or an add on?<br>Which technology will best support teaching and learning specific topic? |

Adopted from: Guererro (2010)

Similarly, before teaching Coordinate Geometry using GeoGebra or Web-Based Practice the teacher/lecturer should ask himself/herself questions on Table 2.1. These guiding questions serve as a guide for the teacher and also show the level of preparedness of the teacher to teach Coordinate Geometry using technology (GeoGebra and Web-Based Practice)

### 2.02.2 Constructivism Theory

Another theory that strongly supports the integration of technology in the classroom is Constructivism Theory. Constructivism according to Educational Broadcasting Cooperation (EDC, 2013) is a theory based on observation and scientific study on how people learn. It says that people construct their own understanding and knowledge of the world through experiencing things reflecting on those experiences. The focus here is to be able to take the knowledge form locally to solve global problem. Malabar &Pountey (2014) Observed that the aim of Constructivist learning is beyond the ability of the learner to recall given information but constructivist are interested in the learner acquiring the ability of applying knowledge and skills in different based environment. The fundamental principle of Constructivist Theory as stated by Glassfield (2005) is that learning is very much constructive activity that students themselves have to carry out. From this point of view the task of educator is not to dispense knowledge but to prepare the learner to build it. In a nut shell Constructivism says that knowledge is constructed by the learner not taught by the teacher. Gilakjani, Leong and Ismail (2013) explained that construction of knowledge is a dynamic process that requires the active engagement of the learners who will be responsible for one's learning while the teacher only creates an effective Web-based Learning Environment. Philips (2005) explained various learning process of Constructive point of view as cited in Amairin and Ghishan (2011) as:

- People of all ages construct knowledge rather than discover it
- . People construct knowledge by relating or connecting it to their prior knowledge.
- . Learning involves active cognitive activity and cognitive restricting

- . People use personal experiences to create knowledge
- . Learning is an adaptive activity
- . Learning is situated in the context in which it occurs
- . All knowledge is personal and idiosyncratic
- . Learning is essentially a process of making sense of the world.
- . Effective Web-based learning requires open ended, challenging problem for learner to solve.

Cognitive growth is stimulated when people are confronted with practical and personal problems though Constructivism is a learner centered, the teacher remains the most important factor in the constructivist environment. The role of teacher in the constructivist classroom was summarized by Brooks and Brooks in Gilakjani, Leong and Ismail (2013). Teacher should:

- encourage and accepts students autonomy and initiative
- allow students response to drive lessons, shift instructional strategies and alter content
- use cognitive terminology such as “classify”, “analyze”, “predict” and “create” to direct students learning.
- enquire students understanding of concepts before sharing their own understanding of those concepts.
- encourage students to engage in dialogue, both with the teacher and with one another.
- encourage students’ inquiry by asking thoughtful open ended questions and encouraging students to ask each other question.
- Seek elaboration of students’ initial response

- structuring learning around primary concept
- engage students in experience that might contradict their initial hypotheses and then encourage discussions
- provide time for students to construct relationship and create metaphor.
- nature students natural curiosity through frequent use of the learning circle model.

Similarly, Adaramola (2014) views constructivism as a theory that emphasizes the important of knowledge belief and skills of an individual learning. The content of constructivism in exploration, proposing explanation/solution helps to shift from telling, talking (teacher centered) to constructive learning strategy (Learners centered) where learners dominate their learning process and teachers serve as guide. GeoGebra in particular and the use of technology in education generally avail learners the opportunity to explore, experiment, practicalise and become problem solvers which is the goal of modern education.

Comment [AA3]:

Technology is referred to as the application of scientific knowledge for the benefit of humanity. Computer Technology has changed the method of teaching Mathematics in many part of the world. Gilakjani, Leong and Ismail(2013) asserted that technology in education is no longer a luxury but a necessity as there is close relationship between technology and constructivism, the implementation of each one benefit the other .To buttress this fact Wilson (2007) opined that if education is to be pertinent, progressive and productive, technology should be used in the classroom. Both technology (Web-Based Practice and GeoGebra) and constructivism are learners centered. Technology provides the learners with the environment to manipulate tools discuss among themselves and arrive at a new knowledge which is tandem with constructivism point of view. Furthermore, Richard(2008) is of the view that technology and constructivist change the way the

students learn in a positive way by creating a learning atmosphere centered on the student rather around the teacher. The students are engaged in meaningful activities such as problem based learning projects, browsing internet for report or preparation of presentation or assignment. The use of technology promotes cooperation among students and collaboration between the teacher and the learner which is also in line with the constructivist theory of learning. Another positive side of the use of technology (GeoGebra and Web-Based Practice) in the classroom is that the learners can control his learning process by creating his own problem and provide the solution which is also in agreement with the constructivist point of view. The use of technology in the classroom enhances exploration by the learners which can lead to high ordered level of thinking; this also same as constructivism theory. Notwithstanding the use of technology can be hindered by problems according to Richard(2008) such as lack of resource, lack of computer knowledge and skills; teachers' negative attitude and belief towards the use of technology; cost of updating ; maintaining computer hard and soft wares and weak data network. These problems raised by Richard (2008) are obstacle which educational institutions in Nigeria have to overcome in order to successfully move from teacher centered instructions to learners' centered instruction such as Constructivism.

### 2.02.3 Implication of Theoretical Frame Work to the Present Study

From the proceeding discussion the following can be deduced:

- Technology is essential to the teaching and learning of Mathematics.
- Technology has been integrated into Mathematics classroom in many parts of the world.
- Integration of technology into the class room depends on what teachers know.

- The use of computer, computer software and other devices has changed the way Mathematics is being taught in many countries.
- The use of technology in form of calculators, computers, interactive white board. has the support educationist
- Teaching and learning of Mathematics is much more students centered rather than teachers centered

**Conceptual Frame Work:** Conceptual Frame work as explained by Svinicki (2010) is an interconnected set of ideas (theories) about how a particular phenomenon functions or it's related to its parts. The conceptual framework for this study is the blended form of Behaviorism and Constructivism theory. Sulton (2003) opined that teaching with technology encompass the Behaviorist and Constructivist theory. The independent variables of the study are GeoGebra and Web-Based Practice while the dependent variables are attitude and performance in Coordinate Geometry.

Thorndike law of effects stated that "An act that is followed by favorable effects is more likely to be repeated in a similar situation, while an act that is followed by an unfavorable act is not likely to be repeated". Web- Based Practice provides drills and practice; it also gives students hints and feedback. This type of practice according to Shield (2000) where students are rewarded through correct answers before moving to the next question is apparent in the use of computer based learning.

Similarly, Constructivism which encourages the learner to create his learning from the environment is in agreement with the Web-based learning with GeoGebra software. Learning with GeoGebra can be students centered where the teacher serves as a guide.

**2.03**. **Geometry:** Geometry is the study of figures in space of a given number of dimension and a given type. The study of Geometry according to Jones (2012) contributes to helping students develop the skills of visualization, critical thinking, intuition, perspective problem solving, conjecturing, deductive reasoning, logical argument and proof.

Geometry has been an integral part of Mathematics curriculum at all levels of education since the beginning of Western Education in Nigeria. The aim of teaching Geometry has been summarized by Jones (2002) are to:

- develop spatial awareness , geometrical intuition and the ability to visualize.
- provide a breadth of geometrical experience in two and three dimension.
- acquire the knowledge and understanding of Geometry and learn the ability to use geometrical properties and theorem.
- encourage the use of conjecture, deductive reasoning and proof.
- develop skills of applying Geometry through modeling and problem solving in real world context.
- apply useful ICT skills in specifically geometrical context.
- engender a positive attitude to Mathematics.
- develop an awareness of the historical and cultural heritage of Geometry in society and contemporary application of Geometry.

**2.03.1 Types of Geometry**

- **Euclidean Geometry**

Geometry can be broadly classified into two, Euclidean and Non Euclidean Geometry. Euclidean Geometry is the study of flat space which was based on the assumption of Euclid (330B.C). Some of the elements of Euclid include:

- The shortest distance between two points is one unique straight line.
- The sum of the angles in any triangle equals to $180^{o.}$

The most famous postulate is the fifth postulate which is known as the parallel postulate states that:

*If a straight line crossing two straight lines makes the interior angles on the same side less than two right angles, the two straight lines if extended indefinitely, meet on that side on which angles less than two right angles.*

All other types of geometries are referred to as Non Euclidean Geometry. These are:

**Riemannian Geometry**: This type of Geometry is also known as Spherical Geometry. This Geometry is named after a German Mathematician Riemannian Geometry. This type of Geometry studies the curved surface called planet earth. In curved space, the shortest distance between any two points (called a geodestic) is not unique. For example, there are many geodestics between the north and the south poles of the earth (lines of longitude) that are not parallel since they intersect at the poles.

**Hyperbolic** Geometry: also known as Lobachevkian Geometry named after Russian mathematician who also furthered the studies of non-Euclidean Geometry. Hyperbolic Geometry has a lot of applications to certain areas of science applications such as the orbit prediction of objects within intense gravitational fields, space travel and astronomy. Einstein stated that space is curved and this general theory of relativity uses hyperbolic Geometry.

**Projective Geometry**: Projective Geometry deals with properties that are invariant under projection. In many ways its more fundamental than Euclidean Geometry and its also simpler than Euclidean Geometry. Euclidean Geometry is a subset of Projective

Geometry according to Birchfield,(2012).. Projective Geometry is just like Euclidean Geometry in terms dimensions. For instance, the projective line $P^1$ is equivalent to one dimensional Euclidean. Similarly two dimensional projective plane $P^2$ corresponds to 2D Euclidean plane.

**Topology**: Topology according to Bruner (2010) is the modern version of Geometry that studies different sorts of spaces. Topology is also concerned with the properties of space that are preserved under continuous deformation, such as stretching and bending not tearing or gluing. This can be studied by considering a collection of subsets called open sets that satisfy certain properties, turning the given sets into what is known as topological space.

In topology, any continuous change which can be continuously undone is allowed. So circle is the same as triangle or square because you just "pull on" parts of a circle to make corners and then straighten the sides to change circle into square. Then you "smooth it out" to turn back into circle. These two processes are continuous in the sense that during each of them nearby point at the start are the still nearby at the end. Topology is almost basic form of Geometry that it is used in almost all branches of Mathematics in one form or the other.

**Differential Geometry:** Differential Geometry is a mathematical discipline that uses the techniques of differential Calculus, integral Calculus and linear Algebra to study problems in Geometry. The study of plane and space curves and surfaces in the three dimensional Euclidean space formed the basis for the development of Differential Geometry during the $18^{th}$ century.

Since the late $19^{th}$ century differential Geometry has grown into field that is concerned more generally with geometrical structure on differential manifold.

Differential Geometry is closely related to Differential Topology and geometrical aspect of theory of Differential Equation. Differential Geometry has applications in Physics, Chemistry, Economics, and Engineering.

**Coordinate Geometry**: The method of describing the location of points a according to their coordinates was first proposed by a French mathematician and a philosopher called Rene-Descartes (1596-1650). A point on a plane is represented by a unique set of coordinates namely the x and the y coordinates called the Cartesian Coordinates named after the inventor. Odili (2006) further explained that through Coordinate Geometry lines and curves can be represented by equations. This technique bridges the gap between Algebra and Geometry. If you know the coordinates of groups of points you can find: the distance between them; their midpoints; slope; equation of line segments that joint them with the help of Coordinate Geometry. Some of the applications of Coordinate Geometry were outlined by Mukti (2016) as Coordinate Geometry: is used in describing the position of any object; it is also useful in in locating air transport; it's very essential in map projection and essential in learning longitude and latitude. In addition to these, the knowledge of gradient (slope) which is a topic in Coordinate Geometry is fundamental in the study of architecture.

## 2.04 Students Performance in Geometry:

Geometry is one of the oldest and most valuable branch of Mathematics. Geometry is a rich source of both theoretical and practical knowledge and are of great benefit to humanity (Gloria, 2015). She further explained that geometrical shapes (both 2D and 3D) with their properties contributes to development reasoning, analytical mind and overall academic performance

Academic Performance in Geometry can be explained as the level of success in Geometry. Most countries monitor learning and general performance. In global economy, the yardstick for success is no longer improvement in national performance but how education system perform internationally (PISA, 2000).Researchers such as Mbugua, Muthaa ,Nkonke(2012) and Agyman ,Enu, and Daniel(2015) identify some factors that affect students' performance which include: Students factors(entry behavior, opportunity to learn, motivation and attitude);School factor(availability and usage of teaching material, teachers) and Social economic factor(education of parents and their economic status).

Reports from PISA (2000) stated that economic status explains only 6% of students' performances. The extent of the student opportunity to learn (OTL) Mathematics contents bears directly and decisively on Mathematics achievement. OTL includes the scope of Mathematics presented and how Mathematics is taught and match between student entry skills and the new material. In fact strong correlation was found between student entry OTL score and the mean performance.(Schmit,Mcknight andRaizan,(2000).

PISA (2000) reports showed that students from privately managed but not necessary privately financed performed better than students from public schools. Fuch and Wossman (2014) reported that school autonomy is positively related to students' performance. It is the desire of every teacher that his students to perform well in Geometry, Majerek (2014).However literatures from different parts of the globe shows that students' performance is unsatisfactory. For example Aktlas and Aktlas (2012) reported that students from 38 countries out of 44 countries that participated in the Trend in International Mathematics and Science Studies (TIMSS) got the lowest scores in part of the test that consisted geometrical questions. The story is the same in the results of Program me for International Assessments (PISA). Though Nigeria didn't take part in both

TIMSS and PISA students' performance in Geometry in the country is also lower than other branches of Mathematics (Adolphus, 2011). Kajuru and Isa (2014) also reported poor performance of students in Geometry in a research they conducted among junior secondary school students in Sokoto State. They however found that the use of cooperative Web-based learning helps in improving students' performance in Geometry. Researchers such as Adolphus (2011); Ali, Bhagawati and Sharmah (2014) ; and Gloria (2015) advanced the following reasons as causes of students' poor performance in Geometry:

- ❖ The students have poor performance in Geometry due lack of basic knowledge of the subject from primary school. Most students cannot solve problems even with similar examples.
- ❖ Lack of visualization. Most teachers use lecture method in which they only tell the students. The students hardly understand what they only hear and did not see.
- ❖ The teaching environment in most Nigerian classroom are not conducive for learning Geometry and Mathematics due to problem such as overcrowded classrooms; deli plated structures, absence of technology such as computers and internet connections.
- ❖ The students lack the willingness and readiness to learn. Students have the tendency to copy the solution of the exercises whenever they are given in the classroom. Most students give importance to copying the problem from the black board without understanding it.
- ❖ Most teachers do not connect geometrical lessons with the students environments; therefore the learners will not realize the importance of Geometry to their life as a results of this the students will not do well in the subject.

- ❖ Many teachers cannot teach Geometry effectively because they have a weak foundation in it.
- ❖ Many teachers lack the knowledge of current technological innovations in the teaching and learning of Geometry such dynamic geometrical soft wares.

These causes of performance of students in Geometry are some of the problems that mathematics educators and other researchers (such as this) are trying to address through researches; conferences and seminars.

**2.04.1 Gender Performance in Geometry**:

African culture in general and Nigeria in particular man is the head of the family. He provides food, shelter and protection to his wife, children and other members of the family. In order to prepare boys for adult life, they are engage in more demanding task such as farming and hunting while girls take care of household duties. With the coming of western education to Nigeria boys more than girls take courses in maths and science while girls take more courses in art and languages (Framajimakin, 2010). In an attempt to change this culture some countries under the umbrella of the united nation set some goals.

The Millennium Development Goals (MDGs) which was signed by more than one hundred countries and ended in 2015 had gender equality as one of its goals. Then followed by Sustainable Development Goals (SDGs) which was signed on 25$^{th}$ September,2015 has gender equality as one of its goals to be achieved in the next fifteen years. Gender equality in politics, in education among others. However researches have been giving contradictory results in Mathematics.

Reports from Organization for Economic Cooperation (OECD, 2010) that conducted Programme for International Student Assessment (PISA) in which 65 countries participated showed that boys out performed girls in Mathematics in 35

countries, while girls out performed boys in 5 countries including United States and Hungary. In the remaining 25 countries no differences was found between the performance of boys and girls.

In another study Ugbechie, Aghamie and Ughamadu (2009) took the CGPA of male and female students in the Department of Mathematics in a college of education in Nigeria from 2004-2006. They sample NCE1; NCE11; NCE111; from all Mathematics combinations. The data collected were analyzed using t test. The results showed that male students out performed female students in all the years and all the combinations.

However, Zogheib, Zoghieb and Saheli (2010) studied male and female students' performance in a university in Kuwait. The population of male students offering Mathematics in the university is by far more than the female students but the female students outperformed the male students.

Anchor, Imoko, and Ajai (2012) reported that when students are taught Geometry using games and simulation gender performance are equivalent. Indicating that games and simulations are gender friendly Suleiman, Gamagiwa (2010) and Ademola (2010) could not find any significant difference in male and female students' performance when taught using e-learning method.

. In a similar development Saidu and Binyamin (2015) conducted a research in which the experimental group was taught Geometry using Geogeometric set while the control group was taught using lecture method. The results showed that there was no significant difference between the performance of male and female students. Similarly Imoko and Ajai (2015) reported that when students are taught Geometry using Problem Based Learning (PBL) no significant difference between the performance of male and female students in Geometry. The results indicated that male and female students are capable of

completing and collaborating in classroom activities that could be the reason of not having gender difference.

Linver, Eccles(2007); Imoko and Aji (2015) reported that women have slightly higher grades in Geometry/ Mathematics than men but the difference is not statistically significant. In the same vein, Ganley and Lubienski (2016) stated that both male and female students have similar scores in Geometry/Mathematics. However male students have more interest in Mathematics, science related courses.

The colleges of education in North West Zone, where the present study was conducted have more male students studying mathematics than their female counterparts in all the eleven coeducational colleges of education. There is one college of education in the zone, Federal College of Education (Technical), Gusau, has only female students in the college and it's the college of education that has the least number of students in it. Therefore it can be concluded that; there were more male students in the mathematics departments in colleges of education in the Zone than the female students at the period of the conduct of this study. However the performance of each gender can only be known at the end of the study.

**2.05 Students Attitude towards Geometry:**

Students' attitude towards Geometry in particular, Mathematics in general is a well-studied aspect in educational research. Eshun (2004) sees attitude towards Geometry as a disposition towards aspect of Geometry that has been acquired by a student through his/her experience which can be changed. Students' attitude towards Geometry was also defined by Brovey and Hull (2014) as the feeling expressed by students regarding the teaching and learning of Geometry, its relevance in academic and application to real world setting.

The studies of students attitude towards Mathematics according to Kalder and Leish (2011) was popularized by the work of Elizabeth Fennema and Sherman in 1976 in which they used nine scales to study students attitudes towards Mathematics which gave birth to the famous Fennema –Sherman attitude scale. Most researches reviewed on attitude towards Mathematics or its branches were based on this scale. Another giant stride made was recently made in the area of studying of students attitude towards Mathematics was made by Tapia and Mash in 2004 in which they reduced Fennema-Sherman scale from nine to six ;.

Students' attitude towards Geometry was researched using these scales. Some of the works reviewed are: Sunzuma, Masocha and Zezekwa (2012); Dede (2012); Aktas and Aktas (2013) which was summarized as follows: The researchers reported that student generally have positive attitude toward Geometry. They also reported that student believe in the usefulness of Geometry in everyday live but they have very high anxiety towards Geometry. Among their findings include that students from science based schools have more positive attitude towards Geometry than students from art and vocational schools. The researchers also revealed that students attitude towards Geometry in terms of enjoyment increases with grade. Students enjoy Geometry more and find it more meaningful as they grow older through exploring concrete materials and relate it with their environments. The researchers observed strong correlation between attitude towards Geometry and students achievement in Geometry.

This research was aimed at finding out; if GeoGebra Software and Web- Based Practice would change colleges of education mathematics students' attitude towards Coordinate Geometry.

### 2.05.1 Gender Attitude towards the Use of Computers in Learning Geometry

Literature has shown that both genders have positive attitude towards the use of computers in learning Geometry. However researchers' did not have the same opinion on which of the gender has more positive attitude towards the use of computer in learning Geometry. De- Haven (2003) found that female students attitude towards Geometry increases more than their male counterpart when computers are used in teaching. This increase in attitude is both confidence and usefulness. Similarly Pihlap (2005) opined that the application of computers in teaching of Geometry definitely improved students attitude, it also felicitated team work, group discussions and willingness to study. Pihlap (2005) concluded that females' students gained more than male counter parts in all he stated.

On the other hand Kahvez(2010) revealed that both male and female have positive attitude towards the use of computer but male students are confident in the use of computers in learning Geometry. In the same vein, Trappers and Moniz (2011) stated that male students are more confident in learning Geometry when exposed to computers. However, both male and female are more confident and more willing to learn Geometry when exposed to computers than the traditional method. In another submission Furgasz (2015) reported that more male than female believe that computers help them in learning (31%) compared to female (20%). The male reported that the use of computers in learning Geometry allow them to solve problems, exercises faster than the traditional method. While the girls believe that computer does not help them because it is the computer that does everything when they solve problem.

Comment [AA4]:

Therefore, the result of this study would determine which of the two groups the researcher will throw his weight behind. Either male students will be better than female when expose to GeoGebra and Web –Based Practice or the other way round.

## 2.06 Computer Soft wares In Mathematics Education

Computers soft wares of different forms and calculators have been integrated into the teaching and learning of Mathematics in many countries since 1970 (Kiano and Salani ,2004). As a result of that; the use of computer soft wares has changed positively in many countries the way Mathematics is taught and learned as well as the way students are assessed and evaluated. The recent introduction of Computer Based Test in the Unified Tertiary Matriculation Examinations (UTME) is a good testimony of Nigerian experience. Computer soft wares in Mathematics Education are broadly divided in to two: Dynamic Geometry Soft wares (DGS) and Computer Algebraic System (CAS).

**2.06.1 Dynamic Geometric Soft wares: (DGS)** Dynamic Geometric Software was defined by Straber (2002) as a general term used to describe certain soft wares which are predominately used for the construction and analysis of task in elementary Geometry. While Bantchev (2010) sees DGS as a computer program that enables interactive creation and manipulation of geometric constructions. In a more explicit way Baki, Kosa and Guven (2011) defined DGS as computer soft wares which allow users to construct geometrical figures, measure some variables of these figures to determine their properties, drag the figures through the screen, make geometrical constructions, hypothesize about the construction, test the hypotheses and enable users to make generalization. The geometrical objects include points, lines circles and other 2D and 3D shapes .The user can manipulate the geometrical objects by moving parts of it to suits the needs of the user. Preiner (2008) described pure DGS as software that is operated mainly

with mouse by activating different tool geometric applying them to drawing pad or already existing objects. The main difference between CAS; Spread sheet and DGS are three according to Preiner (2008) which include: Customizable tool, drag mode and trace or locus of objects which are in DGS not in the other two.

The origins of Dynamic Geometric Software (DGS) as stated by Philip (2006) are generally agreed to lie with a program called "Geometric Supporter" which was developed for one of the first domestic computers, "The Apple II". This package supported the teaching and learning of plane Geometry in many countries of the world. Based on this other soft wares that are used in the teaching and learning of of Geometry such as Cabri, Geometer Sketchpad Cinderra were developed. Some of the uses and features of DGS were given by Bantchev (2010) as:

- Graphical presentation of Geometry on the screen
- Exploring geometric properties, testing hypotheses
- Visualizing complex data
- Geometrical reasoning
- Illustration in document presentation
- Illustration for the web
- Libraries geometrical programming

Choosing a DGS for your class is just like choosing a text book or any other instructional material. As a teacher some of the key things to bear in mind when choosing a DGS for lesson include: Suitability of the DGS to your lesson; availability and affordability of the software to your students. Bantchev (2010) gave a list of some important features that one should be interested in when choosing a dynamic geometric system for his class:

- 2D or 3D
- Constructive richness
- easy to use interface and other convenience-related issues
- kinds and degrees of dynamisms
- adaptability to specific domains and needs
- accepting text command
- extensibility (through programming)
- observability of the constructive dependencies
- reusability (of parts or technique)
- portability to foreign environments
- independence of operating system and other elements of the operating environment
- ability to talk to the user in different languages.

Table 2.2 Dynamic Geometric Softwares

| Software | Cost (USD) | Licence | Platforms |
|---|---|---|---|
| Apollonius | 0.00 US$ | Proprietary | iPhone/iPod Touch |
| Baghera | ? | ? | Windows/? |
| Cabri Geometry | ? | Proprietary | Windows, Mac OS X |
| Cabri-Euclide | ? | ? | Windows/? |
| C.a.R. | Free | GPL | Windows, Linux, Mac OS X |
| CaRMetal | Free | GPL | Windows, GNU Linux, Mac OS X |
| Cinderella 1.4 | Free | Proprietary | Windows, Linux, Mac OS X (Java) |
| Cinderella 2.0 | 69 US$ | Proprietary | Windows, Linux, Mac OS X (Java) |
| Defi | ? | ? | ? |
| DrGeo | Free | GPL | Windows, Linux, Mac OS X |
| Euklid DynaGeo | Shareware | Proprietary | Windows |
| Euklides | Shareware | Proprietary | Windows |
| Eukleides | Free | GPL | Windows, Linux, Mac OS X |
| Gambol | ? | ? | Windows, Linux, Mac OS X |
| GCLC | Free | Proprietary | Windows, Linux |
| GeoGebra | Free | Proprietary | Windows, Linux, Mac OS X |
| GeoKone.NET | Free | GPL | Web Browser (HTML5 & js) |
| Geolog | ? | ? | Windows/? |

| Software | Calculations | Macros | Loci | Animations | Scripting | Assignments | LaTeX export | Web export | Multilingual | Proofs | Extra |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cabri II Plus | Yes | Yes | Yes | Yes | Yes | Yes (with plug-in) | No | Yes | Yes | Yes (on relations) | Available on TI |
| CaR | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | ? |
| CaRMetal | Yes (recursive) | Yes | Yes | Yes (multiple) | Yes (JavaScript) | Yes | Yes | Yes | Yes | Yes (probabilistic) | Amodality, fold the Monkey |
| Cinderella | Yes | Yes | Yes | Yes | Yes | Yes | Yes (PDF) | Yes | Yes | Probabilistic | Several geometri simulations |
| GCLC | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No | Yes | Readable proof for 3D |
| GeoGebra | Yes | Yes | Yes | Yes | Yes (JavaScript) | No | Yes (PSTricks & PGF/TikZ) | Yes | Yes (55 languages) | No | CAS, HTML5 E version 3D & Autom (from version 5.0 |
| Geometria | Yes | No | Yes | Yes | No | Yes | No | Yes | Yes | No | Two-role (teach model |
| Geometrix | Yes | No | Yes | Yes | No | Yes | No | No | Yes | Yes | Interactive proo checking, tea models, labe dynamic placeho |
| Geometry Expressions | Yes | No | Yes | Yes | No | No | Yes | Yes (Interactive HTML5/JS Apps) | Yes | No | Symbolic c which can be input for CAS, source code formats/language Functions. Arcs function or curv for exported Canvas and Interactive App Muse). |

### 2.06.2 Computer Algebraic System (CAS)

CAS is a package comprising a set of algorithm for performing symbolic manipulation on Algebraic expressions and objects. The primary goal of a Computer Algebraic system is to automate tedious and sometimes difficult Algebraic manipulation task. Fuch (2007) described CAS as software that mainly deals with symbolic and numeric representation of mathematical objects'. George (2013) explained that CAS has not only changed how Mathematics is taught in many universities worldwide but has also provided a flexible tool for mathematician. He further stated CAS such as Mathematica; MathCAD can be used to simplify rational function, factors polynomial, find solution to system of equation and various other manipulation. CAS can also be used to find limit of function, symbolically integrate and differentiate arbitrary equations. For example in an attempt to expand the expression: $(a \pm b)^{5000}$ using binomial through the use of paper and pencil will be a very tedious task or impossible to be done without committing an error. However with the aid of CAS such as maple this question can be solved in a millisecond. CAS is not only used to save time but to solve problem that cannot be easily be solved by the use of traditional method, (Wolfram, 2016).

The question is that if students can use CAS to factorize Algebraic Expressions, differentiate functions, and evaluate integrands then what will the students learn in their maths lessons? The answer to this question according to Lehning (2012) is that CAS should be used as a problem solving tool, this means that the students have to deal with abstract ideas while the CAS perform the calculations. University of Chicago Mathematics Project (2012) posited that CAS can be used to experiment with Algebraic Expressions, perform complicated Algebraic Manipulation and understand how Algebraic Expressions behave while paper and pencil should be used for normal Algebraic Manipulations.

NCTM (2012) argued that the use CAS enables students learn Mathematics more deeply and it promotes conceptual understanding as the calculation aspect has been taken care of. In their contributions Hirsch and Kramarshi (2013) opined when CAS is used with Self-Regulated Learning (SRL) improves students thinking ability, performance and positive attitude towards Mathematics. In evaluating students' Mathematics performance classical questions are chosen so that CAS may help without doing everything. Some of the common CAS are:

Table 2.4 Table of Computer Algebraic System

| | Creator | Development started | First public release | Latest stable version | Latest stable release date | Cost (USD) | License | Notes |
|---|---|---|---|---|---|---|---|---|
| Axiom | Richard Jenks | 1977 | 1993 and 2002[7] | | August 2014[8] | Free | modified BSD license | General purpose CAS. Continuous Release using Docker Containers |
| Cadabra | Kasper Peeters | 2001 | 2007 | 1.42 | November 9, 2014 | Free | GNU GPL | CAS for tensor field theory |
| Calcinator | George J. Paulos | 2013 | 2016 | 2.0 | February 2015 | Free | Proprietary | Browser-based CAS for desktop and mobile devices |
| CoCoA-4 | The CoCoA Team | 1987 | 1995 | 4.7.5 | 2009 | Free for non-commercial use | own license | Specialized CAS for commutative Algebra |
| CoCoA-5 | Abbott, Bigatti, Lagorio | 2000 | 2011 | 5.1.1 | 2014 | Free | GNU GPL | Specialized CAS for commutative Algebra |
| Derive | Soft Warehouse | 1979 | 1988 | 6.1 | November 2007 | Discontinued | Proprietary | CAS designed for pocket calculators; it was discontinued in 2007 |
| DataMelt (DMelt) | jWork.ORG (Sergei Chekanov) | 2005 | 2015 | 1.5 | May 14, 2016 | $0 for academic usage, commercial license unknown | Proprietary | Java-based. Runs on the Java platform. Supports Python, Ruby, Groovy, Java and Octave. |
| Erable (aka ALGB) | Bernard Parisse, Mika Heiskanen, Claude-Nicolas Fiechter | 1993 | 1993 | 4.20060919 | April 21, 2009 | Free | LGPL | CAS designed for Hewlett-Packard scientific graphing calculators of the HP 48/49/40/50 series; discontinued in 2009 |

Source: Walform At NCTM, 2016

**Table 2.5 CAS And their Functions**

| Arbitrary precision | Calculus | | | | Solvers | | | Graph theory | Number theory | Quantifier elimination | Boolean Algebra | Tensors | Probability | Control theory | Coding theory | Group theory | System |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Integration | Integral transforms | Equations | Inequalities | Diophantine equations | Differential equations | Recurrence relations | | | | | | | | | | |
| Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | No | No | Yes | Axiom |
| No | Yes | Yes | Yes | No | Yes | No | No | No | No | No | No | No | No | No | No | No | Calcinator |
| Yes | No | No | Yes | No | Yes | No | No | Yes | Yes | No | No | No | ? | ? | Yes | Yes | Magma |
| Yes | No | No | No | No | No | No | No | ? | ? | No | ? | No | No | No | No | Yes | Magnus |
| Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | No | Yes | Maple |
| No | Yes | No | Yes | No | No | No | No | No | No | No | No | No | No | No | No | No | Mathcad |
| Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes[20] | Yes | Yes | No | Yes | Mathematica |
| Yes | Yes | Yes | Yes | Yes | No | Yes | No | No | Yes | No | Yes | No | Yes | No | No | No | MathHandbook |
| No | Yes | Yes | Yes | No | No | No | No | No | Yes | No | No | No | No | No | No | No | Mathomatic |
| Yes | Yes | Yes | Yes | No | No | Yes | No | No | No | No | No | No | No | No | No | No | Symbolic Math Toolbox (MATLAB) |
| Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | No | Yes | Maxima |
| Yes | Yes | Yes | Yes | Yes | Yes[A] | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | No | Yes | Yes | SageMath |
| Yes | Yes | Yes | Yes | Yes | Yes[21] | Yes | Yes | No | Yes | No | Yes | Yes | Yes | No | No | Yes | SymPy |
| Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | ? | ? | No | Yes | Wolfram Alpha |
| Yes | No | No | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | No | No | Yes | Yes | GAP |
| Yes | Yes | No | Yes | Yes | No | Yes | Yes | No | Yes | No | No | No | Yes | ? | No | ? | Xcas/Giac |
| Yes | Yes | No | Yes | No | No | No | No | No | No | No | No | No | ? | ? | No | No | Yacas |

Source: Walform At NCTM, 2016

## 2.07 GeoGebra Software:

GeoGebra ( is a Software that combines the functions of CAS and DGS) was invented by Marcus Hohenwarter in 2001/2002 as part of his Master Thesis in Mathematics Education in University of Salzburg Australia. He earlier studied computer programming which helped in the development of this software. Hohenwarter later acquired scholarship from Austria Academy of Science which helped to continue with the development of GeoGebra in his Ph.D. program. GeoGebra software has won so many awards including European and Germany soft wares Development Awards.

GeoGebra is an Open Source Software (OSS) dynamic software for all levels of education that combines Algebra, Geometry, Spread Sheet, Graphics, Statistics and Calculus all in a single user friendly package. Open Source software has been defined by Chyrsanthou (2008) as a software for which the underlying programming Code is available for the user to read it ,translate it, make some changes and build a new version of software in cooperating the changes. It's also called dynamic software because the user can create and manipulate Geometry constructions (Dikovic, 2009).The users of GeoGebra are rapidly increasing in almost every country in the world. It has been estimated to have more than three hundred thousand users every month all over the world. The software (GeoGebra) has been translated into 45-55 different languages.

Chyrsanthou (2008) reported that GeoGebra influences education practice in three dimensions namely: classroom practice, cognitive development and learning attitude. From classroom development it facilitates classroom activity and enhances productivity and quality. GeoGebra facilitates display of information to increase access to information, to pattern generation, to assist the execution of tasks and provide students the opportunity to work at their own pace at the same time the teacher remain in control.

Dikovic (2009) reported that GeoGebra has positive effects on geometrical knowledge and understanding of students. He further showed that GeoGebra can be a powerful tool for visualization of key notions of Differential Calculus.

Similarly, Timizi, Ayub and Saha (2010) reported that GeoGebra enhances cooperation among students of different ability groups. In addition to that GeoGebra bridges the gap between high spatial ability group and low spatial ability group.

Leong and Shadaan (2011) explained that GeoGebra increases students' progress and conceptual understanding of Mathematics. They also stated that GeoGebra enables realization of vibrant classroom where cooperative Web-based learning and collaborative principles were evident.

Zengin (2011) compared the constructivism strategy alone in one hand and constructivism strategy supplemented with GeoGebra in the other hand to teach some Mathematics concepts. He found that constructivist strategy supplemented with GeoGebra produces better results than constructivism alone. Constructivist with GeoGebra promotes more students autonomy to their learning than constructivism alone.

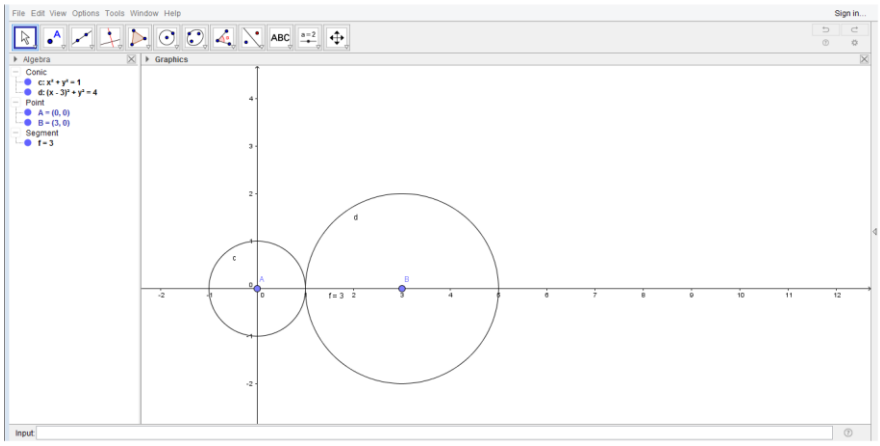
GeoGebra Forum reported that students love GeoGebra because it makes Mathematics tangible. GeoGebra makes link between Algebra and Geometry in an entirely new visual way. Students can see, touch and experience Mathematics. Teachers also love GeoGebra according to GeoGebra Forum (2011) because it does not only allow them to continue teaching but it makes them teach best. Finally schools love GeoGebra because students who use GeoGebra become more motivated and get better results.

**2.07.1 Uses of GeoGebra**:

GeoGebra is very useful software for both teachers and students. Some of the uses of GeoGebra as advanced by Dikovic (2009) and Briscoe (2010) are: demonstration/visualization, construction tool, discovery Mathematics, preparing teaching aids and worksheet.

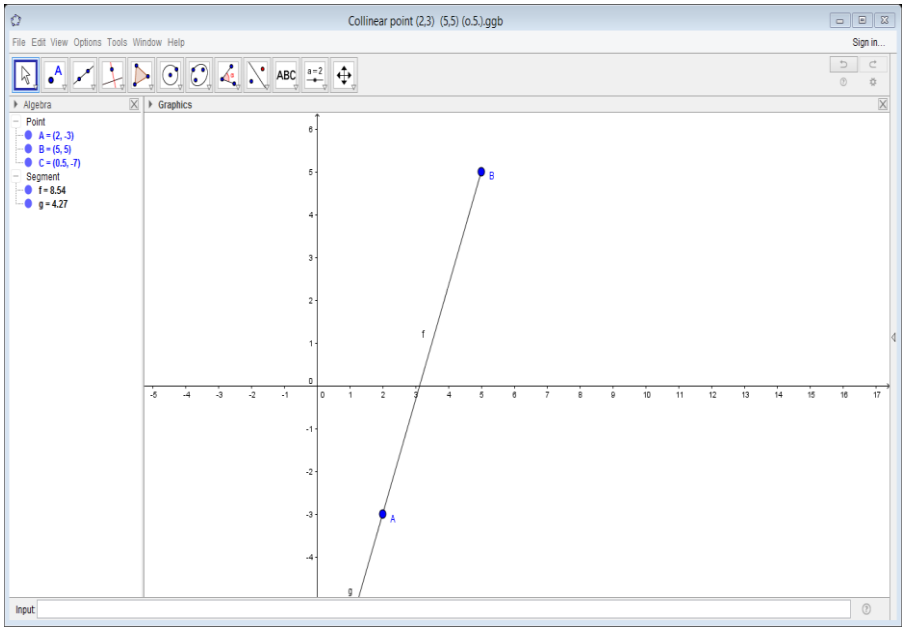
**Demonstration/Visualization**: Teacher can build dynamic demonstration through creating a relationship live in front of a class. The teacher can project a geometrical figure on the screen of a board as he demonstrates some concepts on Coordinate Geometry on GeoGebra, Briscoe (2010).The whole class can follow up teacher as he/she demonstrates concepts on the white board using GeoGebra. The students can also asks their own questions as teacher demonstrates. Examples on Figure 2.3 can be used to demonstrate and visualize the concepts of touching circles and Figure 2.4 for collinaerity of points

Fig 2.2 **Touching Circles**




Source: Researcher's GeoGebra Practice

Fig 2.3 **Collinear points**




Source : Researcher's GeoGebra Practice

**Visualization:** Visualization according to Vasquez (2015) is a powerful learning as it involves five different skills: observation, recognition, interpretation and self-expression. All these and more are achievable through effective use of GeoGebra. Visualization enables us to remember 90% of what we learn compared to 20% of what we only hear and 50% 0f what we see and hear. In addition to these visualization of geometrical figures helps students to understand Coordinate Geometry better and make it more concrete.(Sipos,2011;Kocugul,Karatas and Gulscen 2012).

Comment [AA5]:

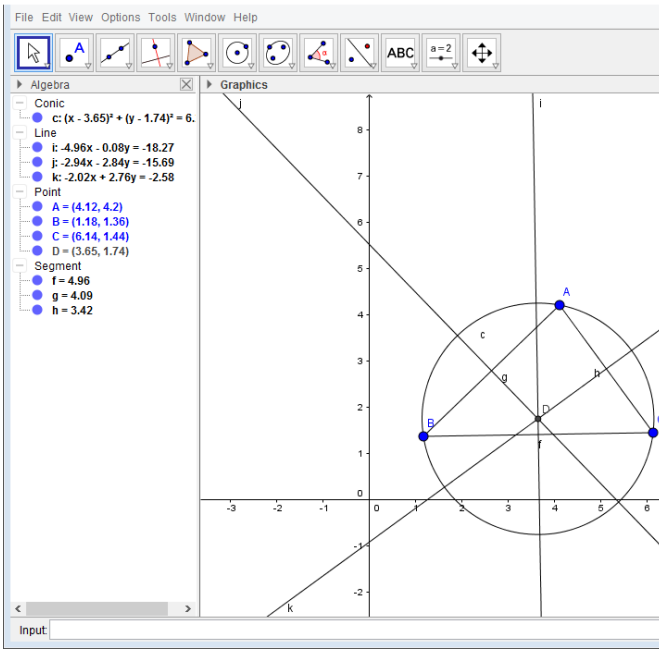
Macekova (2014) pointed that GeoGebra contributes positively to the white board environment through enriching the visualization option of interactive white board. Construction with GeoGebra can be used in tandem with any kind of interactive white board to enhance visualization of geometrical objects. The use of GeoGebra and white board as observed by

Majerek(2011) enables the whole class to see and follow the teacher movement while constructing not just follow from behind the computer and monitor teachers mouse.

**Exploration:** The teacher can guide the students to explore some mathematical ideas and relationship using GeoGebra by giving the students assignments, guided questions. Tran, Nguyen and Bui (2012) revealed that GeoGebra enhances students' exploration. In his contribution Briscoe (2010) described GeoGebra as an excellent tool for Mathematics exploration and creativity. For example the students can be asked to use GeoGebra to observe the gradients of some parallel lines. If two circles touch each other externally what is the relationship between their radii and centers? Learning objects /questions are prepared so that learners can find their relationship (Zaiskines, 2014).

**Geometrical Constructions**: GeoGebra is an effective and efficient tool for geometrical constructions of points, loci circle, triangles, quadrilaterals and many others geometrical figures. Whatever can carry using ruler and compass geometrical constructions can be done using ruler and compass can also be carried out using GeoGebra. In addition to this GeoGebra can be used to drag points, enlarge and rotate geometrical figures .However Fuch and Hohenwarter(2008) opined that the integration of GeoGebra constructions is not meant to replace traditional use of pair of compass and rule rather to compliment it. Fig 2.5 and 2.6 are typical examples of GeoGebra constructions.

Fig 2.**4 Circumscribed Triangle**



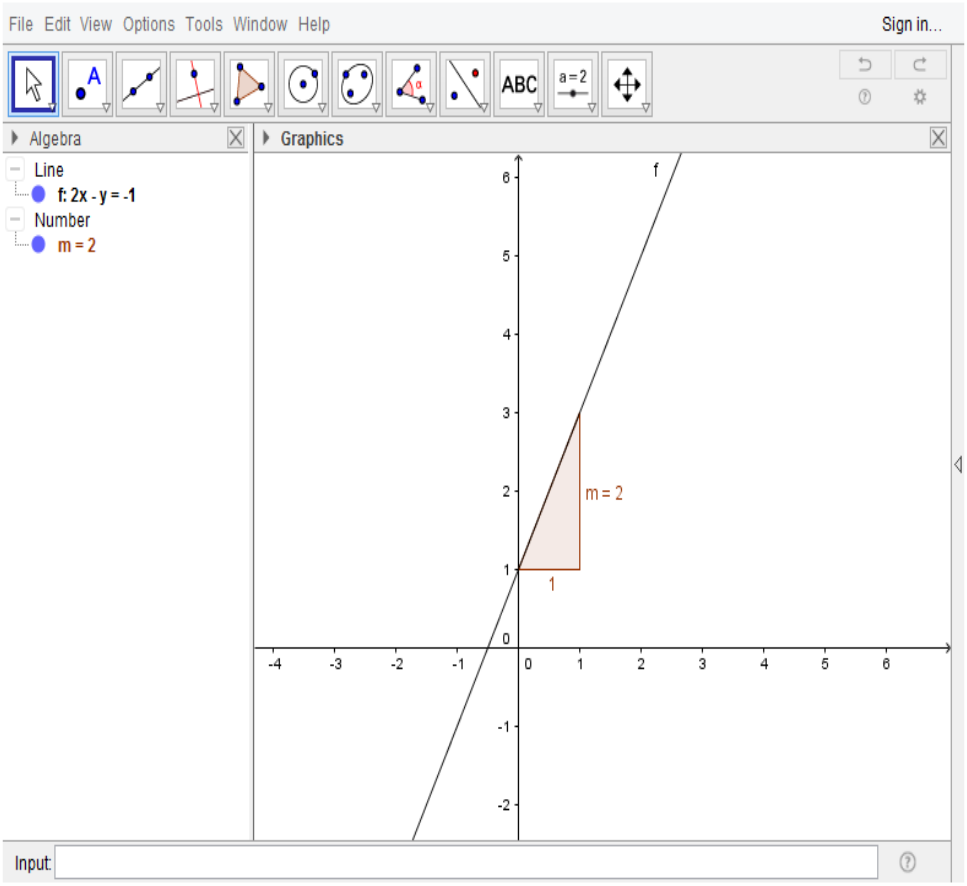

Source: Researcher's GeoGebra Practice

Experimentation: According to Fuch and Hohenwarter (2008) GeoGebra is a very suitable software for students to carryout experiment in Mathematics classrooms as well as Mathematics laboratories. With the aid of GeoGebra, Mathematics students can take ownership and personalize their work in order to create meaningful learning or produce something new. Zianskiene (2014) stated that GeoGebra can serve as means where students can build their own ideas through experimentations.

**Verification of solutions**: According to Majerek (2014) GeoGebra is used an instrument not only for visualization but also for verifying solutions to exercises done through the use of paper and pencil. Solutions to problems such as gradient of straight line; angles between two straight lines; and many others can be checked through the use of GeoGebra. Students can use paper and pencil to

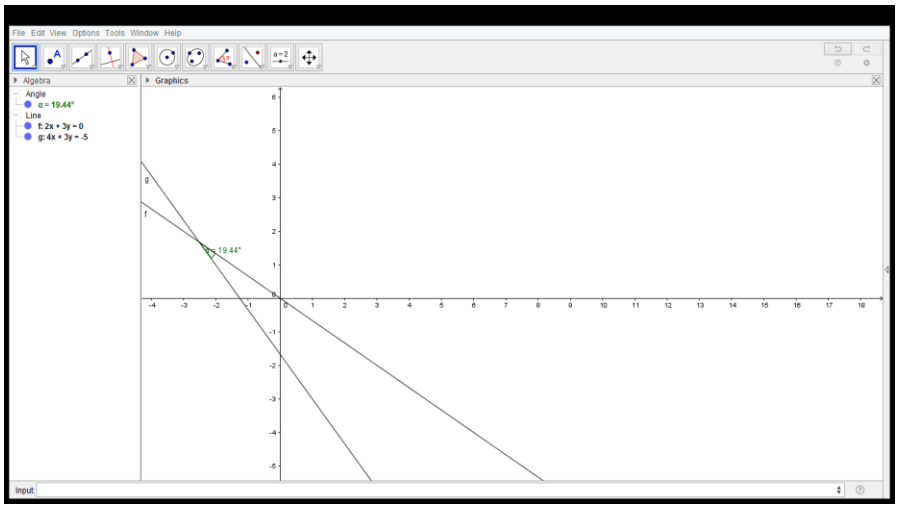
solve problems in coordinates Geometry and then use GeoGebra to verify the results the figures below illustrates two examples on Slope of a straight line and angles between two straight lines:

Fig 2.5 **Slope of a Line**




Source: Researcher's GeoGebra Practice

Fig 2.6 **Angle Between two Straight lines**




Source: Researcher's GeoGebra Practice

This could increase students understanding of this concepts and make learning of Geometry more enjoyable to students.

**2.07.2 Advantages of GeoGebra**: Scholars all over the world have listed the advantages of GeoGebra over other soft wares. Some of the advantages are:

- **Free Software**: GeoGebra is free software which does not require permission or subscription before it can be installed. One can download it in his personal computer or school computer (Priener, 2008). Furthermore it does not require in-depth knowledge of computer before it can be installed or used. As a result of this it has the highest number of users all over the world than any other software of its kind. Another advantage of GeoGebra over other soft wares according to Dikovic (2009) is that updates are made automatically guaranteeing that users will always have access to the newest version of GeoGebra once he/she install it once.

- **Versatility**: GeoGebra being an (OSS) has been translated into more than 44 languages worldwide, (Escuder, 2009). According to GeoGebra newsletter (2015) more translations of GeoGebra into other languages are in the pipeline. More so, more than three hundred thousand teachers and students visit GeoGebra website monthly. In addition to that GeoGebra community conducts workshops and seminar where they share teaching materials and exchange idea. GeoGebra is used for all grades from primary school up to university level, Primer (2008).
- **Multiple representations**: GeoGebra combines Computer Algebraic System (CAS) and Dynamic Geometry Software (DGS) in the same software while others soft wares do not .GeoGebra connects Algebra, Geometry, Spreadsheet, and Calculus all in the same software. Clements and McMillan (2010) reported that GeoGebra dynamically link different representations and maintain tight connections between pictures, object and symbols. They added that GeoGebra goes beyond what can be done with physical manipulative. In other words Hohenwarter and Jones (2007) described GeoGebra as interactive software that provides an interactive Web-based learning environment enabling the users to create mathematical objects and interact with them.
- **User friendly**: Another advantage of GeoGebra is that its user friendly. It can be used by students at all levels from primary school to tertiary level. It adopts KISS principles (Keep it Small and Simple) as it does not require advanced computer skills (Hohenwarter in Priener (2008). GeoGebra support materials are impressive where it provides wide ranging online features (Leong and Shadaan,2011). One can learn GeoGebra through GeoGebra manuals that are available on line and also through numerous free tutorial video and you tube that are also available on line. GeoGebra is programmed in Java. It can be installed and run in any operating

system by just requiring java plug in. in addition to that all operating system can run same version of GeoGebra which prevents delay of software releases for different operating system.

- **Elementarization of Mathematical Method**: GeoGebra as a construction tool has all abilities demanded from a suitable drawing/designing software which are important for teaching Geometry (Zilinskiene, 2014).GeoGebra also opens opportunity for the teachers/students to share knowledge construction and for learners' autonomy all over the world. Furthermore Hohenwarter and Fuch (2014) asserted that introducing GeoGebra in Mathematics classroom can be a way of providing opportunities' for mathematical investigation, encouraging discussion and generally it can make Mathematics a more practical subject which is accessible and more manageable to pupils/students.
- **Coherence with reality**: use of images, photo, drawing in GeoGebra according to Macekova (2014) is a feature that helps students to connect the properties of surrounding world and Geometry.

### 2.08.0. Web-Based-Learning in Mathematics Education

E-learning according to Epigenesist (2014) is a computer based educational system that enables you learn anywhere and at any time. Today e- learning is mostly delivered through internet, although in the past it was delivered using computer hard wares like CD-ROM. E-learning is classified into four categories namely: E instructions, e- practice, e- homework and e assessment. This work is interested in Web-Based Practice.

E-Practice enables students from different parts of the world irrespective of their geographical locations master some mathematical concepts through internet practice. Students normally get feedback as soon as they finished answering the questions. If the question is technical hints to answering the questions are provided. Web-Based Practice offers ability to

share materials of all kinds also communicating with one another through mails .Khan and Yushau (2014) reported that e practice is faster than paper and pencil practice. Web-Based Practice offers students hint and more than one trial in solving problem which are not available in paper –pencil trial. The researchers also reported that Web-Based Practice improves students understanding.

### 2.08.1 Advantages of Web-Based Practice in Mathematics Education

Web-based learning and practice have been studied by many scholars such as Rosenberg (2001), Brando (2001), Bass (2008), Ferriman (2013), Arkorful and Abaidoo (2014). Some of the advantages are:

- It flexible when issue of time and place are taken into consideration. Every student can learn and practice at his own discretion and convenience as long as the learner has access to computer and internet connection.
- Web -based gives students access to huge information and exercises that he/she cannot get from text books in the library
- It is faster than the traditional method of practice. Web-Based Practice gives immediate results to students' exercises.
- It provides opportunities for relation between learners by the use of discussion forum. Through this e practice helps eliminate barriers that have potential of hindering participation including fear of talking to other learners.
- E- Learning increases number of learners who achieve mastery level and it also enhance better and long term retention.
- Web-based learning / practice reduces the need of much paper, thus saving trees which are good for environmental protection.

- It allows self-pacing as a result of these individual differences is catered for.
- Research has shown that Web-Based Practice improves test scores and retention of learnt materials.
- Web-Based Practice /learning allows educators to achieve great degree of coverage for their audience.
- Web-based learning/practice helps in the development of computer and internet skills that are transferable to other facet to learners.
- Successful completion of online or computer based course builds self-confidence and encourage students to take responsibility for their learning.

**2.08.2 Disadvantages of Web-Based Practice in Mathematics Education**

- Web-based learning /practice as a method makes the learners undergo contemplation, remoteness as well as lack of interaction/ relation.
- Web-based learning / practice is less effective than the traditional practice in the area of giving of hints or explanation as well as interpretation in solving problem.
- Weak, unmotivated students and those with poor studies habits may be discouraged and fall behind others.
- Web-based learning may lead to congestion or heavy use of some website.
- In developing countries like ours internet connections are not always accessible by students, this may discourage students.
- It may also deteriorate institutional role for peer group tutoring and group work as students may practice at home

**2.09 Lecture Method**: The term lecture comes from a Latin word to read aloud. Lecture method was defined by Farouk (2012) as one way of communication from the lecturer (the source) to the

students (receiver). Students' involvement in this method is just to listen sometimes to write down some important points. Gurpret (2011) described lecture method as the most used method and the same time the most criticized method. Gurpret (2011) cited Perrot in which he opined that almost all other methods of instructions have lecture method embedded in them. He continued that the teacher has to present information and ideas. He has to introduce topics, summarize the main point of learning activity which is part of lecture method. This study intends to compare two other methods i.e GeoGebra, Web- Based Practice and lecture method in order to find their effectiveness in teaching Coordinate Geometry. Some of the advantages and disadvantages of lecture method are summarized as follows:

**2.09.1 Advantages of Lecture Method:**

- Many concepts can be covered in a short period.
- Lecture method is flexible can be used in teaching some many subjects.
- Lecture method is easier to deliver than any other teaching strategies.
- Not much equipment are required by both the teacher and the students.
- The teacher can teach a large number of students at the same time if there is large venue for example Lecture Theater in higher institutions in Nigeria.

**2.09.2 Disadvantages of Lecture Method**

- If the lecturer is very fast in delivering the lectures, the students cannot easily take notes and will not have any records of salient points.
- In the process of lecturing learners are more passive than active.
- There is no cooperation and interaction between the teacher and the students and also among the students themselves.
- Students often forget what they learn as soon as the lecture is over.

- The teacher may not get the attention of all the students.

**2.10. Review of Related Studies:**

So many related empirical studies related to GeoGebra; Web-Based Practice and Geometry were carried out all over the world. The empirical studies reviewed were carried out at all levels of education from primary school to tertiary institutions. Some of the studies are:

Sarracco (2005) investigated the effects of incorporating dynamic geometric software into Seventh Grade Mathematics curriculum. Students in the experimental group were engage in lessons that involved the augmentation of Geometer Sketchpad software while the control group received instructions that involved lecture method. During the four weeks of study, the students were carefully observed and monitored in trying to asses' changes in attitude and motivation. The results obtained by Sarracco indicated that in cooperation of the software did not improve students' performance on the post test. However students' responses to the interview questions revealed that Geometer Sketch pad enhances students' motivation and performance in Geometry. The research of the reviewed work failed to indicate the sample of his study which can help to decide whether the sample is adequate or not. Furthermore the period of the study is shorter than the accepted period in Educational Research, this could be the reason why software could not improve students' performance in Geometry.

Philap (2005) conducted a study with the aim of clarifying the impact of using computer on teaching Geometry in Grade 8. The researcher carried out survey among students in four schools in Esthonia .The sample was divided into experimental (N=119) and control (N=174). The experimental group was taught Geometry using computer software called Geometrics, and MS Excel work Sheet).and the Control Group was taught using lecture method. The research reports shows that teaching Geometry using computer does generate better results than the control group in

terms of students performance in Geometry, However, the findings revealed that the use of computer in teaching Geometry has definitely improved students attitude towards Geometry. This study produces a contrary result from most the empirical research reviewed. The reason could be that the researcher used more than one computer program at once.

In the same vein Yushau (2006) researched on the effects of blended Web-based learning on Mathematics and computer attitude in pre-Calculus class in King Fahd University of Petroleum and Minerals Resources(KFUP). A blended learning mixes various events based activity including face to face classroom learning, live Web-based learning and self-paced learning. This often mixed a mixed of traditional instruction led training, synchronous on live e conferencing or training. He used 70 students of preparatory year program of KFUP, data were collected at the beginning (preprogram) and the end (post program) of the semester using Aiken Mathematics Attitude Scale and Gressen and Computer Attitude Scale. The result indicates the subjects have positive attitude towards Mathematics and computer. However analyses of variance show no significant change in students' attitude towards Mathematics and computer, except for computer confidence and anxiety subscale.

Chyrsanthou (2008) conducted a study titled the use of ICT in primary Mathematics in Cyprus: The case of GeoGebra. Her study consisted of 16 pupils and their teacher. Her research used several data collection techniques to ensure triangulation of the data and to explore different perspective. Her data collecting instruments included: observation, interview and questionnaires. The research findings included: That the introduction of GeoGebra influences the educational practice in three dimension namely: Classrooms practice, cognitive development and learning attitude. The level of Chyrsanthou research is lower than the current study. She also used a small

sample size which can affect the basis of generalization. Researchers are of the view that when a sample is very small it cannot be regarded as a true representative of the population.

On the other hand Nguyen (2008) studied the used of Web- Based Practice on enhancing Mathematics learning and achievement. The researcher collaborated with a group of Mathematics educators, mathematicians and computer scientist to design a Web- Based Practice tool. This study consisted of 95 students in which 41 were females and 54 males of seventh graders. Half of the students participated in Web based Assisted Learning Practice (WALA) and were given time to practice Mathematics in the school computer laboratory. The other half of the students did paper and pencil practice which is referred to as Traditional Assisted Learning Practice (TALA). The students were pre tested and the results showed that there was no significant difference between the WALA and the TALA groups; however the posttest showed that the WALA grouped outperformed the TALA group. The students in the computer based group revealed that the computer gave them more practice, more fun, more clue and more understanding. Furthermore Web- Based Practice is gender friendly as female students gained 29 points more than their male counterparts on the posttest compared to the pretest. The present study will also collaborate with computer scientist in designing web based tool that gave the sample students practice in Coordinate Geometry. The difference between this study and Nguyen's works is that her study is on General Mathematics of seventh grade (equivalent to junior secondary School one in Nigeria) while the current study is narrowed to Coordinate Geometry.

Dikovic (2009) carried a study captioned the application of GeoGebra into the teaching of some topics of Mathematics at the college level. The study was carried out with 31 students (19 female and 12 male). The subjects used were Bussiness- Technical School Students of the Vocational College Serbia which were randomly chosen and taught by same teacher. The

instrument used for the study was specially designed GeoGebra applet. After lectures and exercises on Calculus had been done in traditional way, the experimental group was included in a class which Calculus was taught using GeoGebra in a computer laboratory. The students in the experimental group were free to communicate among each other and they develop group discussion. The result showed significant differences in favor of the experimental group. Just like the first research, Dikovic research used a small sample which affects the basis of generalization in research. The larger the sample the more valid the result. Consequently, the current research used larger sample than Dikovic's. Furthermore, Dikovic's work differ from the present work because he conducted research of the effects of GeoGebra on Calculus while the present research was conducted on Coordinate Geometry.

In similar development, Suleiman, Gamagiwa and Ademola (2010) carried a research on the effects of e-learning method on the teaching and learning of Mathematics. The three scholars sampled thirty (30) National Diploma students from and the Department of Accounting, and thirty (30) National Diploma students of the Business Studies from Polytechnics in North West in Nigeria using multi-stage sampling technique. The sample was divided into experimental and control groups. Both groups were pre tested and protested. The experimental group was taught Business Mathematics using e- learning while the control group was taught same content using lecture method. The findings of this studies shows that e- learning has significant effects on students but they did not find significant difference between male and female students in both experimental and control group. The work of the trio is similar to the present study in the area of Web-based learning and the educational level of students but they differ in the content area. The trio's work was in Business Mathematics while the present study is on Coordinate Geometry. More so the three

researchers did not discuss the reliability and validity of their instrument which has affected the quality of their work

On a similar development Geban (2010) undertook a study for one year on the effects of constructed web support instruction on students' achievement in education Statistics. The research was conducted at a German Schools aged 12 to 15 years in which the samples were divided into experimental and control groups. At first all the students took a standardized pretest to determine their knowledge of basic arithmetic operations. The pretest was prepared in e fit website environment used only by the experimental group of students during the year. These students were using e fit to work on maths problem of increasing difficulty level twice a week. After completing a set of task, students were informed of their results and received follow up sets of task. During other lessons the work of experimental and control group did not differ. At the end of the experiment both groups took a final test in the e-fit environment. The experimental group of students achieved remarkably better results in this test. However the question is whether their better result was not influence by the difference in teaching methodology. The significant better results may also occurred due to the fact the post test was prepared in the e environmental group which the experimental group used for their school work throughout the year. Even though the present study was carried out for a shorter period than Geban Study, the control group was post tested using paper pencil.

Yook-kinlong (2010) investigated students' web based Mathematics perspectives. The survey was conducted with the aim of finding students attitudes towards learning of Mathematics using the internet. The researcher sample 97 students whose teachers from seven schools whose teachers have used the web to teach Mathematics. The items in the instruments (questionnaire) used in the study were extracted from Fennema-Sharma Attitude Scale (FSMAS). Factors analysis was

used to determine the construct that underline the survey. The results showed that only 30% of the students that strongly agreed/agreed that the internet is valuable tool for learning Mathematics. Majority seem to have moderate valuation for internet

Anderson; Edwards, and Maloy, (2010) Conducted a study on teaching of Mathematics using a web-based tutoring system .learning games and Story writing. The study involved 125 Massachusetts fourth grade students and their teachers in three rural school district during the 2007-2008 school year. At the beginning of the study the students were provided with on line tutorial support individually as they prepared for a state wide Mathematics achievement examinations. The students were further exposed Mathematics problem solving strategies using computer; Mathematics games and creative writing of Mathematics problems to. The interventions proved successful with 70% of the students improved their performance from pretest to posttest. Based on this study the researchers recommended that math structure practice, creative exploration of Mathematics problem solving using creative blend of online and face to face activities should be in cooperated in maths classroom. The study of three scholars looked three independent variables on Mathematics achievement. The common variable of interest between the work of the trio and the present study is e-tutoring.

Ajai, Imoko and Achor (2010) work titled “Effects of games and simulations on gender related differences in achievement and interest in Geometry. The sample consisted of 287 Senior Secondary School Students of which 158 are boys while129 are girls, chosen from 46 secondary schools in Benue state. The study adopted a pretest and posttest quasi experimental design where intact classes were used as experimental and control groups. Data were generated using Geometry Achievement Test (GAT) and Geometry Interest Inventory (GII). Descriptive Statistics was used to answer the research questions while Analysis of covariance (ANCOVA) was used to test the

hypothesis. Findings showed that male and female students taught Geometry using games and simulation did not differ from one another in in interest and performances. The independent variables of this study differ from the independents variables of the current study.

Zoranis (2010) research tried find out the influence of Geometer Sketchpad on the Geometry achievement of Greek School Students. The experimental group consisted of approximately 40 students who spent at least one hour per week doing computer exploration for six weeks of a semester. There were 39 students in the control group which was not exposed to computer exploration. Students in both groups were pretested for their geometrical performance. The results indicated that the use of Geometer Sketchpad is needed to make significant progress in Geometry. Zorani's work is similar to the current research work but his/her work used different software. Furthermore, Zorani's did not look at other variables such as gender, and attitude while the current work will do so.

In a similar work, Tarmizi, Ayub and Saha (2010) looked at the effects of GeoGebra on Mathematics achievement. They sampled 59 secondary schools students in a quasi-experimental design study with non-equivalent control posttest only. The sample was classified as high visual special ability students (HV) and low visual ability (LV).The spatial visualization ability test had been used to categorize the students in different spatial ability groups. The sample students were further divided into experimental and control Groups. The experimental group was taught Coordinate Geometry using GeoGebra while the control group was taught Coordinate Geometry using lecture method .Students achievement was measured using Mathematics Achievement Test. The test format was based on Additional Mathematics syllabus. Independent sample t test showed significant difference in the mean achievement between the experimental and control group in favor of the experimental groups. The researchers concluded that GeoGebra enhances students'

Comment [AA6]:

achievements in Coordinate Geometry. The study of Tarmizi, Ayub and Saha (2010) has lesser number of independent and dependent variables than this study. In addition to this, the work of Tarmizi and his coauthors' did not discuss the reliability and the validity of their instrument. Furthermore, the design used by the three researchers is a disadvantage design because it does not establish students' ability before the intervention was given.All these were addressed in the present work.

Jazdwski (2011) compared the attitude of boys and girls in grade three from high and low ability group. The attitude studied were confidence in learning Mathematics, perception of teachers' attitude towards the students as learners of Mathematics, perceived usefulness and stereotype of Mathematics as male domain. The students were given the modified Fennema Sharma Attitude Scale to measure attitude. In the survey there were 12 statements for each attitude in which 6 were stated positively and 6 negatively. There were 533 students where 282 were females and 251 were males in which 278 were considered to be low ability and 255 were high ability. The only attitude that was found statically significant was stereotype of Mathematics as a male domain.

In a similar study Zengin (2011) carried out a research with the aim of determining the effects of Mathematics software GeoGebra on students' achievement in teaching of trigonometry. The sample of the study consists of 51 students. The experimental group was subjected to the lessons arranged with GeoGebra software while the control group was subjected with the same lesson based on constructivist instruction. The data collected after 5 weeks of application show that there was meaningful difference between experimental and control groups' achievement in trigonometry. The difference is in favor of the experimental group which had lesson with GeoGebra. The study of Zengin's differs from the present study in subject matter. Furthermore, Zengin's did not look at gender while the present study looked at performance, attitude and gender.

Adolphus (2011) looked at the problems of teaching of Geometry in secondary schools in River State. In an attempt to solve this problem; the researcher asked the following: What factors are responsible for the difficulty in teaching and learning of Geometry in secondary schools in Rivers State, Nigeria? What strategy could be adopted to enhance the teaching and learning of Geometry? Some factors were investigated which revolve about physical facilities, quality and quantity of teaching staff; attitude of Students; parents and government. Data were collected by the means of two questionnaires' administered to 800 students and 30 teachers drawn from ten secondary schools. Some of the findings include: Majority of the teachers and students have poor background in Geometry. Also the Web-based learning environments in the area of studies is not conducive as its lacks basic learning facilities.

Kocugul, Karatas and Gulsecen (2012) in an attempt to answer the question; "Can GeoGebra make easier the understanding of Cartesian Coordinate? First, they translated the instrument of the study called "Polar Grapher" into Turkish and then developed a new worksheet with GeoGebra about visualizing complex numbers and Cartesian Coordinates. After presenting the material to $4^{th}$ grade students from high school in Turkey; questionnaires were administered to both students and their teachers. The views of the students were: Majority of the students indicated that GeoGebra makes Mathematics clear and more understandable. It also makes the subject more concrete and it saves time. The teachers are of the opinion that they enjoy using GeoGebra than the traditional teaching method. The study of these three researchers did not reveal the validity and reliability of the instruments they used. Also the researchers did not indicate the size of the population of the studies nor the sample. These reduced the credibility of their work.

Micheal (2012) investigated the potential of the joint use of GeoGebra and interactive white board (IWB) for teaching and learning straight line graph. The researcher collected data through

interview and observation from a class teacher and 23 students of grade 9 in Bristol United Kingdom. The findings indicated that the joint use of GeoGebra and IWB lead to three type of orchestrations as the guides' students instrumental geneses. The study also found the joint use of GeoGebra and IWB has influence the whole class interaction.

Aktas and Aktas (2012) investigated high School Students attitudes towards Geometry according to different variables. The study was conducted using survey with an instrument developed by the researchers. The reliability of the instrument was calculated to be 0.89. Data were collected by administrating the questionnaire to 536 students. The data was analyzed through calculating the standard deviation as well as independent t test and one way ANOVA for group comparison. The results revealed that there is significant difference in students towards Geometry according to school type. While there is no significant difference according to gender and grade. The study of Aktas and Aktas was analyzed using a wrong Statistics. Attitude can be measured using non parametric Statistics however Aktas and Aktas used ANOVA and T test which they are parametric Statistics.

The work of Abakpa and Iji (2012) focused on the effects of Mastering Learning Approach (MLA) on secondary school students achievements in Geometry. They asked five research questions and formulated five hypotheses. The researchers used a sample of 270 students out of 885 from 26 secondary schools in Makurdi Benue State Nigeria. The research work adopted non randomized pre-test and posttest design. The instrument for the study was Geometrical achievement Test with reliability coefficient of 0.72. Research questions were answered through the use of mean and standard deviation while the hypotheses was tested using Analysis of Covariance (ANCOVA).The results showed that MLA improved students achievement in Geometry; it also

narrowed the gap between the high and low ability in Geometry. Finally male and female students equally improved in GAT.

Ozerem's (2012) worked on a topic titled "Misconception in Geometry Suggested Solution for the Seventh Grade Students". The principal of his study was to find out the weakness of secondary school students at geometrical questions of measures, angle, shapes, transformation and constructions .The research covered 4 geometrical topics out of the 17 Mathematics of $7^{th}$ Grade Mathematics curriculum of Turkey. Data were collected from 4 examinations including two midterm test. The tests cover measures and angles shape skills, transformation and constructions of geometrical shapes. The results show that the students have a lot of misconception about Geometry. It also shows that the students lack background knowledge in Geometry and the students are weak in geometrical reasoning. Ozerem's work has a lot of short comings as it did not mention specifically the instrument he used for data collection nor discussed its reliability and validity.

From South Africa, Dickson (2013) conducted a study into the difficulties faced by students in learning of transformational Geometry for the partial fulfillment of Masters Degree in Mathematics Education. The study employed the use of the Van-Haile's levels of learning to investigate and describe the difficulties students have in learning of rotational transformation Geometry. Both written test and oral interview were used to collect data regarding students' difficulties in identifying and naming transformation of rotation, finding the center, angle of rotation and locating the exact image of a rotated figure after rotation. The results of that most students had difficulties at the level of abstraction and deduction and also majority of the students are reasoning at the lowest level of Van-Heile model which are visualization and description.

Sunzuma, Masocha and Zazekwa (2013) looked at the secondary school students' attitude towards learning Geometry. The study adopted quantitative descriptive survey research using

simple frequency to analyze the data. A sample of 100 students was taken using stratified sampling from three urban school. The research was conducted quantitatively using questionnaire that comprised 15 closed questions which were adapted from Fennema-Sharma Mathematics attitude scale. The analyses showed that the students' attitude towards usefulness of Geometry was positive and many of them believed that Geometry is valuable and necessary concept that can help them in their future carrier. Though the students indicated that Geometry is not difficult, they did not like solving geometrical questions. The three researchers used only one independent variable (attitude) against one dependent variable (Geometry) while the present study will look the effect of two independent variables on another two dependent variables.

Leong and Shadaan (2013) examined the effectiveness of using GeoGebra on students understanding in learning circle. Fifty three year 9(form 3) students participated in the study from two intact classes in which one was assigned to be experimental and the other to be control group. Both the experimental and the control groups were pretested and then experimental group was taught circles using GeoGebra while the control group was taught using chalk and board method. After that the students were post tested and the results were analyzed using "t' test. The results indicated significant differences between the experimental and the control group in favor of the experimental group. The use of GeoGebra according to the researchers also significantly increased the experimental group conceptual understanding of circles. The work of Leong and his colleague is one variable (GeoGebra) on one variable (understanding of circle) while the current work investigated two variables against two variables which means that the current research work is wider in scope. Furthermore, Leong and his colleague wrongly used a non-measurable term "understanding" in the title of the study.

In his Thesis Akgul (2014) studied the effects of using GeoGebra on students' achievements in Transformational Geometry, Geometric Thinking, and attitude towards Mathematics and technology in Turkey. The researcher used a sample of 34 (17 males and 17 females) eighth grade students in a static group pre-test post-test research design in a private school. The study lasted 10 hours in three weeks. The sample was taken from two intact classes in which one was assigned to be experimental and the other control the assignment was done randomly. The experimental group was taught transformational Geometry using GeoGebra while the control group was taught same content using traditional method. The researcher used two instruments which include: Van Haile Geometrical level Test (VHL) and Mathematics Test Attitude Scale (MTAS) to collect data. The quantitative data analyses were done using independent t test. The result of the study indicated that GeoGebra software had significant effects on students' mathematical achievement and geometrical thinking. However, GeoGebra has no significant effects on student's attitude towards Geometry and attitude. This study has a weak research design which does not establish the homogeneity of the two research groups as a result of that the researcher cannot confidently conclude that the change recorded was due to the intervention given. The researcher of the reported work considered gender in the selection of the sample but failed to report the research report in respect to gender.

Shakur and Arabain (2014) carried out research study on the effects of GeoGebra on students' achievement in Statistics in Malaysia. They sampled 62 students and divided them into experimental and control group. They first gave them pretest, followed by the intervention to the experimental group and no intervention to the control group. The research findings are: GeoGebra can increase students' interest, confidence and motivation in learning Statistics'. Also the results revealed that the experimental group outperformed the control group. The work of Shakur and

Arabain is similar to the present study in terms of research design but they differ in terms of variables. Shakur and his colleague looked at the area of Statistics' while the current work is on Coordinate Geometry. Their work did not study variables such as gender and student attitudes towards the use of GeoGebra while this work did so.

In another work, Nguye, Bui, and Tran (2014) carried out research titled "Discovering Learning with the Help of GeoGebra Dynamic Geometry Software". The three researchers surveyed 282 Upper Secondary Students in Vietnam on the exploitation and the uses of GeoGebra software for help of discovery learning. The results indicated that 71% of the students use GeoGebra to perform self-research; 86% of the students use GeoGebra to carry out projects given to them by the teacher; 78% of the students use GeoGebra to solve exercises; 79% of the students use GeoGebra in self check answer while 84% of the students use GeoGebra in for familiarity. This work covers major area of GeoGebra applications but used a descriptive statistic (percentages) to analyze the result instead of inferential statistics. Descriptive statistics is not sufficient in analyzing research report such as this. The three researchers would have made their work more credible, if they had used inferential statistics in addition to descriptive statistics.

YenChang and Bhaghat (2014) attempted to examine the impact of using GeoGebra on $9^{th}$ Grade Mathematics achievement in learning Geometry. A total of 50 students were selected from public schools in Eastern India. The study used quasi experimental research design in which 25 students are in the experimental group and same number in control group. The experimental group was taught Geometry using GeoGebra while the control was taught same content using traditional method. The researchers taught the students by themselves. Analysis of Covariance (ANCOVA) was calculated using Statistical Packages for Social Science (SPSS). The results showed that GeoGebra is an effective tool for teaching and learning Geometry in the middle school. The study

of Bhagat and his colleague did not look at variables such as attitude of students towards Geometry, gender performance among others. Throughout the study of Bhagat and his colleague the reliability and validity of the instruments were not discussed. These lower the standard of their research work.

Akanmu (2015) undertook a research on the effects of GeoGebra packages on learning of Senior Secondary School Students in Ogbomosho, North Local Government in Osun State. The study used nonequivalent pretest and posttest control group. The study sample was selected using purposive sampling. The two groups were chosen based on the availability of computer resources in the school. 54 students experimental and 51 students control group. The study was conducted for six weeks. This study found that the experimental group (those taught) the using GeoGebra gained higher scores in test performance than the control group. However he didn't find any difference between the performance of male and female students in the experimental group. In addition to that he found that the experimental group developed positive attitude towards Mathematics. Akanmu's work differs from the present study in terms of sampling technique. Akanmu used purposive sampling which is not as credible as random sampling. However, the present researcher used random sampling throughout the research process ( in choosing participing schools, in allocation of school as Experimental and Control Groups and selecting individual subjects)

The work of Emaiku,Iji and Abari (2015) examined the effects of GeoGebra on Senior Secondary School Students interest and achievement in Statistics in Makurdi Local Area of Benue state . A sample size of 242 was used in a quasi-experimental design. Data were collected using two instruments. Statistics Achievement Test and Statistics Inventory Test. Four research questions were answered and four hypotheses were tested using Analysis of Covariance (ANCOVA). The researchers found that students taught Statistics using GeoGebra software achieved higher score in the test. The study also revealed that students taught Statistics using GeoGebra showed greater

interest than those taught using traditional method. The study also showed that both male and female students achieved same in Statistics.

Suleiman, Ali, Ismail and Rajjagopal (2015) investigated the attitude of students towards the use of GeoGebra in learning loci in two dimensions in Malaysia. The sample consisted of thirty form 2 students from a secondary school. The study was conducted for two days, five hours per day and six lessons. The researchers asked the students to do the activities in GeoGebra applet and the students were given were served with questionnaires' consisted of 18 items. The results reveals that the perceive ease if the use of GeoGebra had a significant relationship on perceived usefulness. More so, perceived usefulness has significant impact on students' attitude towards GeoGebra in learning two dimensional loci.

Vasquez (2015) in her thesis; "Evaluating Students Achievement Using GeoGebra in Technologically Rich Environment". The research project included 112 High School students all taking Geometry from the same teacher. The control and the experimental learned geometric transformation with treatment group using interactive GeoGebra activities. The research used a mixed method to determine whether GeoGebra impacted students' achievement and engagement. Qualitative data was collected in the form of field notes, informal interviews and examination. Quantitative data was collected on three assessments and analyzed using ANOVA. The findings show that GeoGebra software enhances understanding of abstract concepts, increased students comprehension and retention of geometric transformation and had a positive effect on students' attitude towards Mathematics, thus enhancing their learning and achievement. The researcher that work concluded that the use of GeoGebra in learning Geometric transformation increased overall motivation, engagement and achievement. Vasquez work examined geometrical transformation while the present study is on Coordinate Geometry therefore the two studies differ in subject

matter. The thesis of Vasquez also differs with this study in environment because she referred to her area of study as technologically riched environment while the area of this study cannot be classified as so.

Similarly Laolck (2015) studied the effects of Mathematics teaching outcome with Geometer Sketchpad towards geometrical concept and attitude of tenth .Participant of the research were 36-10 grade students in Bangkok, Thailand. The researcher used 8 periods for teaching and data collections. The topics covered during the teaching include: Distance between two points; midpoints of a line segment joining two points; Slope of a line; the equation of a line; parallel lines; perpendicular lines; distance from a point to a line and distance between two parallel lines. Results of the findings showed that the GSP helped students to improve their understanding in geometrical concepts. It also showed that the use of GSP has improved students attitude positively towards learning of Geometry. Laock's work is similar to the current work because the subject content of the research is Analytic Geometry However; Laock's work omitted some important research component such as research design and method of data analysis. These omissions can reduce the credibility of his work.

Gloria (2015) studied the mathematical competence and performance in Geometry of high school students. The study tried to find out if variables such as gender, grade in English language, learning style, class size and classroom structure significantly affect the performance of high school students in Geometry. Respondents were 212 high who were taken at random from three schools in Philippines. The data was analyzed using SPSS program. Results from the findings revealed the following: Students taking Geometry have varied learning style. Students have low level of academic performance in Geometry. The study further revealed that class size, classroom structure

affects students' performance in Geometry. The work of Gloria failed to state the research design used and also did not state the validity and reliability of the instruments used in data collection.

Similarly, Salman and Kayode (2015) investigated the conceptions of selected concepts in Geometry held by Senior Secondary School Students in Ogun State, Nigeria. The method of the study was a descriptive survey. Proportionate and stratified sampling techniques were employed to select 757 Senior Secondary 2 students from 56 coeducational schools in Ogun State. Data were collected using 26-item researcher designed questionnaire titled Geometry Conception Test (GCT). The instrument was validated by six university lecturers and two experienced secondary school teachers. A test retest method was used to determine the reliability of the instrument and a reliability coefficient of 0.86 was obtained using Pearson Moment Correlation Coefficient. Data collected were analyzed using frequency counts, percentage and Chi square Statistics. The findings showed that the number of students holding misconception and alternative conceptions were more than the students with correct conceptions on Geometry. The researchers recommended that teachers should first find out the conceptions of key concepts in Geometry before teaching them the concept.

Ali, Bhagawati and Sharmah (2015) examined the geometrical performance and gender in learning of Geometry. The data were collected using questionnaire and interview from selected secondary school in India. A simple descriptive Statistics was used to analyze the data. The result indicated that fundamental knowledge of Geometry among students in India. It also found that most students have difficulties in the geometrical portion of Mathematics curriculum. The researchers' concluded that India Government should organize seminars in order to improve the situation. The work of these three researchers did not identify the causes of the poor performance in Geometry.

The work failed to suggest specific method that will improve the teaching and learning of Geometry in India.

In a very recent Mwingirwa and Miheso-O'connor (2016) worked on a research titled "Status of Teachers Technology Uptake and Use of GeoGebra in Teaching Secondary School Mathematics In Kenya". The study investigated teachers' perspective towards training and eventually using GeoGebra as a tool to enhance Web-based learning of Mathematics. The researchers trained 33 secondary school Mathematics teachers in the use of GeoGebra. Data were collected using questionnaire and interview. The data collected during the training session were analyzed using descriptive Statistics. The findings of this research indicated that teachers identify Geometry as the most branch of Mathematics curriculum where GeoGebra should be used. The teachers also stated that GeoGebra could enable students to comprehend difficult and abstract of Geometry. Furthermore the teachers opined that GeoGebra would enhance more effective teaching and learning of geometrical concepts. The research of the Kenyans differs from the present work in terms of the type of sample used. They used practicing teachers while this study would use the students of colleges of education in Nigeria.

Bostan and Erkuk (2016) conducted a study titled "Is the Use of GeoGebra Advantageous in the process of Argumentation?", with the purpose of investigating the advantages and disadvantages of using GeoGebra in argumentation application. Argumentation is defined as a process of establishing or validating a conclusion on the basis of reasons. For this purpose, data were collected from eight prospective Mathematics teachers through video recording, reflective papers and interview. Data were analyzed through qualitative data analyses methods. The findings of the study gave the advantages of GeoGebra as making accurate drawing, creating confident justifications based on exact measurement, dragging objects to see the relationship between objects

and saving time. Some of the disadvantages of GeoGebra are students not attending class discussion and not reasoning the relationship after measuring with GeoGebra.

### 2.11 Implication of Literature Reviewed on the Present Study:

Much researches have been carried out on GeoGebra and Web Based Learning all over the world. These studies cut across all levels of education from elementary to tertiary institutions. The findings from the literature reviewed can be summarized as follows: ICT in general, GeoGebra and Web- Based Learning in particular have been integrated into Mathematics classroom in many countries. Furthermore GeoGebra and Web- Based Learning have improved learners performance in Mathematics and have changed the learners' attitude positively towards Mathematics. In addition to these, GeoGebra and Web- Based Learning have helped in making teaching and learning of Mathematics from being teachers centered to learners centered.

However, almost all the studies reviewed on GeoGebra and Web- Based Learning were done on other branches of Mathematics such as Statistics, Calculus, Trigonometry ,Circle ,Euclidean Geometry, Geometrical transformation and General Mathematics .This research didn't find any research that was conducted on teaching and learning Coordinate Geometry using GeoGebra and Web based Practice. Besides, Coordinate Geometry has more features in common with GeoGebra than any other branch of Mathematics. Both GeoGebra and Coordinate -Geometry provide connections between Algebra and Geometry. For example if you choose a point on the graphic view of GeoGebra its coordinates automatically appears on the Algebraic view. Likewise, if you move or change the point on the graphic view of GeoGebra the coordinates change automatically. Based on these similarities between GeoGebra and Coordinate Geometry, there is strong need to find out through research such as this work whether GeoGebra and Web- Based

Practice can improve students' performance in Coordinate Geometry and also change the students attitude positively towards Coordinate Geometry.

Gender is an important variable of study for many years in Science Education in general and Mathematics Education in particular. The research reviewed so far did not study gender issue. As a result of that the current work tried and filled that important gap.

Although the research works reviewed so far on GeoGebra and Web based learning were conducted at all level s of education as stated earlier, none of these research works was carried out in a college of education. Colleges of education are key teacher training institutions in Nigeria. Therefore this research work filled that gap and it also helped in popularizing the use of GeoGebra and Web Based Learning in Nigeria. This is because if you teach a prospect teacher how to use GeoGebra and Web- Based Practice, the teacher is likely teach same to his pupils when he/she becomes a teacher.

Another gap that this research filled is that very few studies on GeoGebra and Web- Based Practice were conducted in Nigeria. Furthermore those studies were not on Coordinate Geometry. More than 95% of the work reviewed on GeoGebra and Web- Based Practice were carried out in other countries. This give rise to the need of carrying a research such as this in Nigeria on the effects of GeoGebra and Web- Based Practice on attitude and performance in Coordinate Geometry among colleges of education student so that Mathematics Educators and researchers would benefit from it.

## CHAPTER THREE

## RESEARCH METHODOLOGY

### 3.1 Introduction

This study attempted to find the effects of GeoGebra and Web- Based Practice on Attitude and Performance in Coordinate Geometry among students of colleges of education in the North West Zone, Nigeria. This chapter discussed the following:

- Research Design
- Population of the Study
- Sample and Sampling Technique
- Web Based-Practice Method
- GeoGebra Method
- Validation of the Instrument
- Reliability of the Instrument
- Pilot Testing
- Administration of the Instrument
- Procedures for Data Analysis

### 3.02 Research Design

This research work adopted the pre-test –post-test, control group quasi experimental research design as proposed by Sambo (2008). At the beginning of the work the two experimental groups $EG_1$, EG2 and control group CG were pretested to ensure that they are homogenous. This enable the researcher concluded that changes observed were due to the treatment. Then $EG_I$ was taught Coordinate Geometry using GeoGebra software; $EG_2$was taught Coordinate Geometry using Web based -practice while the CG was taught using conventional lecture method. Finally the three groups were post tested and then the results were analyzed .The design is illustrated in Fig 3.1.

**Fig3.1 Research Design Illustrations**

| Group | Pretest | Treatment | Posttest |
|---|---|---|---|
| EGI | $0_1$ | CGPT<br>CGAT | X1 $0_2$ | CGPT<br>CGAT |
| EG2 | $0_1$ | CGPT<br>CGAT | $X_2$ $0_2$ | CGPT<br>CGAT |
| CG | $0_1$ | CGPT<br>CGAT | $X_0$ $0_2$ | CGPT<br>CGAT |

Adapted from Sambo (2008)

Key:

EGI: Experimental Group I

EG 2: Experimental Group 2

CG: Control Group

CGPT: Coordinate Geometry Performance Test

CGAT: Coordinate Geometry Attitude Test

$X_1$: Treatments for Experimental Group 1

$X_2$: Treatment for Experimental Group 2

Xo: Teaching the Control Group using Lecture Method

01: pretest for CGPT and CGAT

02: posttest CGAT and CGAT

### 3.03 Population of the Study

The population of the study consisted of all the NCE 1 Mathematics students in the-colleges of education of the North-West Zone. There are twelve Colleges of Education in the zone according to the National Commission for College of Education (NCCE): Five Federal Colleges of Education, Seven State owned Colleges of Education. The total number of NCE1 Mathematics students in these colleges from the researcher's field survey as of 2016 is 1465 in which 997 are males and 468 are females. Most of these students are between the ages of 16 to 25. The students have at least twelve years of schooling. The students have experience of computer usage at least during Unified Tertiary Matriculation Examination (UTME) computer based examination. The distribution of the population of the study is presented in the Table 3.1.:

**Table 3.1 Distribution of Population of the Study**

| S/No | Names of Institution | Male | Female | Total |
|---|---|---|---|---|
| 1 | Federal College of Education Zaria | 250 | 100 | 350 |
| 2 | Federal College of Education Kano | 148 | 80 | 228 |
| 3 | Federal College of Education Katsina | 130 | 60 | 190 |
| 4 | Federal College of Education Bichi,Kano | 50 | 28 | 78 |
| 5 | Federal College of Education (Technical) Gusau | - | 20 | 20 |
| 6 | Kaduna State College of Education, Kafachan | 56 | 30 | 86 |
| 7 | Isa Kaita College of Education Dustinma | 54 | 33 | 87 |
| 8 | Saadatu Rimi College of Education | 113 | 19 | 132 |

| | | | | |
|---|---|---|---|---|
| | Kano | | | |
| 9 | Shehu Shagari College of Education Sokoto | 45 | 14 | 59 |
| 10 | Zamfara State College of Education Maru | 50 | 20 | 70 |
| 11 | Adamu Augie College of Education Argungu Kebbi State | 56 | 34 | 90 |
| 12 | Jigawa State College of Education Gumel | 45 | 30 | 75 |
| TOTAL | | 997 | 468 | 1465 |

Source: Researcher's Field Survey 2016

### 3.04 Sample and Sampling Technique

Three colleges of education were selected out of twelve using simple random sampling. After that the chosen colleges were assigned as EG1; EG2 and CG through balloting. Seventy (70) students comprising of forty (40) males and thirty (30) females were selected from each of these colleges using random numbers. Two hundred and ten (210) students were used as the sample of the study. The sample used satisfied the central limit theorem that proposed minimum of 30 as a sample size for a study of this nature, Franklin and Wallen (2000).

**Table 3.2 Sample of the Study**

| S/N | INSTITUTION | MALE | FEMALE | TOTAL |
|---|---|---|---|---|
| 1 | Federal College of Education, Kano | 40 | 30 | 70 |
| 2 | Federal College of Education ,Katsina | 40 | 30 | 70 |
| 3 | Federal College Of Education Zaria | 40 | 30 | 70 |
| | TOTAL | 120 | 90 | 210 |

Source: Researcher's field Survey

### 3.05 Instrumentation

The following instruments were used to collect data

(a) Coordinate Geometry Performance Test (CGPT)

(b) Coordinate Geometry Attitude Test (CGAT)

#### 3.05.1 Coordinate Geometry Performance Test

Coordinate Geometry Performance Test (CGPT) consisted of 40 multiple-choice questions. The questions were drawn from: Coordinate Geometry past question papers from Colleges of Education in the North West Zone; relevant Mathematics text books such as Pure Mathematics Book1 by J.; S.P.T Houldsworth and P.T.Horril; Advanced Level Pure Mathematics by Bounday and also from some questions bank that are available on line such as Geometry Multiple Choice Regents Exam Questions. The test questions covered the major areas of straight line and circle Coordinate Geometry: Distance between Two Points, Midpoints, Division of Line in a Given Ratio ; Angles between Two Straight Lines; Equations of a Line; Equations of a Circle ,Finding the Center and the Radius of a circle; tangent to a circle. The questions were set based on the objectives stated Briscoe (2010) modified Blooms Taxonomy Mathematics Chart.

Table 3.3 **Specifications of Test Item**

| Content | Knowledge | Comprehension | Application | Synthesis | Evaluation | Total |
|---|---|---|---|---|---|---|
| Distance between two pts | 2 | 2 | 2 | 1 | 1 | 8 |
| Gradient | 2 | 2 | 2 | 2 | 1 | 9 |
| Straight line | 2 | 2 | 2 | 1 | 1 | 8 |
| Circle | 3 | 2`` | 2 | 2 | 1 | 10 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Tangent | 1 | 1 | 1 | 1 | 1 | 5 |
| Total | 10 | 9 | 9 | 7 | 5 | 40 |

**3.05.2 Coordinate Geometry Attitude Test**

Coordinate Geometry Attitude Test (CGAT) is a 20 item questionnaire which was adapted from Mogari (2004), "Attitude towards Euclidean Geometry" .The expression attitude towards "Euclidean Geometry" in Mogari's work was replaced with attitude towards "Coordinate Geometry" throughout the questionnaire. The questionnaire which consisted of 20 items was divided into five subscales each under the items: Enjoyment, Value, motivation and belief as follows:

Enjoyment: 1, 5,9,13 and 17

Value: 2, 6, 10, 14 and 18

Motivation: 3,7,11 and 19

Belief : 4,8,12,16 and 20

The questionnaire has response as: Strongly Agreed (S.A); Agreed (A), Undecided (UD), Disagreed (D) and Strongly Disagreed (SD). This questionnaire was used to find out the effects of GeoGebra, Web- Based Practice on the students attitude towards Coordinate Geometry. Each of the options carries weight in descending order from 5-1 points. While the negative statements carries weight in ascending order from 1-5 points. Each of the item in the questionnaire has the maximum (5 x 20) = 100 marks while the minimum (1 x 20) = 20 marks. The average of 50 point is considered as positive attitude towards Geometry while less than 50 is considered as negative attitude towards Geometry.

**3.05.3 Web-Based Practice Method**: This research adopted Khan Academy practice site

on Coordinate Geometry. The web page is available on: https;//www.khanacademy.org/math/Geometry-home/analytic-Geometry-topic.

Khan Academy is a non -profit education organization created in 2006 by an educator Salman Khan with a goal of creating a set of on line tools that help educate students. The organization produces lectures in form of you tube, text, exercises, assignment and practice. The main mission of Khan Academy is to provide a free, world class education to anyone at anywhere. It is being run by volunteers whose qualification is from first degree to those of the rank of professors. It education materials cuts across so many subjects both science and humanities. It is also for all grades from kindergarten to university. Khan Academy Analytic Geometry (Coordinate Geometry) is one of such products: The page provides practice exercises and quiz on the following:

- Distance between Two points
- Midpoint of Two Points
- Division of Line Segment
- Equation of Parallel and Perpendicular Lines
- Equation of Circle (Expanded form and standard form)
- Points Inside and Outside a Circle
- Touching Circles.

The questions are well graded, one stage leading to another. Instant result is given to each question answered by the student. Hints are also available to guide the students in case of wrong answers. The researcher guided Experimental Group 2 on the use of this web based page as a treatment to that group. This was done after the researcher was sure that the course lecturer has covered the relevant areas with the students in EG2.

**3.05.4 GeoGebra Teaching Method**: The GeoGebra teaching for EG1 was conducted in computer laboratory equipped with a projector. GeoGebra software was installed in all the computers' in the laboratory. The Course lecturer taught EG1 same concepts as EG2. The Course Lecturer used whole class demonstration in teaching the lesson through projecting the concepts. The students were allowed to repeat the process using the computers in the computer laboratories individually and in groups before they proceeded to solve exercises using GeoGebra on Straight line and circle Coordinate Geometry. Students that have their personal computers were encouraged to take further practice on using GeoGebra in addition to the one they have in the computer laboratory. The first week was general introduction to GeoGebra, its inventions, its development and its capability. The students were also introduced to different views of GeoGebra such as Graphic View, Algebraic View and Input View. The second lesson was on: Location of point on a plane; Distance between two points and Point using GeoGebra. The next lesson of two hours covered gradient, collinear points angle between two straight lines. The fourth lesson dealt with equations of straight lines and circles. Commands for obtaining three different types of equation of a circle were treated. The fifth lesson treated touching circles as well as point inside and outside a given circle. The sixth GeoGebra lesson was general practice for all the students. The students were asked to revise what they have learnt using GeoGebra. They brought questions from different text book which they practiced as the facilitator goes round to help those that needed help. The researcher observed that teaching using GeoGebra was faster than teaching using the conventional method. As a result of that more ground was covered in a shorter time; and students had some left for revision.

**3.06 Validations of the Instruments**

The two instruments CGPT and CGAT were validated by the Supervisors of the work who are from the rank of Senior Lecturers and above in Mathematics Education Section of Ahmadu Bello University, Zaria . The experts verified that-

**i)** the content of the test is appropriate

**ii)** the content is within the level of the students.

**iii)** the questions are clear and unambiguous

**iv)** suggest areas of improvement.

After the validation question 7,15 and 19 of CGAT were modified as suggested by the experts. Also questions 11,13, 21 and 28 of CGPT were reworded as advised by the validators.

### 3.07 Pilot Study

The two instruments CGPT and CGAT were pilot tested at Zamfara State College of Education, Maru. The college is within the study area but not in the sample. The aims of the pilot testing are to:

i. test the adequacy of the research instruments;

ii. assess the feasibility of a full scale study;

iii. collect preliminary data;

iv. determine what resource financially are needed to carry out the full study

v. identify logistical problems which may occur using proposed method

vi. assess whether the research protocol is realistic and workable

vii. convince the supervisory team that the study is worth doing

The results of the pilot testing confirmed to the researcher the feasibility of the study. It also indicated the adequacy of the test instruments.

**3.08 Reliability of the Instrument**

The reliability coefficient of CGPT and CGAT were calculated using the result of the pilot study. The reliability of CGPT was obtained using split half method while that of CGAT was obtained using through the use test, retest method.this was done using test and retest method. The calculations were done with the aid of Statistical Packages of Social Science (SPSS). The reliability coefficient of CGPT and CGAT were calculated as 0.79 and 0.80 respectively. (See appendix 9 for details)

**3.09 Item Difficulty**: Item difficulty of a test is simply the percentage of the students who answer an item correctly. Item difficulty is relevant to determine whether the student have learnt concept being taught or not. It also plays the role of determining the ability of an item to discriminate between student who know the test material and those who do not know. An item is said to have a low discrimination if it is so difficult that almost everybody got it wrong; or so easy that almost everybody gets it right. The item difficulty of CGPT was also calculated using SPSS. Item difficulty of a test can be classified as follows:

Easy: 85%-----above

Moderate: 51%-------84%

Hard : 50%-------below

This research work used only moderate test items. Test items that were found to be too easy or too difficult were either discarded or reframed.

**3.10 Item Discrimination Index:-** Item discrimination according to Office of Education Assessment (OEA,2015) refers to the ability of an item to differentiate among students on the basis of how well they know the item being tested.

(i) Items that have less than 0.15 index were restructured or discarded.

(ii) Distractors that were not chosen by any candidate were replaced or eliminated. Those options do not contribute to the test ability to discriminate the good from the poor students.

(iii) Items that virtually everyone gets right are useless for discriminating among student and should be replaced by more difficult item.

The researcher subjected the items in CGPT. To this analysis items that have discrimination index below 0.15 were either removed or reframed. The researcher used the formular: $DI = \frac{RU-RL}{\frac{1}{2}N}$ Where:

DI= Discrimination Index

RU= Number of upper27% of the respondents

RL=Number of lower 27% of the respondents

N= Total number of the respondents

**3.11 Administration of the Treatments**: The treatments was given to the experimental groups ie the teaching of Coordinate Geometry to EG1; EG2; was done by the researcher .The researcher arranged with the Coordinate Geometry course lecturers of the sampled institutions so that he can go round and deliver the treatments. Specifically EG1 was taught Coordinate Geometry using GeoGebra: EG2 was taught Coordinate Geometry using Web- Based Practice; while the CG was taught using the conventional lecture method. The period of treatment was for six weeks as suggested by Sambo (2008).Then all the three groups were post tested.

**3.12 Data Collection Procedures**: The results of the pretest and posttest were marked, scored and recorded. The CGPT which consisted of 40 questions was marked over hundred meaning that every question has $2\frac{1}{2}$ marks. While the CGAT was coded from 5 points to 1 point depending on

the response. Since there are 20 items in the instrument the maximum score will be (20 ×5 =100) while the mean will be 50.

**3.13 Data Analyses**: All the data collected in this study were analyzed using SPSS. Data from the research questions were described using mean, standard deviation and mean differences. The null hypotheses were tested at 0.05 as shown below:

$Ho_1$: There is no significant difference between the mean performances of NCE1 Mathematic student taught Coordinate Geometry using GeoGebra and those taught using lecture method. Independent t- test was used to analyze this hypothesis.

$Ho_2$: There is no significant difference between the academic performances of NCE1 Mathematics students that taught Coordinate Geometry through Web-Based Practice those taught using lecture method. Independent t-test was also used to analyze this hypothesis.

$Ho_3$: There is no significant difference in attitude between NCE1 Mathematics students that learned Coordinate Geometry using Web-Based Practice and those that learned through the use of lecture method. Mann-Whitney U-test was used to analyze this hypothesis.

$H0_4$: There is no significant difference in attitude between NCE 1 Mathematics students taught Coordinate Geometry using GeoGebra and those taught using lecture method. Mann-Whitney U test was used to analyze this hypothesis

$Ho_5$: There is no significant change in gender attitude among NCE 1 Mathematics students taught Coordinate Geometry using GeoGebra, Web-Based Practice and those taught same course using lecture method. Kruskal Wallis H-test was used to analyze this hypothesis.

$H0_6$: There is no significant difference in male and female NCE1 Mathematics students'

academic performance among those taught Coordinate Geometry using GeoGebra, Web-Based Practice and those taught using lecture method. ANOVA F-test was used to analyze this hypothesis.

## CHAPTER FOUR

## DATA PRESENTATION, ANALYSIS AND DISCUSSIONS

### 4.1 Introduction

The findings of statistical analysis of data from the study on effects of GeoGebra and Web-Based Practice on attitude and performance in Co-ordinates Geometry among students of colleges of education in North West Zone of Nigeria are presented in this chapter. Three groups made up of 70 students each were involved in the study. One group was exposed to the use of the GeoGebra; one to Web-Based Practice and the other to the conventional lecture method (Control). Performance and attitudinal scores were collected from the three groups after the experiment. Results of the tests were presented along the study objectives and research questions. The tests of hypotheses were presented at the end of the chapter with discussion of the findings.

### 4.2 Data Presentation

The research questions were asked to aid the establishment of the effects of GeoGebra and Web- Based Practice on Attitude and Performance in Co-ordinates Geometry among the NCE students are as follows:

**Research Question one:** What is difference in the academic performance between NCEI students taught Coordinate Geometry using GeoGebra and those taught using lecture method. To find out the effects of GeoGebra software on students' academic performance in Coordinate Geometry at NCE I level, the mean performance of the students in GeoGebra and those taught with the conventional lecture method were computed and compared. Table 4.1 presents the mean performance of students exposed to the two methods.

**Table 4.1: Summary of Mean and Standard Deviation of Students Exposed to GeoGebra and Lecture method**

| Instructional method | N | Mean | Std. Dev. | Std. Error | Mean diff |
|---|---|---|---|---|---|
| GeoGebra | 70 | 56.71 | 10.664 | 1.275 | |
| | | | | | 14.24 |
| Lecture method | 70 | 42.47 | 36.053 | 4.309 | |

Table 4.1 revealed that students exposed to the use of GeoGebra had higher mean performance in the subject compared to their counterparts who were taught using Lecture method. On the overall average, mean scores for students exposed to the use of GeoGebra was 56.71±10.664 compared to 42.47±36.053 for students taught with the conventional Lecture method. The mean difference between the two groups was 14.24 in favour of the students exposed to the GeoGebra method of instruction. Another observation indicated by the observed standard deviations is that there was higher variability in mean performances of students taught with the lecture method than was observed among those exposed to the GeoGebra method of instruction. This means that the GeoGebra method of instruction have more general improvement on performance in Coordinate Geometry among students than the use of the lecture method.

**Research Question two:** What is the difference in academic performance between NCEI mathematics students taught Coordinate Geometry using Web-Based Practice and those taught same course using Lecture method. To find out the effects of Web-Based Practice on the performances of the NCE I students in Coordinate Geometry of the selected colleges of education, performances of the two groups (Web-based and Lecture) were computed and compare. The mean scores for the two groups on the subject are tabulated in Table 4.2.

**Table 4.2:** ***Summary of Mean and Standard Deviation of Students Performance Exposed to Web-based and Lecture method.***

| Instructional method | N | Mean | Std. Dev. | Std. Error | Mean diff |
|---|---|---|---|---|---|
| Web-based | 70 | 39.64 | 6.363 | 0.760 | |
| | | | | | -2.828 |
| Lecture method | 70 | 42.47 | 36.053 | 4.309 | |

The mean performance of students taught with lecture method is higher than that of students exposed to the use of Web-Based Practice as indicated in the table. The table shows that the mean score by students taught with lecture method is 42.47±36.053 while the mean performance of those exposed to the use of the Web-Based 39.64±6.363. The mean difference was -2.828 in favour of students taught with the lecture method. The effect of the use of Web-Based Practice is however more generalized as obtained in the standard deviations observed for the two groups. The performances variability of students taught with the lecture method though higher is more random than was observed among those exposed to the use of the Web-Based Practice of instruction used in the experiment. But the mean score shows that the use of the conventional method is better than that of the Web-based.

**Research Question three:** What is the difference in attitude between NCE1 Mathematics students taught Coordinate Geometry using Web- Based Practice and those taught same course using lecture method. To determine the influence of Web-Based Practice on students' attitudinal change towards Coordinate Geometry at NCE I level, the attitudinal scores of the two groups were computed and compared as indicated in Table 4.3.

**Table 4.3: Summary of *Mean Difference of Web-Based and Lecture Method on Attitudinal Change towards Coordinate Geometry*.**

| Instructional method | N | Mean | Std. Dev. | Std. Error | Mean diff |
|---|---|---|---|---|---|
| Web-based | 70 | 70.61 | 7.517 | .898 | |
| | | | | | 1.38 |
| Lecture method | 70 | 69.23 | 6.720 | .803 | |

Table 4.3 revealed no major difference in attitude towards Coordinate Geometry by the students exposed to the use of the Web-Based instructional method and those taught with the lecture method. Though mean attitudinal score (70.61±7.517) for Web-Based students was slightly higher than that (69.23±6.720) of those taught with the lecture method but the variability was very low as indicated with the mean difference of 1.38. The general variability in attitude within each of the groups was approximately the same as indicated by their standard deviations in the table. This indication here is that the use of the Web-Based instructional method has no major advantage over the lecture method in improving students' attitude toward Coordinate Geometry at the NCE I level in the selected colleges. The significance of the differences is subjected to statistical test in the related hypothesis.

**Research Question four:** What is the difference in attitude between NCE I Mathematics students taught Coordinate Geometry using GeoGebra and those taught same course using lecture method? To find out whether the use of GeoGebra will enhance NCE I students' attitude towards learning Coordinate Geometry than the conventional lecture method, the attitudinal scores of the two groups were computed and compared. The summary is presented in Table 4.4.

**Table 4.4:** ***Summary of Mean And Standard Deviation of Attitudinal Scores of Students Exposed to the GeoGebra and Lecture Method.***

| Instructional method | N | Mean | Std. Dev. | Std. Error | Mean diff |
|---|---|---|---|---|---|
| GeoGebra | 70 | 79.00 | 6.400 | .765 | |
| | | | | | 9.97 |
| Lecture method | 70 | 69.23 | 6.720 | .803 | |

Table 4.4 revealed major difference in the attitude of the students in the two groups towards the teaching of the subject. The mean attitude of those exposed to the use of the GeoGebra was 79.00±6.400 and that of those taught with the lecture method was 69.23±6.720 with a mean difference of 9.97 in favor of the students taught with the GeoGebra method. The variability in attitudinal scores was almost the same in the two groups as indicated with their standard deviations. This would mean that the exposure to the use of GeoGebra has major advantage in improving the attitude of the students towards Coordinate Geometry over the use of the traditional lecture method.

**Research Question five:** What is the difference in attitude between male and female NCE1 Mathematics students taught Coordinate Geometry using GeoGebra and Web-Based learning in one hand and those taught same course using lecture method in the other hand. To find out the gender effect of uses of GeoGebra and Web-Based Practice along with that of the conventional lecture method on attitude towards Coordinate Geometry at NCE I level, the attitudinal scores were computed for the male and female students in the three groups and compared on a pair wise base as summarized in Table 4.5.

**Table 4.5: Attitude of Male and Female Students in the Three Groups Toward Coordinate Geometry**

| | Male | | Female | | Mean |
|---|---|---|---|---|---|
| Instructional method | Mean | Std. Dev. | Mean | Std. Dev. | difference |
| GeoGebra | 67.93 | 5.631 | 70.43 | 7.147 | |
| | | | | | -2.500 |
| Lecture method | 68.45 | 7.168 | 70.27 | 6.034 | |
| Mean difference | -0.520 | | 0.160 | | |
| Web-based | 71.08 | 7.674 | 70.00 | 7.386 | |
| | | | | | 1.08 |
| Lecture method | 68.45 | 7.168 | 70.27 | 6.034 | |
| Mean difference | 2.63 | | -0.27 | | |

Table 4.5 shows the mean gender difference within each method as well as between the experimental methods of GeoGebra and Web-based with the Control. For male and female students exposed to the use of the GeoGebra their attitudinal mean scores were 67.93±5.631and 70.43±7.147 for the male and female students with a mean difference of -2.500 in favour of the female students. This would imply that the female have high impact of the exposure to the use of the GeoGebra on their attitude toward the teaching and learning of the subject than the male students. But the difference is relatively low as indicated with the mean difference of 2.500. For the male and female students, attitudinal difference between those exposed to the use of the GeoGebra and Lecture method was very low and was -0.520 and 0.160 for male and female students in the GeoGebra group and those in the lecture method respectively.

Male students exposed to the use of the Web-Based Practice had a slightly higher improvement in their attitudinal score than those taught with the conventional lecture method. For the female attitudinal score was almost the same. Between the male and female exposed to the use of the Web-based, the male had their attitude toward the subject more improved on slightly more than the female as indicated with mean scores of 71.08±7.674 compare to 70.00±7.386 for the female. The mean difference was 1.08 in favour of the male group.

Attitudinal improvement with male and female groups exposed to the use of the Web-based and the male and female groups taught with the lecture method only differed slightly as indicated by the observed mean differences which was higher among the male than was observed among the female students. In the overall, it could be concluded that the use of the two experimental (GeoGebra and Web-based) methods have no major improvement on the male and female students' attitude towards Coordinate Geometry over the use of the conventional lecture method.

**Research Question six:** What is the difference in academic performance between male and female students taught Coordinate Geometry using GeoGebra and Web-Based Practice in one hand and those taught same course using lecture method in the other hand. To determine the gender effects of GeoGebra and Web-Based Practice on the Performances of male and female students' academic performance in Coordinate Geometry, the performances of male and female students in each of the groups were computed and compared as summarized in Table 4.6.

**Table 4.6:*Summary of Mean Performance of Male and Female Students Exposed to the use of the three methods***

| Instructional method | Male | | Female | | Mean |
|---|---|---|---|---|---|
| | Mean | Std. Dev | Mean | Std. Dev, | difference |
| GeoGebra | 57.68 | 9.646 | 55.43 | 11.936 | |
| | | | | | 2.242 |
| Lecture method | 37.31 | 6.15 | 49.35 | 54.37 | |
| Mean difference | 20.36 | | 6.08 | | |
| Web-based | 39.18 | 6.272 | 40.27 | 6.536 | |
| | | | | | -1.092 |
| Lecture method | 37.31 | 6.151 | 49.35 | 54.371 | |
| Mean difference | 1.86 | | -9.08 | | |

For the male students exposed to the use of GeoGebra and lecture method, there a major high variability with a mean difference of 20.36 compared to female students whose mean difference between those exposed to the use of the GeoGebra and lecture method was only 6.08. The mean performance for the male students exposed to the use of the GeoGebra was 57.68±9.646 while that of the female students in the same group was 55.43±11.936. The mean difference was 2.242. These imply that the male students have higher improvement in their performances when exposed to the use of the GeoGebra method than the female.

For Web-Based, the female have higher mean performance than their counterparts exposed to the use of the same method. The mean difference was -1.092 in favour of the female students.

Within the male students exposed to the use of the Web-Based and those taught with lecture method, observed mean difference was only 1.86 in favour of those exposed to the Web-based. For the female students exposed to the Web-Based Practice, mean performance was lower than those taught with the lecture method. Mean difference was -9.08 in favour of those taught with the lecture method. These observations imply that major difference in performance could not be attributable to gender but the experimental methods used in the experiment. The observed variability are tested for significance in the related hypothesis.

### 4.3. Hypotheses Testing

The null hypotheses formulated to test the statistical significance of the variability in mean scores of the students exposed to the different instructional methods were tested at the probability level of 0.05. The testing was carried out one after the other.

**Null hypothesis I:** There is no significant difference between the mean academic performances of NCE I Mathematics students taught Coordinate Geometry using GeoGebra and those taught same course using lecture method.

To test this hypothesis, the performance scores of students exposed to the use of the GeoGebra and those taught with the traditional lecture method were computed and compared. Independent t-test was used to test the hypotheses and the result is presented in Table 4.7

**Table 4.7: Summary of t-test on Performance of Students Exposed to GeoGebra and Lecture Method**

| Instructional methods | N | Mean | Std. Dev. | Std. Error | DF | t | P-value |
|---|---|---|---|---|---|---|---|
| GeoGebra | 70 | 56.71 | 10.664 | 1.275 | | | |
| | | | | | 138 | 3.170 | .002 |
| Lecture | 70 | 42.47 | 36.053 | 4.309 | | | |

(critical value for t = 1.96)

From the observed t-value of 3.170 obtained at 138 degree of freedom and the probability level of significance of 0.002, the variability between the means could be considered to be statistically

significant. The critical value of t at the same degree of freedom is 1.96 and the observed probability level obtained is less than 0.05 ($P < 0.05$). With these observations, there is sufficient evidence to reject the null hypothesis. The null hypothesis that there is no significant difference between the mean academic performances of NCE I Mathematics students taught Coordinate Geometry using GeoGebra and those taught same course using lecture method is therefore rejected. This indicates that there is significant difference between the two groups. Thus, students exposed to GeoGebra performed significantly better than the students taught using conventional method.

**Null hypothesis II:** There is no significant difference in the mean academic performances of NCE I Mathematics students that learned Coordinate Geometry through Web- Based Practice and those that learned same course using conventional method.

The academic performances of the two groups of students taught through Web-Based Practice and those taught using lecture were compared here using the two sample t-test. A summary of the test is presented in Table 4.8.

**Table 4.8: Summary of t-test on performances of Web-based and Lecture Method**

| Instructional method | N | Mean | Std. Dev. | Std. Error | DF | t-value | P-value |
|---|---|---|---|---|---|---|---|
| Web-based | 70 | 39.643 | 6.3629 | .7605 | | | |
| | | | | | 138 | .646 | .519 |
| Lecture | 70 | 42.471 | 36.0531 | 4.3092 | | | |

(critical value for t = 1.96)

From the observed t-value of 0.646 obtained in the test at the 138 degree of freedom compared with the critical value of 1.96, the variability between the means could be considered statistically significant. The observed probability level of obtained for the test is 0.519 ($P > 0.05$). With these observations, there is no sufficient evidence to reject the null hypothesis. The null hypothesis that there is no significant difference between in the mean academic performances of NCE I

Mathematics students that learned Coordinate Geometry through Web- Based Practice and those that learned it using traditional method is therefore retained. This indicates that there is no significant differences between the two groups.

**Null hypothesis III:** There is no significant difference in attitude change between NCE I Mathematics Students that learned Coordinate Geometry using Web- Based Practice and those that learned Coordinate Geometry through lecture method.

Mean scores on attitude towards the teaching and learning of the subject examined in Table 4.3 were compared to determine significant difference using the Mann Whitney U test. The result of the test is summarized in Table 4.9

**Table 4.9:** ***Summary of Mann-Whitney U test on Attitude of Students Exposed to GeoGebra and Lecture Method***

| Instructional Methods | N | Mean Rank | Sum of Ranks | Mann-Whitney U | Z-value | P-value | Decision |
|---|---|---|---|---|---|---|---|
| GeoGebra | 70 | 82.86 | 5800.50 | | | | |
| | | | | 1584.50 | -3.6 | 0.001 | S |
| Lecture | 70 | 58.14 | 4069.50 | | | | |
| Total | 140 | | | | | | |

(critical value for Z = 1.96)

From the observed Z-value of -3.61 obtained in the test along with the p-value of 0.00 ($P<0.05$), the two groups differ significantly in improving the attitude of the students towards the teaching and learning of Coordinate Geometry in the selected colleges of education. With these observations, there is sufficient evidence to reject the null hypothesis. The null hypothesis that there is no significant difference in attitude change between NCE I Mathematics Students that learned Coordinate Geometry using GeoGebra and those that learned Coordinate Geometry through lecture

method is therefore rejected. This means there is significant difference in change of attitude between the two groups in favour of Experimental group.

**Null hypothesis IV:** There is no significant difference in attitude change between NCE I Mathematics students that were taught Coordinate Geometry using Web-based and those taught using lecture method.

To test the hypothesis, the attitudinal scores of the two groups assessed in Table 4.4 were compared using the Mann Whitney U test to determine the significance of the variability in improving the attitude of the students towards the teaching and learning of the subject. The result of the test is summarized in Table 4.10

**Table 4.10***: **Summary of Mann-Whitney U test on Attitude of Students Exposed Web -based Practice and Lecture Method***

| Instructional methods | N | Mean Rank | Sum of Ranks | Mann-Whitney U | Z-value | P-value | Decision |
|---|---|---|---|---|---|---|---|
| Web-based | 70 | 72.79 | 5095.00 | | | | |
| | | | | 2290.000 | .668 | .504 | NS |
| Lecture | 70 | 68.21 | 4775.00 | | | | |
| Total | 140 | | | | | | |

(critical value for Z= 1.96)

From the observed Z-value of 0.668 obtained in the test and the significant level of 0.504, the variability between the mean attitudes of the two groups is not statistically significant. The observed probability level (0.504) of obtained for the test is higher than the fixed level of 0.05 (P > 0.05). These observations did not provide sufficient evidence for rejecting the null hypothesis. The null hypothesis that there is no is no significant difference in attitude change between NCE I Mathematics students that were taught Coordinate Geometry using Web-based and those taught

same concept using lecture method is therefore retained. Which means that there is no significant difference between the two groups in attitude change.

**Null hypothesis V:** There is no significant difference in attitude change between male and female NCE I Mathematics students taught Coordinate Geometry using GeoGebra, Web-Based Practice and those taught using lecture method.

The attitudinal scores of the students in the three groups were compared along with their gender. The Kruskal-Wallis Test procedure was used. Comparison were conducted between the three methods for male and female students independently and then combined. The result of the test is summarized in Table 4.11.

**Table 4.11:** ***Summary of Kruskal-Wallis Test on Attitude of Male and Female Students Exposed to GeoGebra, Web-Based Practice and Lecture Method***

| Gender | Methods | N | Mean Rank | DF | Chi-square | P-value |
|---|---|---|---|---|---|---|
| | GeoGebra | 40 | 55.16 | | | |
| | Web-based | 40 | 68.73 | 2 | 3.466 | .177 |
| | Lecture method | 40 | 57.61 | | | |
| Male | Total | 120 | | | | |
| Female | GeoGebra | 30 | 46.42 | | | |
| | Web-based | 30 | 43.20 | 2 | .335 | .837 |
| | Lecture method | 30 | 46.88 | | | |
| | Total | 90 | | | | |
| Total | GeoGebra | 70 | 100.81 | | | |
| | Web-based | 70 | 111.27 | 2 | 1.074 | .585 |
| | Lecture method | 70 | 104.42 | | | |
| | Total | 210 | | | | |

The result in Table 4.11 did not reveal significant gender based attitudinal change towards the teaching and learning of the subject by male and female students. The observed p-value for determining significant changes in the attitudinal disposition towards the teaching and learning of the subject among the male and female students exposed to the three methods are 0.177 for male, 0.837 for female and 0.585 for the combined male and female students involved in the three methods. These observations did not provide enough evidence for the rejection of the null hypothesis. The null hypothesis that there is no significant difference in attitude change between male and female NCE I Mathematics students taught Coordinate Geometry using GeoGebra, Web-Based Practice and those taught same course using lecture method is therefore retained. This indicates there is no significant gender difference among the three groups based on gender.

**Null hypothesis VI:** There is no significant difference in academic performance between male and female NCEI Mathematics students that were taught Coordinate Geometry using GeoGebra and Web-Based Practice and those taught same course using lecture method.

This hypothesis was tested using the instructional methods and the sex of the students as the independent variables while their performance was used as the dependent variable. The Two way analysis of variance was used to determine significant differences between the three methods and sex of the students along with the interaction between the students' sex and the instructional methods. The result of the analysis of variance model is presented in Table 4.12.

**Table 4.12:** ***Summary of ANOVA on Performance of Male and Female Students Exposed to GeoGebra, Web-based And Lecture Method***

| | Sum of Squares | DF | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Method | 10771.240 | 2 | 5385.620 | 11.241 | .000 |
| Sex | 677.358 | 1 | 677.358 | 1.414 | .236 |
| Methods * Sex | 1913.240 | 2 | 956.620 | 1.997 | .138 |
| Error | 97737.202 | 204 | 479.104 | | |
| Corrected Total | 112047.981 | 209 | | | |

The result of the test showed that the performance of male and female students differed significantly by the method of instruction used as a main factor ($P< 0.05$). Between the performance of the male and female group in the overall, no significant difference was observed ($P>0.05$) and in the interaction between the methods and the sex of the students, no significant difference was observed ($P > 0.05$). These observation means that gender have no significant effect on the performances of students exposed to the three methods of instruction for teaching and learning of the subject. But performance differed significantly by the method of instruction used in teaching and learning of the subject. With these observations, the null hypothesis was rejected on the basis of the method of instruction used. But on the basis of gender, there are no sufficient evidence for rejecting the null hypothesis.

The mean performance scores for the male and female students exposed to the three methods of instruction were examined in Table 4.6. To determine the method of instruction that significantly improved the performances of the students more than the other(s), a post hoc test was

performed on the means using the Scheffe procedure. The result of the post-hoc test is presented in Table 4.13

**Table4.13:** ***Summary of Scheffe test on Mean Performance by Instructional Methods*****.**

| (I) Method | (J) Method | Mean Difference (I-J) | Std. Error | Sig. |
|---|---|---|---|---|
| GeoGebra | Web-based | 16.833* | 3.738 | .000 |
| | Lecture | 13.223* | 3.738 | .001 |
| Web-based | GeoGebra | -16.833* | 3.738 | .000 |
| | Lecture | -3.610 | 3.738 | .335 |
| Lecture | GeoGebra | -13.223* | 3.738 | .001 |
| | Web-based | 3.610 | 3.738 | .335 |

Note: *. Indicates mean difference is significant at the .05 level.

The result of the post hoc test shows that performance of students exposed to the use of GeoGebra was significantly different from those taught with the lecture method and the Web-based instructional methods. Between the performances of students exposed to Web-based and lecture method, no significant difference was observed.

### 4.4 Summary of the Major Findings

From the data collected and analyzed the following findings are made:

1. The use of GeoGebra in the teaching and learning of Coordinate Geometry has significant positive effect in improving students' academic performances of NCE I Mathematics students over the use of lecture method and Web-Based Practices in the selected colleges of Education.
2. The use of Web-Based Practices has no statistics significance effect on performance of NCE I mathematic students in the selected colleges of Education in the zone.

3. The use of GeoGebra in the teaching and learning of Coordinate Geometry has significant effect on improving the attitude of NCE I students towards the learning of the subject.
4. The use of Web-Based Practice has no significant effects on improving the attitude of NCE I mathematic students towards learning of the subject.
5. There are no significant effects in improving the attitude of male and female students towards Coordinate Geometry when exposed to GeoGebra, Web-Based Practice and Lecture Method in the selected colleges of education.
6. There is no gender effects on the use of GeoGebra, Web-Based and Lecture method of instruction in improving the academic performances of the NCE I mathematic students.

## 4.5 Discussion of Results

The findings from the six null hypotheses tested in this study towards determining the effects of GeoGebra and Web-Based Practice on attitude and performance in Co-ordinates Geometry among NCE I Mathematics students of some selected Colleges of Education in the zone are discussed as follows:

The finding from the test of hypothesis I, showed that the performance of students exposed to the use of GeoGebra was higher. In the test of the hypothesis, the mean score was significantly higher than that of students taught with the lecture method. The null hypothesis was therefore rejected. This finding supports the findings of Dikovic (2009) who reported that GeoGebra has positive effects on geometrical knowledge and understanding of students. He further showed that GeoGebra can be a powerful tool for visualization of key notions of Differential Calculus. The finding is consistent with Leong and Shadaan (2011) who explained that GeoGebra increases students' progress and conceptual understanding of Mathematics. They also stated that GeoGebra enables realization of vibrant classroom where cooperative Web-based learning and collaborative

principles were evident. The finding reflect the postulation of Macekova (2014) who pointed out that GeoGebra contributes positively to the white board environment through enriching the visualization option of interactive white board. Construction with GeoGebra can be used in tandem with any kind of interactive white board to enhance visualization of geometrical objects. Furthermore, it was observed that NCE 1 Mathematics students did not have any technical difficulty in learning Coordinate Geometry using GeoGebra. The students were active, alive curious, throughout the GeoGebra learning periods. On the other hand, the researcher observed if Coordinate Geometry is taught using GeoGebra without preceding it with lecture method a lot of mathematical skills can be lost by the students. The whole Coordinate Geometry could be reduced to pressing of buttons. Consequently the teaching and learning of Coordinate might lose it meaning. The students can gain more if lecture method is enriched with the use of GeoGebra

The finding from the second test of hypothesis II of the study revealed that performances of Web- Based Practice group and Control group were not significantly different. The null hypothesis was therefore retained. From the mean scores obtained for the two groups, students taught with the lecture method had a higher score which implied that the Web-Based Practice had no academic performance advantage over the conventional lecture method. The finding contradicts the report of Nguyen (2008) from a study on the use of Web- Based Practice in enhancing Mathematics learning and achievement. The result revealed that students in the computer based group were of the view that the computer gave them more practice, more fun, more clue and more understanding. This result which is different from that of Nguyen could be due to the fact the wireless network used by the students of this study was very slow sometimes it was epileptic. There was a time during the research when the students had to use their individual data. The hypothesis would have produced a different result if the network used was efficient.

The finding from hypothesis III tested for effects of GeoGebra on improvement of attitude of the students towards teaching and learning of the subject by comparing the attitudinal score of students exposed to the use of the method with that of students taught with the lecture method. The test revealed significant difference between attitudinal scores of the two groups. The null hypothesis was therefore rejected. The mean score revealed that the use of GeoGebra had higher potential in improving the attitude of the students more than the use of the Lecture Method. The findings agree with the report of Chyrsanthou (2008) from a study titled "the use of ICT in primary Mathematics: The case of GeoGebra in Cyprus where it was reported that the introduction of GeoGebra influences the educational practice in three dimension namely: Classrooms practice, cognitive development and learning attitude.

The findings from hypothesis IV which tested for effects of Web-Based Practice on improvement of attitude of the students towards teaching and learning of the subject by comparing the attitudinal score of students exposed to the use of Web-Based Practice with that of students taught with the lecture method. The test did not reveal significant difference between attitudinal scores of the two groups. The null hypothesis was therefore retained. From the mean scores obtained, students who were exposed to the use of Web-Based Practice had higher attitudinal score but the observed difference was not significant. The finding is different from the findings of Esucuder and Furner (2008) who asserted that Web- Based Practice change students' attitude and increase students confidence towards Mathematics and Rebova (2013) who reported that Web-Based Practice increases students' motivation and performance in Mathematics. The finding is not in consistent with that of Khan and Yushau (2014) who reported that e practice is faster than paper and pencil practice. Web-Based Practice offers students hint and more than one trial in solving

problem which are not available in paper –pencil trial. The researchers also reported that Web-Based Practice improves students understanding.

The findings from hypothesis V which tested for significant difference in attitude towards the teaching and learning of the subject by male and female students who were taught with the GeoGebra, Web-Based Practice and the traditional lecture method. The result of the test did not reveal significant difference in attitude towards the teaching and learning of the subject by the male and female students. No significant difference was found in the attitude of students exposed to the use of the three different methods. The null hypothesis was therefore retained. The finding here contradicts the report of Laolock (2015) who studied the effects of Mathematics teaching outcome with Geometer Sketchpad towards geometrical concept and attitude of 36-10 grade students in Bangkok, Thailand and reported that the use of GSP has improved students attitude positively towards learning of Geometry..

The finding from hypothesis VI, which tested the difference in academic performances of the male and female students who were taught with GeoGebra, Web-based and Lecture method was tested. The result did not reveal significant difference between the male and female students. Between the male and female students taught with the three different methods, no significant difference was found. But significant difference was found between scores of students taught with the different methods. Students taught the subject with GeoGebra had the highest academic performance and were significantly different from those taught with the use of the Web-based and the Lecture method. Between those taught with the lecture method and Web-Based Practice, no significant difference was found. On the basis of gender, the null hypothesis could not be rejected. But on the basis of the instructional methods used, the null hypothesis was rejected. This finding supports the report of Anchor, Imoko, and Ajai (2010) who stated that when students are taught

Geometry using games and simulation gender performance are equivalent. The finding agrees with Saidu and Binyamin (2015) from a research in which the experimental group was taught Geometry using Geogeometric set while the control group was taught using lecture method. The results showed that there was no significant difference between the performance of male and female students.

## CHAPTER FIVE

### SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

**5.1 Introduction:** This study investigated the effects of GeoGebra and Web- Based Practice on Attitude and Performance in Coordinate Geometry among Students of Colleges of Education in North West zone, Nigeria. This chapter was presented under the following subheadings:

5.2 Summary

5.3 Conclusion

5.4 Contribution to Knowledge

5.5 Recommendation

5.6 Limitations of the Study

5.7 Suggestion for Further Studies

**5.2 Summary**:

This study focused on the Effects of GeoGebra and Web- Based Practice On students Attitude and Performance among College of Education Students in the North West was summarized as follows: The study had six objectives, six research questions and six hypotheses. The research was meant to benefit Mathematics students of colleges of education, their lecturers, parents, writers of Mathematics text books, NCCE, and education association such as MAN, STAN. The scope of the study was NCE Mathematics students of all combinations which was delimited to Straight line and Circle Coordinate Geometry.

The Theoretical Frame Work for the study was TPACK while the blended form of behaviorism and constructivism provided the conceptual framework. Literature all over the globe were reviewed under Coordinate Geometry, GeoGebra, Web based learning, Learning with

technology through DGS, and CAS. Students' attitude and performance in Geometry and other related field were discussed. Gaps that were identified and filled by this work.

Pretest- posttest quasi experimental design was used for this study. A sample 210 - students was chosen from three colleges of education. This sample consisted of 70 students from each of the colleges. The sample was further divided into 40 males and 30 females from each of the three colleges. The instruments used for data collection included CGPT and CGAT for data collections. The research also used six lesson plans each to teach the experimental group1 (GeoGebra) and control group (lecture method). While Khan Academy Analytic Geometry Practice was used as treatment instrument for Experimental Group11 (Web- Based Practice) .The validity and reliability of the instruments were established.

Data collected were analyzed using descriptive Statistics which include: mean, mean differences, mean rank; standard deviation to answer the research questions. After that t-test, u-test F-test; H-test and Fisher test were used to test the hypotheses.

**5.3 Conclusions:**

Based on the analyses and interpretation of the findings; the following conclusions are made:

(i) The study found that NCE1 Mathematics students that were taught Coordinate Geometry using GeoGebra performed better than those taught using lecture method.

(ii) Furthermore, NCE1 Mathematics students in the colleges of education irrespective of their course combination learnt Mathematics through use of computer with little or no difficulty.

(iii) It can be concluded that GeoGebra improves students' performances and change their attitude towards Coordinate Geometry. The subjects of the study really showed interest, appreciation and willingness to learn Coordinate Geometry using GeoGebra and Web-Based Practice.

(iv) However students' performance in Coordinate Geometry when exposed to Web- Based Practice was not better than the performance of those students taught using lecture method.

(v) Similarly, the attitude of students exposed to Web- Based Practice was similar to those taught using lecture method. The reason for these could be that, the wireless network used for the Web- Based Practice was not very efficient. The study encountered some problems such as epileptic network service; or too many users at time that made the researcher to reschedule the practice session. Despite all these problems the students showed interest, curiosity, and willingness to continue with Web- Based Practice in future.

(vi) The results of this study is in consistent with the results of many others studies. It shows that male and female Mathematics performances in Coordinate Geometry in all the three groups- GeoGebra, Web- Based Practice and Lecture method are similar. This shows that GeoGebra and Web-Based Practice helped in reducing gender gap in Coordinate Geometry and Mathematics. Though there are more male students than female students in all the colleges of education used for this studies but their performance in Coordinate. Geometry was similar.

**5.4 Contribution to Knowledge:**

The search for more effective method of teaching Coordinate Geometry led to the use of GeoGebra and Web-Based Practice in this study. The following contribution to knowledge can be extracted from this study.

1. This study established the fact that use of GeoGebra improves students' performance significantly in Coordinate Geometry at NCE level. (P=0.002)
2. The use of Web-Based Practice does not improve students' academic performance in Coordinate Geometry more than Conventional method.(P=0.519)

3. The use of GeoGebra Software led to significant Positive difference in the students' attitude toward Coordinate Geometry than the use of Conventional method (P=0.00)
4. Gender performance in Coordinate Geometry remains the same, whether the students were taught using GeoGebra, Web-Based Practice or lecture method.
5. The students of colleges of education were taught using GeoGebra and other computer software without difficulty.
6. The manual used in teaching the experimental Group can be adopted by other researchers

**5.5 Recommendations:**

The study was meant to find the effects of GeoGebra Web- Based Practice on Students Attitude and Performance in Coordinate Geometry in colleges of education has the following recommendations:

1. Lecturers and students of colleges of education in North West Zone should take advantage of GeoGebra which is free software that can be used to teach Coordinate Geometry and other Mathematics topics. GeoGebra provides visualization of Coordinate Geometry. It improves students' performance in it.
2. Khan Academy Web- Based Practice is another learning resource which students of colleges of education can explore since most colleges of educations have WI-FI (Wireless Computer Network) and also computer laboratories.
3. Parents of students of colleges of education should endeavor to provide their wards with personal computers so that students can learn Mathematics through GeoGebra, Web based learning environments as well as other ICT devices

4. Mathematics departments of colleges education in North West Zone should partner with computer departments and ICT centers of their colleges so that they can deliver Coordinate Geometry content to their students using GeoGebra and Web- Based Practice
5. Publishers and writers of Mathematics text books should in cooperate GeoGebra method in the future editions of their text book.
6. National Commission of Colleges of Education (NCCE) should review NCE minimum standard so that it can capture the method of teaching Coordinate Geometry using GeoGebra
7. NCCE in conjunction with TETFUND and M.A.N should organize work shop s for lecturers in colleges on the use of GeoGebra in teaching Coordinate Geometry in particular and Mathematics in general.
8. Colleges of education in the North West Zones should consider the use of Computer Based Test(CBT) in some of their examinations' because this reveals that students of COE can use computers comfortably

**5.6 Limitation of the Study:**

The work which focused on the Effects of GeoGebra and Web- Based Practice on Attitude and Performance of Colleges of Education Students has the following limitation:

1. Teaching Coordinate Geometry using GeoGebra alone without supporting it with conventional method will lead to the loss of computational skills by the learners
2. The wireless network used for Web- Based Practice was not always very fasts. Therefore, if it were efficient a different result could have been obtained.
3. The software used is GeoGebra. The findings may not be generalized to other softwares such as CABRI, Geometer Sketchpad

**5.7 Suggestion for Further Studies:**

The following are suggestions for further studies from this research work:

1. This research was conducted in COE. Another researcher should conduct a research on the "Effects of GeoGebra and Web- Based Practice on Attitude and Performance in Coordinate Geometry among polythenics and universities students.
2. The present work was done in Coordinate Geometry .Other researchers can carry out study on "The Effects of GeoGebra and Web- Based Practice on students' Performance in other areas of mathematics.
3. Other researchers can conduct similar research using different software wares such Geometer Sketchpad, Cabri
4. A similar research can be conducted looking at different variables such as retention motivation and location

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**APPENDIX 1**

**COORDINATE GEOMETRY ATTITUDE TEST**

Instructions: - Please indicate your response by ticking across in the column you think best represent your feelings about the statement given: S.A (Strongly Agree), A (Agree), U (Undecided), D (Disagree) and S.D (Strongly Disagree).

| | | SA | A | U | D | SD |
|---|---|---|---|---|---|---|
| 1. | Coordinate Geometry is an interesting course to me | | | | | |
| 2. | I need the knowledge of Coordinate Geometry in my daily activities | | | | | |
| 3. | I would like to develop my knowledge of Coordinate Geometry more | | | | | |
| 4. | The course lecturer is the only one who understand Coordinate Geometry in my class | | | | | |
| 5. | I find the study of Coordinate Geometry boring | | | | | |
| 6. | Coordinate Geometry can be used outside the classroom | | | | | |
| 7. | I would always like to learn more about Coordinate Geometry | | | | | |
| 8. | Methods used in the textbooks are the most appropriate approach in learning Coordinate Geometry | | | | | |
| 9. | I don't like solving Coordinate Geometry on my own | | | | | |
| 10. | I don't find Coordinate Geometry useful. | | | | | |
| 11. | I study Coordinate Geometry only when I am going to have test | | | | | |
| 12. | I don't like Coordinate Geometry because there are so many formulae to memorize in the course | | | | | |
| 13. | I always enjoy my Coordinate Geometry lesson | | | | | |
| 14. | I find Coordinate Geometry useful in my daily life | | | | | |
| 15. | I feel students should be given exercises in Coordinate | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Geometry | | | | | |
| 16. | I only learn Coordinate Geometry at school | | | | | |
| 17. | I need the knowledge of Coordinate Geometry to solve problem outside the school | | | | | |
| 18. | I wish we were taught Coordinate Geometry at school | | | | | |
| 19. | I intend studying as much Coordinate Geometry as I can in future | | | | | |
| 20. | For me, to do well in Coordinate Geometry, I have to memorize theorem and formulae | | | | | |

## APPENDIX 2

**Coordinate Geometry Performance Test (CGPT)**

Name ……... Institution …….

Level ….. combination: … sex……

INSTRUCTIONS: Choose the correct answer from the options provided lettered A-D

1. Signs of the abscissa and ordinate of a point in the second quadrant are respectively:
   (A) +,+ ( B) -,- (C) -,+ (D )+,-
2. Triangle ABC has vertices A (0, 0); B (3, 2) and C (0, 4). The triangle may be classified as:
   (A). Equilateral (B) Isosceles (C)Right angled triangle (D).Scalene.
3. Point (-3, 5) lies in the……..,
   (A) first quadrant (B) Second quadrant (C)third quadrant (D) Fourth quadrant.
4. The point at which the two coordinate axes meet is called:
   (A) abscissa (B). Ordinate (C) Origin (D).Quadrant
5. What are the center and the radius of the circle whose equation is $(x-5)^2+(y+3)^2=16$
   A. (-5, 3) and 16 B.(5,-3) and 16 C.(-5,3) and 4 D. (5,-3) and 4.
6. The equation of a circle with centered at (1,-3) which passes through the point (-5, 6) is:
   A. $(x-1)^2+(y+3)^2=117$ B. $(x-1)^2+(y+3)^2=\sqrt{117}$
   C. $(x+1)^2+(y+3)^2=117$ D. $(x+1)^2+(y+3)^2=\sqrt{117}$
7. Which of the following is the equation of a line that passes through (2,-1) and parallel to the line represented by the equation $y=2x+1$ :
   (A) $y=-\frac{1}{2}x$ (B) $y=-\frac{1}{2}x+1$ (C) $y=2x-5$ (D) $y=2x-1$
8. The vertices of a triangle are A. (7,9) B.(3,3) and C.(11,3). What are the coordinates of the centroid of $\Delta ABC$.
   A. (5,6) B. (7,5) C.(7,5). D. (9,6).

9. Determine the equation of a circle with center at (-2, 2) and radius 3.

A. $(x+2)^2+(y+2)^2=9$ B. $(x+2)^2+(y-2)^2=9$

C. $(x-2)^2+(y+2)^2=3$ D. $(x+2)^2+(y-2)^2=3$

10. What is the slope of a line that is perpendicular to the line represented by the equation $x+2y=3$?

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

11. Point M is the midpoint of $\overline{AB}$. If the coordinates of A are (-3,6) and the coordinates of M are (-5,2). What are the coordinates of B?

A(1,2) B.(7,10) C.(-4,4) D.(-7,-2).

12. Parallelogram ABCD has coordinates A (1,5) B. (6,3) C(3,-1) and D(-2,1). What are the coordinates of E, the point of intersection of the diagonal $\overline{AC}$ and $\overline{BD}$?

A. (2,2) B . (4.5, 10) C. (3.5,2) D(-1,3)

13. In a circle O, a diameter has end points (-5,4) and (3,-6). Calculate the length of the diameter.

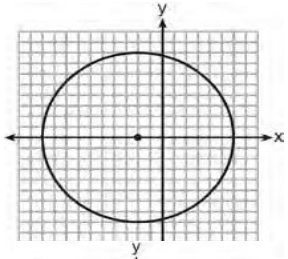
A. $\sqrt{2}$ B.$2\sqrt{2}$ C. $\sqrt{10}$ D.$2\sqrt{41}$

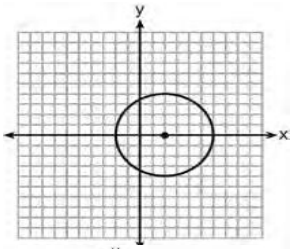
14. Which equation of a circle will have a graph that lies entirely in the first quadrant?

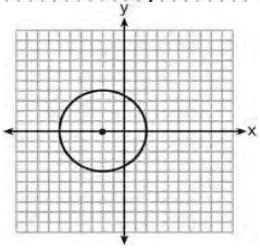
A. $(x-4)^2+(y-5)^2=9$ B. $(x+4)^2+(y+5)^2=9$

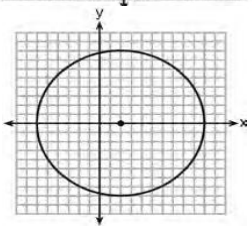
C. $(x+4)^2+(y+5)^2=25$ D. $(x-5)^2+(y+4)^2=25$

15. Which graph represents a circle whose equation is $(x+2)^2+y^2=16$ ?

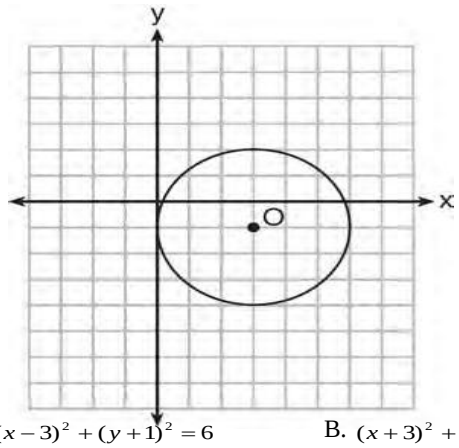
A 


B. 


C. 


D. 

16. What is the equation for the circle O shown in the graph below?




A. $(x-3)^2+(y+1)^2=6$ B. $(x+3)^2+(y-1)^2=6$

C. $(x-3)^2+(y+1)^2=9$ D. $(x+3)^2+(y-1)^2=9$

17. Triangle ABC has vertices A(0,0); B(6,8) and C(8,4). Which equation represents the perpendicular bisector of $\overline{BC}$?

A. $y=2x-8$ B. $y=-2x+4$ C. $y=\frac{1}{2}x+\frac{5}{2}$ D. $y=-\frac{1}{2}x+\frac{19}{2}$

18. If the vertices of $\Delta ABC$ are (-2,4); B(-2,8) and (-5,6) then the triangle can be classified as :

A. Right B. Scalene C. Isosceles D.Equilateral.

19. A quadrilateral ABCD has vertices A(-2,-3); B(4,-1) ; C(2,5) ; D(-4,3). Identify the type of quadrilateral.

A. rectangle B. Trapezium C. Kite D. square.

20. Which set of equations represents two circles that have same center?

A. $x^2+(y+4)^2=16$ and $(x+4)^2+y^2=16$

B. $(x+3)^2+(y+3)^2=16$ and $(x-3)^2+(y+3)^2=25$

C. $(x-7)^2+(y-2)^2=6$ and $(x+7)^2+(y+2)^2=25$

D. $(x-2)^2+(y-5)^2=16$ and $(x-2)^2+(y-5)^2=25$

21. Which of the following equation represents a circle?

A. $x^2 + y^2 + 6xy + 7 = 0$ B. $4x^2 + 8y^2 + 6xy + 7 = 0$

C. $5x^2 + 11y^2 + 4x - 3y = 60$ D. $6x^2 + 6y^2 + 5x - 11y = 13$

22. The point (2, 3) is -------- the circle with an equation $x^2 + y^2 + 8x + 9y - 5 = 0$

A. Inside B. outside C. Coordinates of the center D. on

23. A student wrote the following equations: (i) $3y + 6 = 2x$ (ii) $2x - 3y = 6$ the lines represented by these equations are:

A. Parallel B. same line

C. Perpendicular D. Intersecting but not perpendicular.

24. Line segment $\overline{AB}$ has endpoint A(2.-3) and B(-4,6). Find the coordinates of a point that divides AB in the ratio 2:3.

A. (3.2,0.6) B.(0.4,0.6) C.(2.8;5) D. (4,5)

25. A circle is represented by the equation $x^2 + (y+3)^2 = 13$. What are the coordinates of the center of the circle and the length of the radius?

A.(0,3) and 13 B.(3,0)and $\sqrt{13}$ C.(0,-3) and 13 D.(0,-3) and $\sqrt{13}$

26. The diameter of a circle has endpoints at (-2, 3) and (6,3). What is the equation of the circle:

A. $(x-2)^2 + (y-3)^2 = 16$ B. $(x-2)^2 + (y-3)^2 = 4$

C. $(x+2)^2 + (y+3)^2 = 16$ D. $(x+2)^2 + (y+3)^2 = 4$

27. An equation that represents a line perpendicular to a line whose equation is $2x + 3y = 12$ is….. :

A. $6y = -4x + 12$ B. $2y = 3x + 6$ C. $2y = -3x + 6$ D. $3y = -2x + 12$

28. A tangent to a circle is a straight line that touches a circle at -------point(s).

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

29. What is the length of AB with end point A(-1,0) and B(4,-3)?

A. $\sqrt{6}$ B. $\sqrt{18}$ C. $\sqrt{34}$ D. $\sqrt{5}$

30. Find the length of a tangent drawn to the circle $x^2 + y^2 + 6x + 2y + 1 = 0$ from the point (-1,-1).;

A. 5units B. 4units C. 6units D.11units

31. What is the equation of a straight line which passes through (3,5) and has 7 as gradient is:

A. $y = 7x - 16$. B. $y = 7x + 21$ C. $y = 7x = 36$ D. $y = 7x - 5$

32. Find the acute angle between the lines: $x + 4y = 12$ and $y = 2x - 6$

A. $67^0$ B.$77.5^0$ C $68^0$ D.$88^0$

33. Find the coordinates of the point of intersection of the lines: $3x + 2y - 1 = 0$ and $2x - 3y + 21 = 0$

A(3,3) B. (4,3) C (-3,5) D.(3,3.3)

34. The points A.(-7,5) B.(1,1); C.(5,-1) D.(13,-5) are :

A .collinear B .parallel C. Form a vertices of a triangle D. Form a Kite

35. If K(-3,4) divides the line joining A (3,5) and B(-5,7) internally . Determine the ratio of the division

A 2:1 B. 2:5 C.3:5 D .-1:3

36. Write down the equation of a line that cuts intercepts of 2 and 5 on x and y axes respectively:

A. $\frac{x}{2} - \frac{y}{5} = 1$ B. $\frac{x}{2} + \frac{y}{5} = 1$ C. $\frac{x}{5} + \frac{y}{2} = 1$ D. $\frac{x}{5} - \frac{y}{2} = 1$

37. The equation of a straight line that passes through (2,3) and (-4,9) is :

A. $y - x = 5$ B. $y + x = 1$ C. $y + x = 5$ D. $y - x = 1$

38. The equation of the tangent to the circle $x^2 + y^2 - 10y = 0$ at (3,9) is:

A. $6x + 5y = 45$ B. $4y + 4x = 45$ C. $x + y = 7$ D. $3x + 14y + 45 = 0$

39. The circles represented by this equations $x^2 + y^2 + 2x + 6y = 39$ and $x^2 + y^2 - 4x - 2y + 1 = 0$ touch each other:

A. internally B. externally C. Orthogonally D. none of the above.

40. What is the slope of a line perpendicular to the line whose equation is:

$20x - 2y = 6$

A.-10 B. $-\frac{1}{10}$ C.10 D. $\frac{1}{10}$

## APPENDIX 3

Keys to Coordinate Geometry Performance Test

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

**APPENDIX 4**

PRE TEST- INSTRUMENT

NAME ……. INSTITUTION……

COMBINATION……. SEX……

INSTRUCTION: Choose the correct answer from the options lettered A-D TIME: Ihr 45min

1. The number of degree in the sum of the interior angle of a pentagon is …….

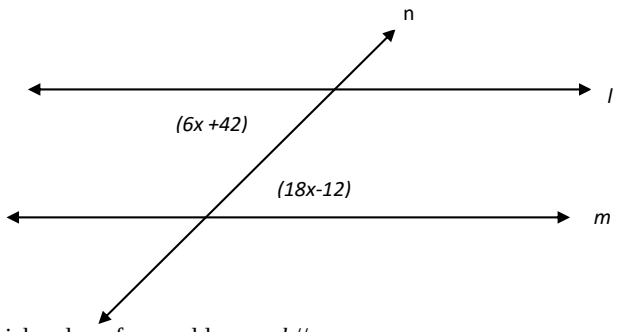
(A) 72 (B) 360 (C) 540 (D) 720

2.In a scalene triangle ABC, B=45 and C=55. What is the order of the sides in length, from longest to the shortest?

(A) AB,BC,AC (B) BC,AC,AB (C) AC,BC,AB (D) BC,AB,AC

3. In a rhombus ABCD, the diagonals AC and BD intersect at E. if AE=5 and BE= 12, what is the length of AB?

4. Line n intersect line l and m, for the angle shown in the diagram below




Which value of x would prove *l* // *m*

(A) 3 (B) 4 (C) 1 (D) 5

5. Which reason would be used to prove that a parallelogram is a rhombus?

(A) Diagonals are congruent (B) opposite sides are parallel

(C) Diagonals are perpendicular (D) opposite angles are congruent

6. The angle formed by the radius of a circle and a tangent to that circle has a measure of

(A) 45 (B) 90 (C) 135 (D) 180

7. Which Quadrilateral has diagonals that always bisect its angles and also bisect each other?

(A) Rhombus (B) rectangle (C) parallelogram (D) isosceles trapezoid

8. The diameter of a sphere is 15cm. what is the volume of the sphere, to the nearest tenth of a cubic centimeter?

(A) 706.9 (B) 1767.9 (C) 2827.4 (D) 14,137.2

9. Given three distinct quadrilaterals a square, a rectangle, and a rhombus which quadrilaterals must have perpendicular diagonals?

(A) The Rhombus only (B) the rectangle and the square

(C) the rhombus and the square (D) the rectangle, the rhombus and the square.

10. What is the measure of each interior angles of a regular hexagon?

(A) 60 (B) 120 (C) 135 (D) 270

11. The volume of a rectangular prism is 144cm. The height of the prism is 8cm. which measurements, in cm could be the dimensions of the base?

(A) 3.3 by 5.5 (B) 2.5 by 7.2 (C) 12 by 8 (D) 9 by 9.

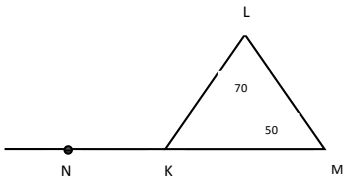
12. The angles of triangle ABC are in the ratio of 8:3:4. What is the measure of the smallest angle?

(A) 12 (B) 24 (C) 36 (D) 72

13. What is the volume, in cubic centimeters, of a cylinder that has a height of 15cm and a diameter of 12 cm?

(A) 180π (B) 540π (C) 675π (D) 2160π

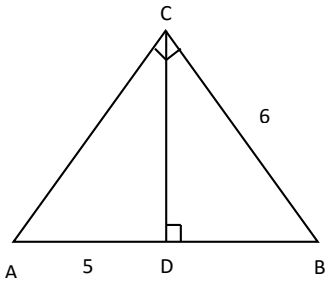
14. The diagram of △KLM below, <*L*, = 70, <M = 50 and MK is extended through N.




What is the measure of <LKN?

(A) 60 (B) 120 (C) 180 (D) 300

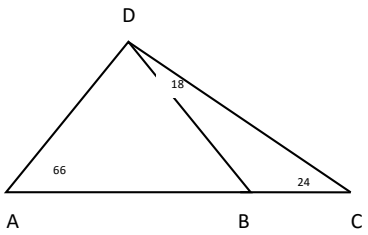
15. In the diagram below of right triangle ABC, CD is the altitude to the hypotenuse AB, CB = 6 and AD = 5.




What is the length of BD?

(A) 5 (B) 9 (C) 3 (D) 4

16. As shown in the diagram of △ACD below, B is appoint on AC and BD is drawn.




If < A=66, < CDB = 18, and <C = 24, what is the longest side of △ABD?

(A) AB (B)DC (C)AD (D )BD

17.The volume in cubic centimeter of a sphere whose diameter is 6cm is

(A) $12\pi$ (B) $36\pi$ (C) $48\pi$ (D) $208\pi$

18. A rectangular prism has a base with a length of 25cm, a width of 9cm and a height 12cm. A second prism has a square base with a side of 15cm.If the volume of the prism are equal, what is the height of the second prism?

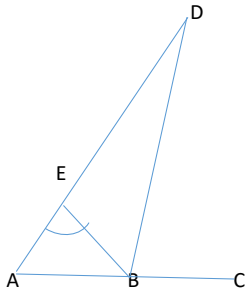
(A) 6cm (B)8cm (C)12cm (D)15cm

(19). What is the perimeter of a square whose diagonal is $3\sqrt{2}$ cm? (A) 18 cm (B) 12cm (C) 9cm (D) 6

20. The total surface area of a right circular cone is $120\pi cm^2$. If the base of the cone has a diameter of 24cm. What is the length of the slant height?

(A) 2.5cm (B) 5cm (C)10cm (D) 15.7cm

21. The diagram below shows Δ ABC, with ABC, BE AD, and <EBD =<CBD



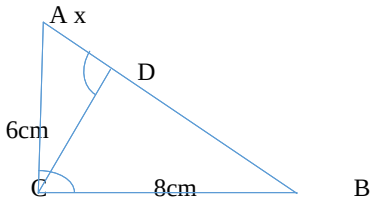

If in <ABE = 52, what is in <D?

(A) 26, (B) 38, (C) 52, (D) 64

22. The measure of an interior angle of a regular polygon is $\Delta 20^0$. How many sides does the polygon have?

(A) 5 (B) 6 (C) 3 (D) 4

23. In the diagram below, the length of the legs and BC of right triangle ABC are 6cm and 8cm, respectively, Altitude CD is drawn to the hypotenuse of ΔABC.




What is the length of AD to the nearest tenth of a centimeter?

If $< CAB = x + 40, m < ACB = 3x + 10, m < CBD = 6x, what < is\ m < CAT$?

(A) 13 (B) 25 (C) 53 (D) 65

24. The lateral area of a right circular cone is equal to $120\bar{}_{\wedge} cm^2$. If the base of the cone has a diameter of 24cm, what is the length of the slant height, in centimeters?

(A) 2.5 (B) 5 (C) 10 ( D) 15.7

25. Which set of numbers could not represent the lengths of the sides of a right triangle?

(A) {1, 3, $\sqrt{10}$} (B) {2, 3, 4} (C) {3, 4,5} (D) {8, 15, 17}

26. Two prism have equal heights and equal volumes. The base of one is a pentagon and the base of the other is a square. If the area of the pentagonal base is 36 square centimeters, how many centimeters are in the length of each side of the square base?

(A) 6 (B) 9 (C) 24 (D) 36

27 Chord $\overline{}_{AB}$ *and* $\overline{}_{CD}$ *intersect at point E in a circle with center at* 0. *If* $AE = 8, AB = 20,$ *and* $DE = 16,$ What is the length of $\overline{}_{CE}$?.

(A) 6 (B) 9 (C) 10 (D) 12

28. What is the measure of the largest exterior angle that any regular polygon can have?

(A) $60^0$ (B) $90^0$ (C) $120^0$ (D) $360^0$

29. What is the difference between the sum of the measures of the interior angles of a regular pentagon and the sum of the measures of the exterior angles of a regular pentagon?

(A) 36 (B) 72 (C) 108 (D) 180

30. For which measures of the sides of $\Delta ABC$ *is angle B the largest angle of the triangle*?

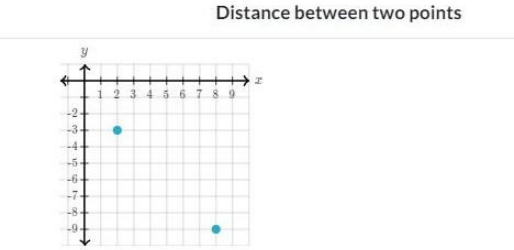
(A) AB = 2, BC = 6, AC = 7 (B) AB = 6, BC = 12, AC =8

(C) AC = 16, BC = 9, AC = 10 (D) AB = 18, BC = 14, AC = 5.

**APPENDIX 5**

SAMPLE OF KHAN ACADEMY PRACTICE QUESTIONS

(1)

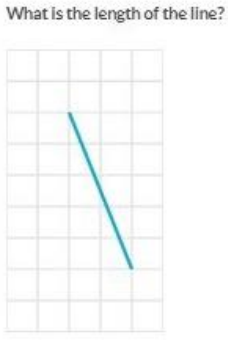



(A) 6 (B) 8 (C) $\sqrt{72}$ )D $\sqrt{79}$

(2)What is the distance between (-5,-5) and (-9,-2)

(A)5 (B) 7 (C) $\sqrt{12}$ (D) 23

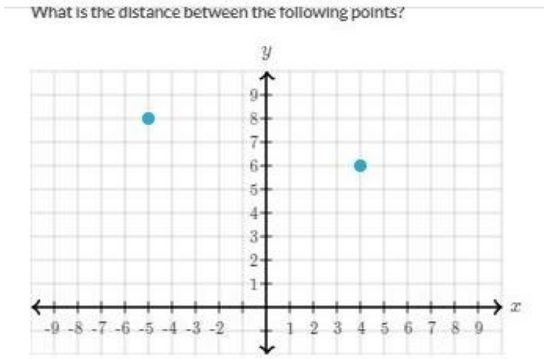
3)




.

(A) 7 (B) $\sqrt{10}$ (C)$\sqrt{29}$ (D) $\sqrt{21}$

(4)

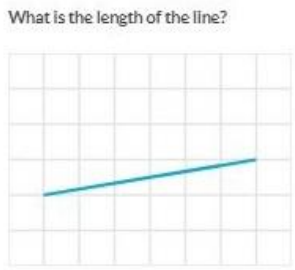



(A) $\sqrt{85}$ (B) $\sqrt{90}$ (C) 11 (D) 12

(5) What is the distance between (4,7) and (2,2)

(A) $\sqrt{10}$ (B) $\sqrt{29}$ (C 8 (D) 9

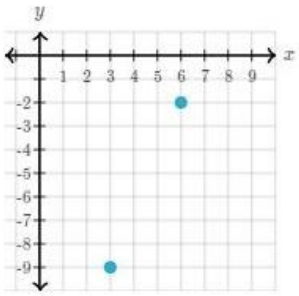
6.




(A) 6.5 (B) 7 (C) $\sqrt{35}$ (D) $\sqrt{37}$

7.

What is the distance between the following points?

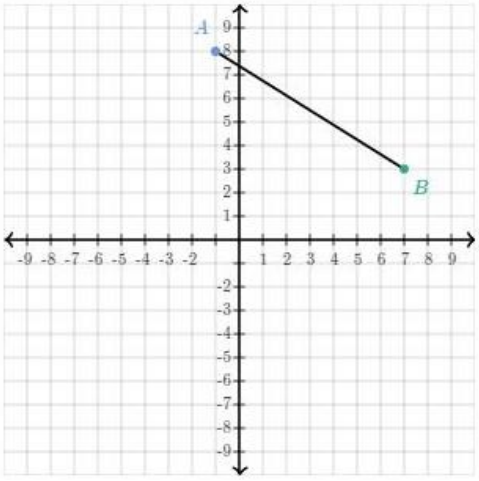


(A) 9 (B) 10 (C) $\sqrt{21}$ (D) $\sqrt{58}$

8.

Point $A$ is at $(-1, 8)$ and point $B$ is at $(7, 3)$.

What is the midpoint of line segment $\overline{AB}$?



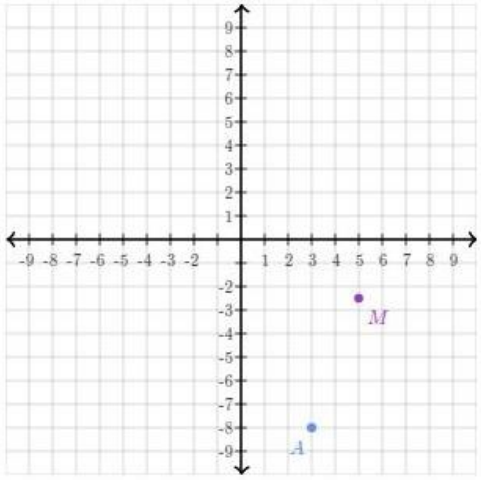
(9

## Midpoint formula

Point $A$ is at $(3, -8)$ and point $M$ is at $(5, -2.5)$.

Point $M$ is the midpoint of point $A$ and point $B$.

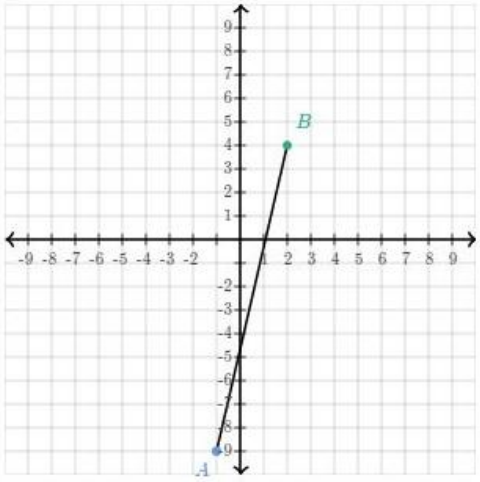
What are the coordinates of point $B$?



10.

Point $A$ is at $(-1, -9)$ and point $B$ is at $(2, 4)$.

What is the midpoint of line segment $\overline{AB}$?

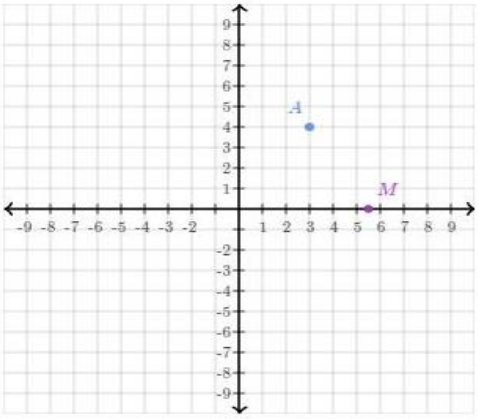


11.

Point $A$ is at $(3, 4)$ and point $M$ is at $(5.5, 0)$.

Point $M$ is the midpoint of point $A$ and point $B$.

What are the coordinates of point $B$?




12. A circle is centered at T(-6,3) and has a radius of 11. Where does N(3,-3) lie?

(a) Inside the circle (b) on the circle (C) outside the circle

13 A circle is centered at I(0,0) the point T(5,8) is on the circle. Where does the point Z($-\sqrt{15}, \sqrt{74}$) lies?

(a) Inside the circle (b) on the circle (C) outside the circle

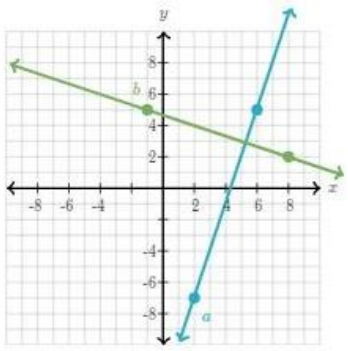
14 A circle is centered at O(0,0) and has a radius of $\sqrt{53}$. Where does V(-3,-7) lie?

(a) inside the circle (b) on the circle (C) outside the circle

15 A circle is centered at P(0,0) the point W(-6,$\sqrt{37}$) is on the circle. Where does the point Z(8, 3) lies?

(a) inside the circle (b) on the circle (C) outside the circle

16. Are the lines in the figure below parallel, perpendicular or neither?




(a) parallel (b) perpendicular (c) neither

17. one line passes through the points (-2,1) and (4,9) another line passes through (-3,8) and (5,2) are the line parallel, perpendicular or neither?

18. What do the following two equation represent?

$$-2x + 4y = 5$$

$$-2x + 4y = 5$$

(a) Equal lines (b) parallel lines (c) perpendicular lines (d) none of the above

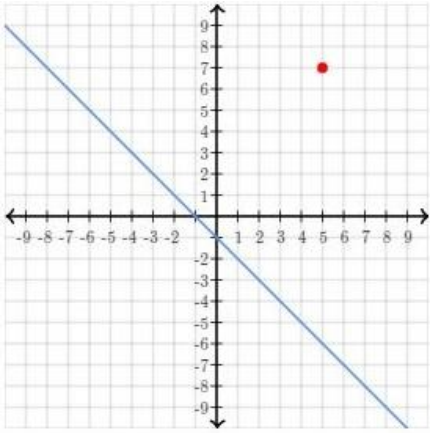
19. What do the following two equation represent?

$$3x - 2y = 5$$

$$3x - 2y = -1$$

(a) Equal lines (b) parallel lines (c) perpendicular lines (d) none of the above

20. Find the slope and y-intercept of the line that is perpendicular to $y = -x - 1$ and passes thru the point (5,7)



Slope= 

Y-intercept 

**APPENDIX 6**

**PRACTICE GUIDE FOR EXPERIMENTAL GROUP 2**

**(WEB-BASED PRACTICE GROUP)**

**WEEK ONE:**

i. General Introduction on Web-Based Practice, on how browse the page. How to progress from one question to another. How to get hint on question could not be solved.

ii. Practicing questions on distance between two points

iii. Questions on division of a line in a given segment

**WEEK TWO:**

i. Students work on Gradient.

ii. Collinear Points

iii. Gradient of Parallel and Perpendicular line

**WEEK THREE:**

i. Practicing questions on equation of a straight line of different types.

ii. Gradient and a point equation

iii. Two point equation

iv. Double intercept equation

**WEEK FOUR:**

i. Equation of a circle

ii. Center and a point on the circumference equation

iii. Center and radius equation

iv. Two point and three point equation of a circle

**WEEK FIVE:**

i. Tangent to a circle from a point

ii. Points inside and outside a given circle

**WEEK SIX:**

i. Touching circles

ii. General Revisions

**APPENDIX 7**

**LESSON PLAN FOR CONTROL GROUP**

**COURSE**: MAT 122- Coordinate Geometry

**TOPICS**: (1) location of point in a plane

(2) Distance Between 2 point

(3) Mid points of 2 points

**TIME**: 2 hours

**OBJECTIVES**: By the end of the lesson, the students should be able to

i. Fix a point in a X-Y Plane

ii. Calculate the distance between 2 points

iii. Find the midpoints of 2 given points

**ENTRY BEHAVIOUR**: The students are familiar with the X-Y plane as well as graphical method of solving problem from O' Level maths.

**REFERENCE TEXT BOOK:**

i. Additional pure maths by A. Godman ans J. F. Talbert

ii. Pure Mathematics by J.KJ.K. Backhouse; S.P.T Houldsworth and P.T.Horril.

**INTRODUCTION**: The lecturer coordinates Geometry and also the x-y plane. i.e Coordinate Geometry is branch of Geometry that bridges the gap between Algebra and Geometry _ _ _ a point in a plane can be fixed with reference to two axes, the x axis and the y axes. The point of intersection of these axis give the point.

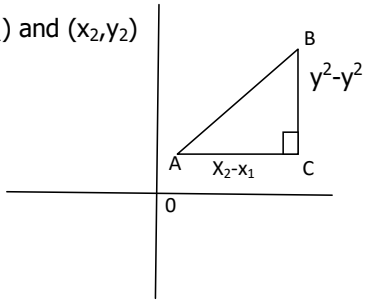
Example: fix the following points on x-y plane

A(2,3) B(-2,3) C(7,-9)

**PRESENTATION**: The lecturer presents his lesson under the following steps:

**Step I**: The lecturer drives the formular for finding the distance between two points if A and B two points on a plane with coordinate $(x_1,y_1)$ and $(x_2,y_2)$

$$|AB| = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$



Example: find the distance between the

Following pairs of points

A(1,-2) B(5,2)

Solution

$$x_1 = 1 \quad y_1 = -2$$

$x_2 = 5 \quad y_2 = 2$

$$|AB| = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$= \sqrt{(5-1)^2 + (2+2)^2}$

$= \sqrt{4^2 + 4^2}$

$\sqrt{16+16}$

$|AB| = \sqrt{32}$ unit

**Step II**. The lecturer discusses the midpoint of two points

Example: if P and Q are two Points with coordinate ($x_1$,$Y_1$) and ($x_2$,$y_2$). The midpoint of p and q is given by

$$M_x = \frac{(x_1 + x_{2)}}{2} M_y = \frac{(y_1 + y_{2)}}{2}$$

**Examples**: find the midpoint of the following points:

i. C(1,2) and D(7,4)

ii. E(-2,3) and F(4,3)

**SOLUTION**

(1) $x_1$=1 $y_1$=2

$x_2 = 7$ $y_2 = 4$

$$M_x = \frac{x_1 + x_2}{2} M_y = \frac{y_1 + y_2}{2}$$

$$\frac{1+7}{2} = 4 \frac{2+4}{2} = 3 = (4,8)$$

(2)$x_1 = -2$ $y_1$=3

$X_2$=4 $y_2$=3

$$M_x = \frac{-2+4}{2} = 2 M_y = \frac{3+3}{2} = 3$$

**EVALUATION**: find the distance between the Pairs of point using distance formula

i. A(3,4) and B(5,2)
ii. F(-3,4) and G(7,1)
iii. W(-6,1) and H(6,6)

2. Show that P(1,7) B(1,2) and C(0,-1) are vertices of parallelogram

3. By finding the length of each side show that P(1,7) B(1,2) , C(0,1) D(-4,-2) are vertices of parallelogram.

3. By finding the length of each side show that P(1,7) Q(7,5) R(6,2) and S(6,4) are vertices of a rectangle. Calculate the length of the diagonals and find the points of their intersection.

4. P, Q, R, are points (5,-3) (-6,11) and (1,8) respectively. Show that the rectangle PQR is isosceles.

**CONCLUSION**: The lecturer goes round to supervise the student work.

**LESSON 2 FOR CONTROL GROUP**

**COURSE**: MAT 122- Coordinate Geometry

**TOPICS**: (i) Gradients of points and lines

(ii) Collinear point

(iii) Angles between two straight lines

**TIME**: 2 hours

**BEHAVIORAL OBJECTIVES:** By the end of the lesson, the learners should be able to

I. find the gradient (slope) of given points and line

II. determine the gradient of parallel lines and perpendicular lines

III. Prove that collinear points have same gradient

IV. Find the angle between two straight lines

**ENTRY BEHAVIOUR**: The students are familiar with finding distance between two given points.

**REFERENCE TEXT BOOK** (i) Additional Pure Mathematics by A. Godman ans J. F. Talber (ii) Pure Mathematics by J.KJ.K. Backhouse; S.P.T Houldsworth and P.T.Horril

**INTRODUCTION**: The lecturer introduces his lesson by asking questions on the previous knowledge i.e find the distance between K(2,5) and L(6,11)

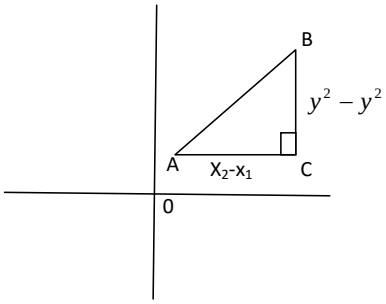
**PRESENTATION**: the lecturer presents his lesson as follows

**Step I.** The lecturer defines gradient/slope as "the rate of rise or fall of a line" or the change in y divided by the change in x.

If $A(x_1, y_1)$and B$(x_2, y_2)$ the gradient of the line AB is

$$gradien(m) = \frac{y_2 - y_1}{x_2 - x_1}$$

**Example**: find the slope of the following




A(2,5) and B(5,7)

$$(m) = \frac{y_2 - y_1}{x_2 - x_1} = (m) = \frac{7-5}{5-2} = \frac{2}{3}$$

Example 2. A(1,3) and B(5,6)

$(m) = \frac{y_2-y_1}{x_2-x_1} = \frac{6-3}{5-1} = \frac{3}{4}$

**Step II**: the lecturer goes on to explain that points on a straight line have same gradient. They are called collinear points.

**Example**: verify if A(1,-1) and B(-2,4) C(0,1) are collinear

**Solution**

$m_1 = \frac{4+1}{-2-1} = \frac{5}{3}$ $\qquad$ $m_2 = \frac{1-4}{0+2} = \frac{-3}{2}$

Since $m_1 \neq m_2$ the points are not collinear

**Example**: D(2, 5) E(-1,-1) F(-4,-7)

$m_1 = \frac{-1-5}{-1-2} = \frac{-6}{-3} = 2$ $\qquad$ $m_2 = \frac{-7+1}{-4+1} = \frac{-6}{-3} = 2$

Since $m_1 = m_2$ , the points D,E and F are collinear.

**Step III**. The lecturer shows that parallel lines have same gradient and perpendicular lines have product of gradient to be = -1

**Step IV**. The lecturer discusses angles between two straight lines.

If $l_1$ *and* $l_2$ are 2 straight lines, where $l_1$makes angle $\theta_1$and $l_2$ makes $\theta_2$

If the angle between the lines is $\alpha$

$$tan\alpha = \frac{tan\theta_2 - tan\theta_1}{1 + tan\theta_2 tan\theta_1}$$

**Example**. Find the angle between the line 2y=3x-8 and 5y=x+7

Grad of $l_1 = m_1 = \frac{3}{2}$

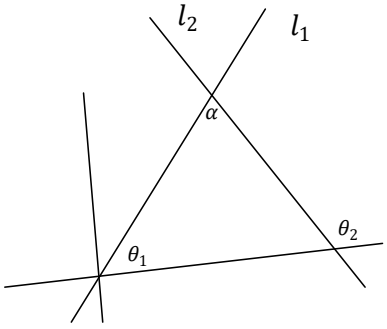
Grad of $l_2 = m_2 = \frac{1}{5}$

The angle between $l_1$ *and* $l_2$ =

$tan\alpha = \frac{\frac{1}{5}-\frac{3}{2}}{1+(\frac{1}{5})(\frac{3}{2})} = \frac{\frac{2/3}{10}}{1+\frac{3}{10}} = \left|\frac{\frac{-1}{10}}{\frac{13}{10}}\right|$

$\alpha = \tan^{-1}(\frac{1}{13})$

$\alpha = 37.6°$



**EVALUATION**: The lecturer gives the students some questions to solve.

Find the angles between the following lines:

I. $y=x+2$ and $3y-x-2=0$

II. $2x+y=4$ and $y-3x+7=0$

**CONCLUSION**: The lecturer goes round to supervise the students.

**LESSON 3: CONTROL GROUP**

**COURSE**:MAT 122- Coordinate Geometry

**TOPIC**: Equation of a line **TIME**: 2 hours

**OBJECTIVE**: By the end of the lesson the students should be able to write

I. Gradient and a point equation of a straight line
II. Gradient and an intercept equation of a line
III. Two points equation of a straight line
IV. Double intercept equation of a straight line

**ENTRY BEHAVIOUR**: The students are familiar with finding of gradient of a straight line

**REFERENCE TEXT BOOK** : (i) Additional Pure Mathematics by A. Godman ans J. F. Talbert

(ii) Pure Mathematics by J.KJ.K. Backhouse; S.P.T Houldsworth and P.T.Horril

**INTRODUCTION**: The lecturer reviews lesson on gradient of points.

e.g find the gradient of the following points

I. A(2,3) B(5,6)
II. E(7,8) F(10,18)

**PRESENTATION**: the lecturer presents under the following steps;

**Step 1**: the lecturer defines equation of a straight line.

An equation of a straight line is an equation that satisfy the points on the line and which does not satisfy the point that lies elsewhere.

**Step II**: the lecturer explains point and gradient equation of a straight line.

If the gradient is $m$ and the point is (x,y). The required equation is

$$\frac{y-y_1}{x-x_1}=m$$

$$y-y_1=m(x-x_1)$$

**Example1**. Find the equation of a line with gradient equals 7 and passes through (2,3)

$$\frac{y-3}{x-2}=7$$

$$y-3=7(x-2)$$

**Step II**. The lecturer discusses equation of a straight line when intercept on the y-axis and a gradient are given.

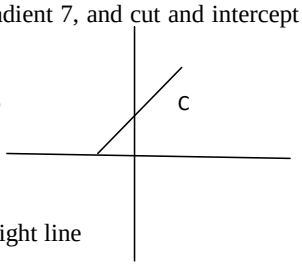
The equation is in the form of $y = mx + c$

**Example**: find the equation of a straight line that as gradient 7, and cut and intercept of 6 in the y-axis.

$$m = 7c = 6$$

$$y = mx + c$$

$$y = 7x + 6$$




**Step III**: The lecturer teaches 2 points equation of a straight line

**Example**: Find the equation of a straight line which passes through (2,3) and (4,7)

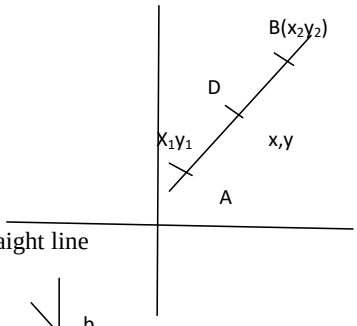
The required equation is

$$\frac{y-y_1}{x-x_1} = \frac{y_2-y_1}{x_2-x_1}$$

$$\frac{y-3}{x-2} = \frac{7-3}{4-2}$$

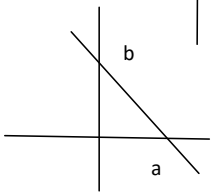
$$\frac{y-3}{x-2} = \frac{4}{2} = 2$$

$$y - 3 = 2(x-2)$$




**STEP IV**. The lecturer discuses double intercept equation of a straight line

$$\frac{x}{a} + \frac{y}{b} = 1$$




Example: find the equation of a straight line which cut an intercept of 2 and 5 on x and y axis respectively.

Soln.

$$\frac{x}{a} + \frac{y}{b} = 1 a = 2 \; and \; b = 5$$

$$\frac{x}{2} + \frac{y}{5} = 1$$

$$5x + 2y = 10$$

**CONCLUSION**: The lecturer gives the students exercise from the reference text books

**LESSON 4 FOR CONTROL GROUP**

**COURSE**: MAT 122-Coordinate Geometry.

**TOPIC**: Equation of a circle

**BEHAVIORAL OBJECTIVE**: By the end of the lesson, the students should be able to write the equation of a circle when.

I. A point and the radius are given

II. Coordinates of the end of diameter are given

III. Any three points on the circumference are given.

2.Find the center and radius from a given equation of a circle.

**Entry Behaviour**: The students can write different type of equation of straight line

**REFERENCE TEXT BOOK**: (i) Additional Pure Mathematics by A. Godman ans J. F. Talbert

(ii) Pure Mathematics by J.KJ.K. Backhouse; S.P.T Houldsworth and P.T.Horril

**INTRODUCTION**: The lecturer introduces his lesson by reviewing the different types of equation of a line.

**PRESENTATION**: The lecturer presents his lesson under the following steps

**Step I**: - The lecturer defines circle and give example of equation of a circle

A circle is a set of points that era equidistant from a fixed point center example of equation of circle

$$x^2 + y^2 + 2x + 5x - 7 = 0$$

$$x^2 + y^2 = 4$$

$$6x^2 + 6y^2 - 7x + 8y = 20$$

**N.B** (i) the coefficient of $x^2$ and $y^2$ are always the same

(ii) No term in $xy$

**StepII**:- The lecturer gives example on a point and radius equation of a circle ; end of diameter equation of a circle.

**Example 1**: find the equation of a circle that passes through (2,3) with radius 7 $units$

**SOLUTION**

$$(x-2)^2 + (y-5)^2 = 7^2$$

$$x^2 - 4x + 4 + y^2 - 10y + 25 = 49$$

$$x^2 + y^2 = 4x - 10y + 29 - 49 = 0$$

$$x^2 + y^2 - 4x - 10y - 20 = 0$$

**Example 2**. What is the equation of a circle that passes through (-2,-6) with radius 4

$$(x + 2)^2 + (y + 6)^2 = 16$$

$$x^2 + 4x + 4 + y^2 + 12y + 36 = 16$$

$$x^2 + 4x + 4 + y^2 + 12y + 40 - 16 = 0$$

$$x^2 + 4x + 4 + y^2 + 12y + 24 = 0$$

**EXAMPLE 3**: Find the equation of the circle with (-5,1) and (2,3) as the coordinates of ends of a diameter.

**SOLUTION**

. $x_1 = -5 y_1 = 1 x_2 = 2 y_2 = 3$

The required equation is

$$(x - x_1)(x - x_2) + (y - y_1)(y - y_2) = 0$$

$$(x + 5)(x - 2) + (y - 1)(y - 3) = 0$$

$$x^2 - 2x + 5x - 10 + y^2 - 3y - y + 3 = 0$$

$$x^2 + 3x - 10 + y^2 - 4y + 3 = 0$$

$$x^2 + y^2 + 3x - 4y - 7 = 0$$

**Step III**: The lecturer discusses how to find the center and radius of a given equation of a circle.

Find the center and radius of the following circles

1. $x^2 + y^2 + 10x - 8y + 37 = 0$
2. $x^2 + y^2 - 8x - 2y = 8$
3. $x^2 + y^2 + 8x + 6y = 24$

**Solution**

(1) $x^2 + y^2 + 10x - 8y = -37$

$x^2 + 10x + 25 + y^2 - 8y + 16 = -37 + 25 + 16$

$(x + 5)^2 + (y - 4)^2 = 4$

C:(-5,4) r=2

(2) $x^2 - 8x + y^2 - 2y = 8$

$$x^2 - 8x + 16 + y^2 - 2y + 1 = 8 + 16 + 1$$
$$(x-4)^2 + (y-1)^2 = 25$$

C;(4,1) ;r=5

**EVALUATION**: the lecturer gives the students exercise from the reference text book.

(1) Find the equation of circle with

| | **Center** | **radius** |
|---|---|---|
| a) | (0,0) | $\sqrt{3}$ |
| b) | (1,2) | 5 |
| c) | (3,-4) | 2 |
| d) | (-1,-7) | $\sqrt{50}$ |

(2) State which of the following equation represent circle and for the circles, find the radius and the center.

a) $x^2 = y^2 - x + 4y$
b) $x^2 + y^2 = 4x + 6y + 1$
c) $x^2 + y^2 = 2x$
d) $2x^2 + y^2 - 3x + 7y = 1$
e) $2x^2 + y^2 - x + 4y = 6$

(3) If the diameter of a circle joins the following points, find the equation of the circle.

a) (1,-1) and (4,1)
b) (3,-5) and (-2,0)
c) (-2,-1) And (3,2)

**CONCLUSION**: the lecturer goes around the class to supervise the students work.

**LESSON 5 FOR CONTROL GROUP**

**COURSE**: MAT 122- Coordinate Geometry

**TOPICS**: (i) touching circle

(ii) Points inside and outside the circle

**B/OBJECTIVE:** by the end of the lesson, the students should be able to

i. find how two given circles touch each other (internally or externally)

ii. Determine whether a given point is inside or outside a given circle.

**Entry Behaviour**: The students are familiar with finding the radius and center of a given equation of a circle.

**REFERENCE TEXT BOOK**: (i) Additional Pure Mathematics by A. Godman J. F. Talbert

(ii) Pure Mathematics by J.KJ.K. Backhouse; S.P.T Houldsworth and P.T.Horril

**INTRODUCTION**: The lecturer reviews how to find the center and radius of a given circle.

i.e $2x^2 + 2y^2 - x + 4y = 6$

$$x^2 + y^2 = 4x + 6y + 1$$

**PRESENTATIONs**: The lecturer presents his lesson under the following steps:

**Step I**: the lecturer explains the concept of touching circle

Two circles touch each other externally if the distance between the center of the two circle $|c_1c_2|$ is equal to the sum of the radii

$$|c_1c_2| = R + r$$

Two circles touch each other internally; if the distance between the center of the two circle $|c_1c_2|$ is equal to the difference between the two radii

$$|c_1c_2| = R - r$$

Example: find how the circle: $x^2 + y^2 = 1$ and $x^2 + y^2 - 6x + 5 = 0$ touch each other.

$$c_1 = x^2 + y^2 = 1$$

$c_1(0,0)$ r=1

$$c_2 = x^2 - 6x + y^2 = -5$$

$$x^2 - 6x + 9 + (y - 0)^2 = -5 + 9$$

$$(x - 3)^2 + y^2 = 4$$

$$c_2(3,0) \quad r = 2$$

$$|c_1c_2| = \sqrt{(3-0)^2 + (0-0)^2} = 3$$

R+r=2+1=3

The circles $c_1$ and $c_2$ touch each other externally.

**Example**: Find how the circle: $x^2 + y^2 + 2x + 6y = 39$ and $x^2 + y^2 - 4x - 2y + 1 = 0$ touch each other

$$C_1 = x^2 + y^2 + 2x + 6y = 39$$

$$x^2 + 2x + 1 + y^2 + 6y + 9 = 39 + 1 + 9$$

$(x+1)^2 + (y+3)^2$=49

$$C_1(-1,-3) \quad r = 7$$

$$C_2 = x^2 + y^2 - 4x - 2y + 1 = 0$$

$$x^2 - 4x + y^2 - 2y = -1$$

$$x^2 - 4x + 4 + y^2 - 2y + 1 = -1 + 4 + 1$$

$$(x-2)^2 + (y-1)^2 = 4$$

$$C_2(2,1) \quad r = 2$$

$$|c_1c_2| = \sqrt{(2+1)^2 + (3+1)^2}$$

$$\sqrt{9+16}$$

$$\sqrt{25}$$

$$5$$

$$|c_1c_2| = R_1 - r_2$$

Therefore the circle touch each other internally

**Step II**: the lecturer discusses how to determine whether a point is inside or outside a given circle: The lecturer explains that : If the coordinates of a given point is substituted into an equation of a circle; the results are :

(i) The point is outside the circle if its greater than zero

(ii) The point is inside the circle if its less than zero

(iii) The point is on the circumference of the circle if its equal to zero

**Example**: which of these points A(2,5) B(1,-3) and C(1,0) lie inside or outside the circle $x^2 + y^2 - 3x + y = 12$ ?

A(2,5): $x^2 + y^2 - 3x + 2y - 12$

$$(2)^2 + (5)^2 - 3(2) + 2(5) - 12$$

4+25-6+10-12

21> 0 .The point lies is outside the circle

B(1,-3) $x^2 + y^2 - 3x + 2y - 23$

$$(1)^2 + (-3)^2 - 3(1) + 2(-3) - 12$$

$1 + 9 - 3 - 6 - 12$

$-11 < 0. Therefore\ the\ point\ is\ inside\ the\ circle$

C(1,0) $x^2 + y^2 - 3x + 2y - 12$

$$(1)^2 + (0)^2 - 3(1) + 2(0) - 12$$

1-3+0-12

$-10 \leq 0\ inside\ the\ circle$

**EVALUATION**: the lecturer gives the students exercise to do

Exercise

1) Find whether the points (1,2) (3,4) (-2,-3) and (-2,-4) lie inside or outside the circle $x^2 + y^2 - 2x + 3y = 2$
2) Show that the circle $x^2 + y^2 = 4$ and $x^2 + y^2 + 8x + 6y = 24$ touch each other
3) Find how the circle $x^2 + y^2 + 10x - 8y + 37 = 0$ and $x^2 + y^2 - 8x - 2y = 8$ touch each other

**CONCLUSION**: The lecturer goes round to supervise the students work.

**APPENDIX 8**

**TEACHING GUIDE FOR EXPERIMENTAL GROUP (GEOGEBRA)**

**COURSE**: MAT 122 –Coordinate Geometry

**TOPIC(S)** (i) location of points in a plane

(ii) Distance between two points

(iii) Midpoint of two points

**METHOD OF TEACHING**: GeoGebra

**TIME**: 2 hours

**BEHAVIORAL OBJECTIVES**: By the end of the lesson, the students should be able to use GeoGebra

(i) to fix point on a plane

(ii) find the distance between two points

(iii) find the midpoint of 2 points

(iv) Compare the results obtained in i-iii using traditional method

(v) Appreciate the use of GeoGebra in solving problems

**ENTRY BEHAVIOUR**: The students are familiar with the calculation of distance between two points, Midpoint of two points using the traditional method (formular method)

**REFERENCE TEXT BOOK:**

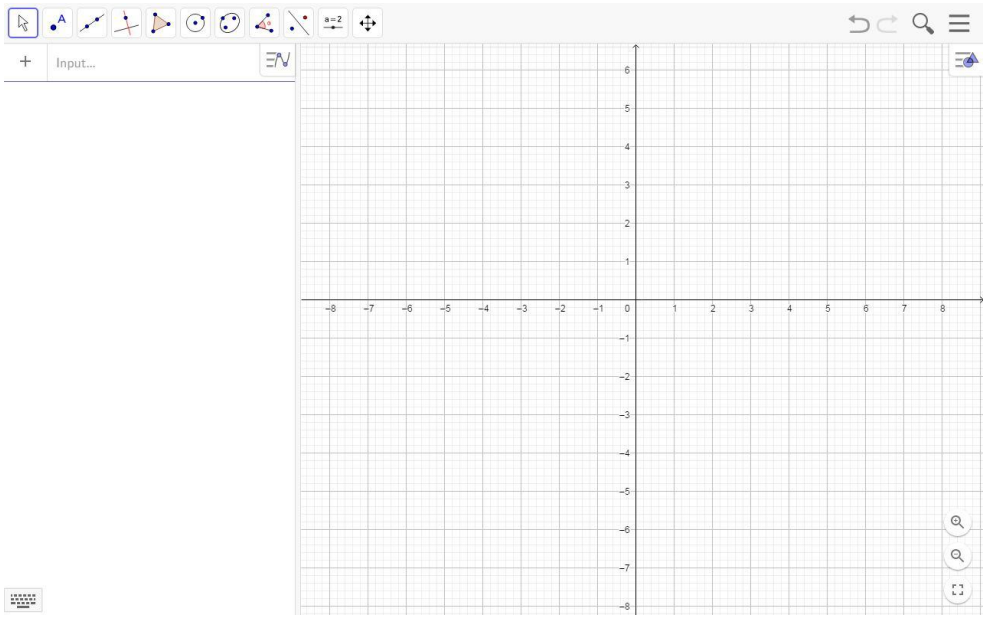
i. Additional Pure Mathematics by A. Godman ans J. F. Talbert

ii. Pure Mathematics by J.KJ.K. Backhouse; S.P.T Houldsworth and P.T.Horril.

**INSTRUCTIONAL MATERIAL**: Projector, Laptop, Desktops.

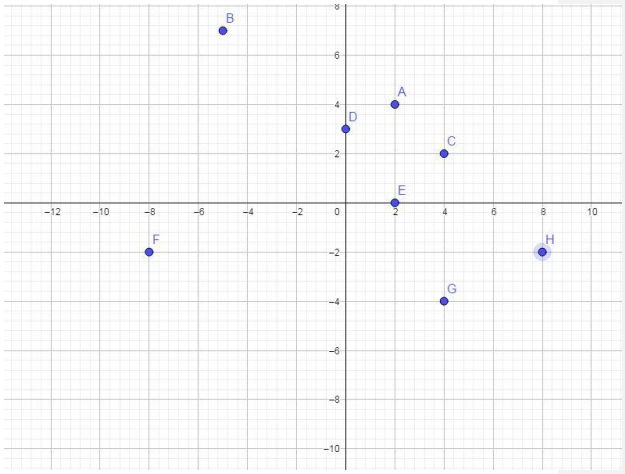
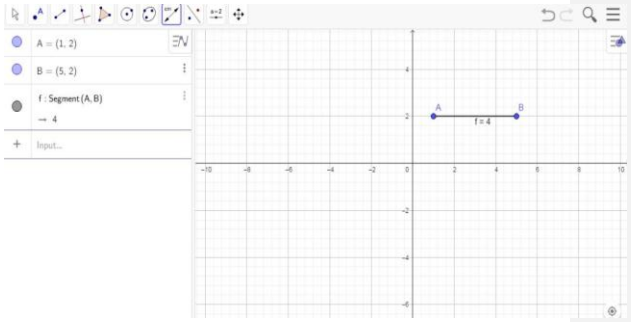
**INTRODUCTION**: The facilitator uses projector to show GeoGebra view in the laboratory for all the students to see. The facilitator goes further to give a brief history of GeoGebra.

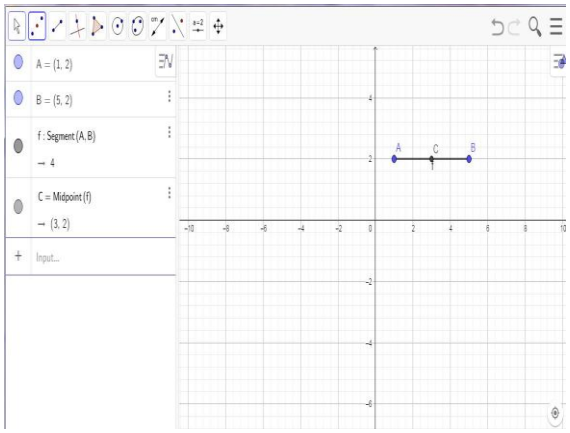
"GeoGebra is free software developed by Micheal Hohenwarter in 2001, it is used in teaching Algebra, Geometry, Calculus, Statistic… it is used for teaching and learning of education from primary school to tertiary level.




The facilitator also explains the three main views of GeoGebra.

i. Graphical view: visualize geometric objects.
ii. Algebraic View: Algebraic representation of object
iii. Input bars: for making input such as function and equation.
iv. Presentation: the lesson is presented below

| Facilitator | Students |
|---|---|
| Step I<br>**Explain the first compartment and their icon: Point , Midpoint**<br><br> | Use input bar and graphic view to locate the following points using GeoGebra A(2,4); B(-5,7); C(4,2); D(0,3) E(2,0) F(8,-2); G(8,-2)<br> |
| Step II<br>**Demonstrate the icon of line segment and its length**<br><br> | find the distance between pairs of points using GeoGebra<br>A(1,2) and B(5,2)<br><br>C(3,4) and D(7,1)<br>E(-2,3) and F(4,3)<br>G(-6,1) and H(6,6) |

| | |
|---|---|
| Step III<br><br> | Students use midpoint icon to find the midpoint of the points in Step II above<br><br> |

**Step IV Evaluation:**:

Using GeoGebra the students solve the following questions

i. Show that that P(-3,1) B(1,2) C(0,-1) D(-4,-2) are vertices of a parallelogram

ii. Show that P(1,7) Q(7,5) R(6,2) S(0,4) are vertices of a rectangle. Calculate the length of the diagonal and find the point of intersection

iii. Show that D(-2,0) , $(\frac{1}{2}, 1\frac{1}{2})$ , F$(3\frac{1}{2}, -3\frac{1}{2})$ arevertices of a right angle triangle. Find the length of the shortest side and the midpoint of the hypotenuse.

iv. P,Q,R are points (5,-3) (-6,1) (1,8) respectively. Show that the triangle PQR is isosceles

v. A triangle ABC has Vertices at the point A(2,4) B(-3,0) and C(5,-2)

(a) Find the coordinate of the midpoint D, E and F of the sides BC, CA, and AB respectively.

(b) Show that $|DE| = \frac{1}{2}|AB|$

**CONCLUSION**: the facilitator goes round the laboratory, to supervise students work and give help to those that need it.

**LESSON 2: FOR EXPERIMENTAL GROUP (GEOGEBRA)**

**COURSE**; MAT 122- Coordinate Geometry

**TOPIC(S)**: (i) gradient of points and lines

(ii) Gradient of parallel and perpendicular lines

(iii) Collinear point

(iv) Angle between two straight lines

**TIME**: 2 Hours

**BEHAVIORAL OBJECTIVE**: By the end of the lesson, the learners should be able to use GeoGebra to;

i. find the gradient (slope) of a given line and point
ii. determine the gradient of parallel lines and perpendicular lines
iii. establish that collinear points have same gradient
iv. find the angle between two straight lines.

**ENTRY BEHAVIOUR**: The students are familiar with the calculations of gradients, gradient of appoint and lines; and how to find the angle between two straight lines using traditional method.

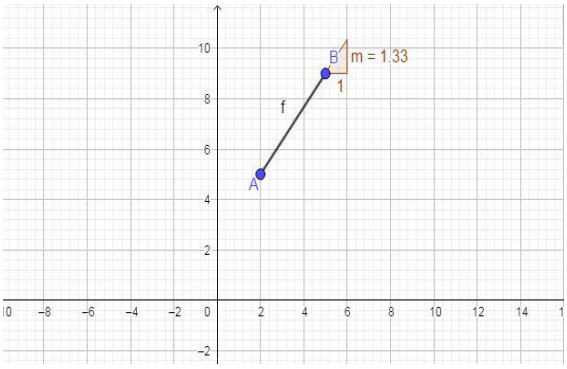
**REFERENCE TEXT BOOK:** Additional pure maths by Goodman (ii) Pure Mathematics by J.KJ.K. Backhouse; S.P.T Houldsworth and P.T.Horril.

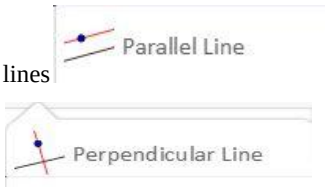
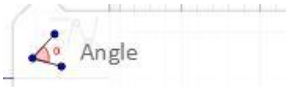
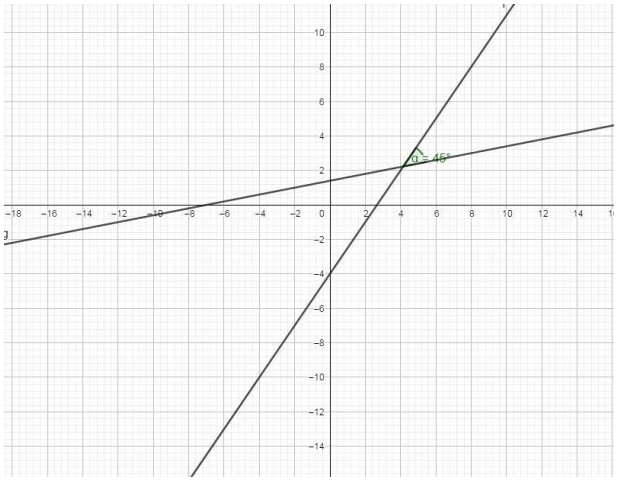
**INSTRUCTIONAL MATERIAL**: Projector, Laptop and Desktop (Computer Laboratory)

**INTRODUCTION**: The facilitator revises the method of finding gradient using traditional method. He goes further to explain the importance and uses of gradient (slope)

Presentation: The facilitator presents the lesson as follows;

\

| Facilitator | Students |
|---|---|
| **Step I**<br>The facilitator projects to the whole class the icons of gradient.<br><br><br>The facilitator also gives the steps to taken;<br>i. Locate the points<br>ii. Use line segment icon to join the points<br>iii. Click at gradient icon and then on line segment, the gradient appears<br><br> | Students use GeoGebra and the icon of gradient to find the gradient of these points<br>a) (2,5) and (5,9)<br>b) (1,3) and (5,3)<br>c) (-4,-1) and (-6,-6)<br>d) (-1,-4) and (-6,-16)<br>e) (2,-3) and (2,5)<br><br> |
| **Step II**<br>Teacher asks the students the relationship between the Slopes of AB and BC in each of the three cases | Students use the guide in Step I to find the Gradients of the following sets of points:<br>a) A(2,5) B(-1,-1) C(-4,-7)<br>b) A(-1,-1) B(-2,4) C(0,1)<br>c) A(7,3) B(-2,1) C($6\frac{1}{2}$, 3)<br>Students |

| | |
|---|---|
| **Step III**<br>The Facilitator projects the icon of parallel and perpendicular lines<br> | Students draw arbitrary parallel lines and also find their gradients. Students construct arbitrary perpendicular lines and find their gradient using GeoGebra<br>i. Students will observe that parallel lines have same gradients<br>ii. Perpendicular lines have product of gradient to be =-1 |
| **Step IV**<br>The facilitator guides the students to identify the icons of angle between two lines.<br><br>He also gives them the steps to take to find the angle between two straight lines<br>i. Type the equation in the input bar<br>ii. Click at the icon of angle and the lines at counter clockwise | Students find the angle between the following lines;<br>a) $2y = 3x - 8$ and $5y = x + 7$<br>b) $Y = x + 2$ and $3y - x - 2 = 0$<br>c) $2x + y = 4$ and $y - 3x + 7 = 0$<br> |

**EVALUATION**: The facilitator asks the learners to solve the following questions using GeoGebra.

(1) Compute the slope of each of the following

i. (0,0) and (8,8) (ii) 5,7) and (8,4) (iii) (-1,-4) and (-12,7 (iv) (11,1) and (17,-5)

(2) Use slope to classify the following lines whether there are parallel, perpendicular or identical

i. x-y=5 and x-y=6 (ii) 2x-y=3 and x+2y-1=) 4x+3y=1 and 3x-4y=10

**CONCLUSION**: The facilitator goes round the laboratory to supervise the students and offer help to those that need it.

**LESSON 3: FOR EXPERIMENTAL GROUP I (GEOGEBRA)**

**COURSE**: MAT 122 Coordinate GeoGebra

**TOPIC**: Equation of line and circle

**TIME**: 2 hours

**BEHAVIORAL OBJECTIVE:** The students are familiar with the writing of equation of lines and circle using formulae

**REFERENCE TEXT BOOK:**

i. Additional Pure Mathematics by A. Godman ans J. F. Talbert

ii. Pure Mathematics by J.KJ.K. Backhouse; S.P.T Houldsworth and P.T.Horril.

**Instructional material**: Projector, Laptop ( computer laboratory)

**I**NTRODUCTION: the facilitator reviews the equations of a circle and lines using the formular as explained in the text books.

**PRESENTATIONS**: The facilitator presents his lesson under the following steps

| **Facilitator** | **Student** |
|---|---|
| **Step I**<br>Equation of a line passing through two given points. The facilitator explains as follows<br>i. Fix the 2 given points using input bar or graphical view<br><br><br>ii. Join the two points using line segment icon<br>iii. Click at the line | Find the equation of the lines which pass through the following pairs of points<br>a) (2,4) and (5,6)<br>b) (-1,-2) and (3,0)<br>c) (-4,3) and (2,-5)<br>d) (-2,-6) and (5,4) |

**Step II**

Gradients and intercept form of equation. The facilitator asks the students to type the equation in input bar

The facilitator gives out the list of circle command that lead to the writing of equation of circle.

i. Circle[ (center), r]

ii. Circle.[ (point, point)]

iii. Circle [(point, point, point)]

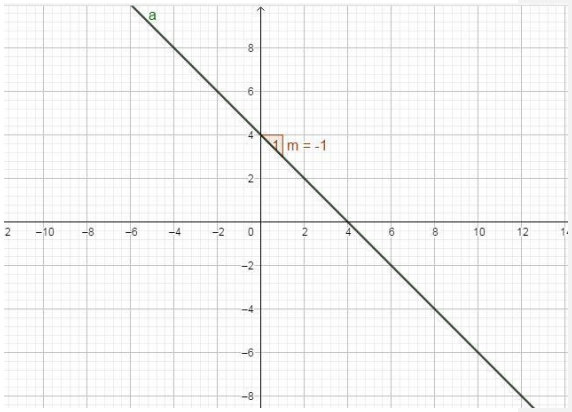






State the gradient and the y-intercept of the following lines

i. x+y=4




ii. Y+2x=3

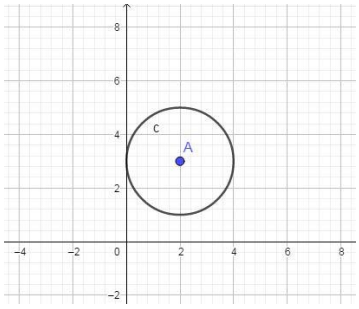
iii. 2x-y=3

iv. X+3y=6

(2) The students write the equation of the following circles using GeoGebra.

Find the equation of the following circles;

i. C(2,-3) r=2

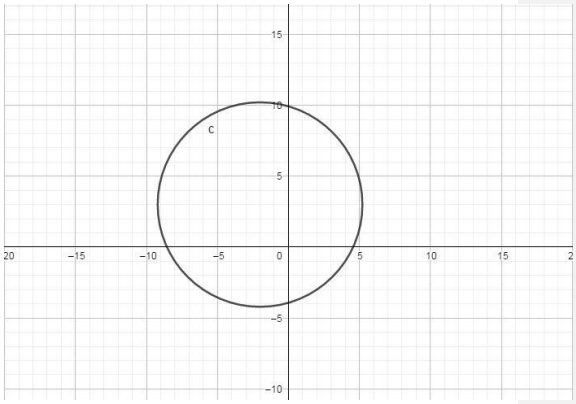



ii. C(0,0) r=4

iii. C(-3,2) r=10

(3) find the equation of the following circles if the coordinate of the end of diameter given are;

i. (-2,3) (4,7)




ii. (1,-1) (4,1)

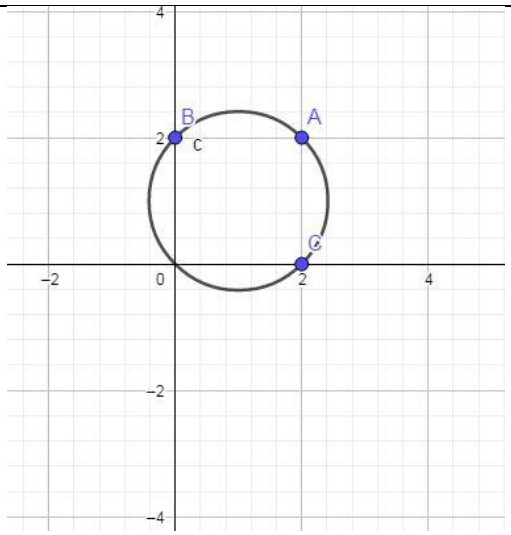
iii. (3,-5) (-2,0)

iv. (-2,-1) (3,2)

(4) write the equation of the circle if three points are given on the circumference

i. (-2,2) (2,2) and (-2,-4)

ii. (2,2) (0,2) and (2,0)




**Students activity**

Use GeoGebra to analyze the following circles;

i. $x^2 + y^2 + 2x + 6y = 39$

ii. $x^2 + y^2 - 4x - 2y + 1 = 0$

iii. $x^2 + y^2 - 4x - 2y + 3 = 0$

iv. $x^2 + y^2 + 2x + 4y - 3 = 0$

v. $x^2 + y^2 + 8x + 6y = 24$

**CONCLUSION**: The facilitator goes round the computer laboratory to supervise and guide the students where necessary.

**LESSON 4: FOR EXPERIMENTAL GROUP I (GEOGEBRA)**

**COURSE**: MAT 122 Coordinate Geometry

**TOPIC(S)**: (i) touching circle

(ii) point inside and outside the circle

**TIME**: 2 hours

**BEHAVIORAL OBJECTIVE**: By the end of the lesson, the students should be able to use GeoGebra to find

1. how two given circles touch each other
2. whether a given point is inside or outside a circle.

**ENTRY BEHAVIOUR**: The students are familiar with the method of finding how two circles touches each other through finding the center and radius

**REFERENCE TEXT BOOK:**

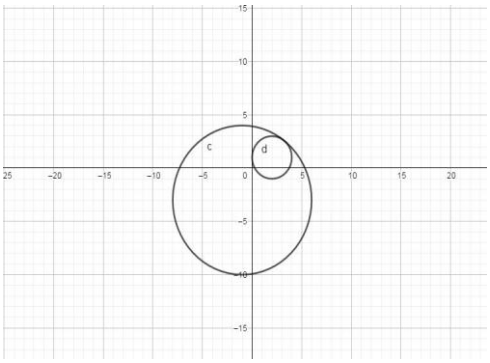
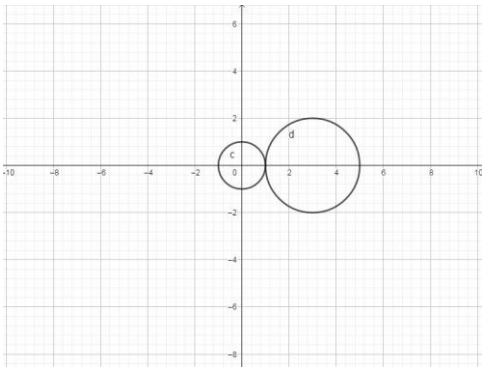
i. Additional Pure Mathematcs by A. Godman ans J. F. Talbert

ii. Pure Mathematics by J.K Bachouse.

**INSTRUCTIONAL MATERIAL**: Projector, laptop and desktop (computer Laboratory)

**INTRODUCTION**: the facilitator introduces his lesson by reviewing the method of finding how two circle touches each other through circle analyses. i.e two circle touches each other internally if $|c_1c_2|$=R+r

**PRESENTATIONS**: the facilitator presents the lesson as follows;

| Facilitator | Student |
| --- | --- |
| The facilitator tells the students to use the input bar to solve the following problem<br><br><br>s | Find how the following circle touch each other:<br>i. $x^2 + y^2 + 2x + 6y = 39$; $x^2 + y^2 - 4x - 2x + 1 = 0$<br><br><br>ii. $x^2 + y^2 = 1$ and $x^2 + y^2 - 6x + 5 = 0$<br>iii.<br><br><br>iv. $x^2 + y^2 = 4x^2 + y^2 + 8x + 6y = 24$ |

| | |
|---|---|
| | **ACTIVITIES**<br>Find the center and radius of each of the following above;<br>Activity: what do you observe? Write down your observation<br><br>Which of these points A(2,-5) B(1,3) and C(1,0) lies inside or outside the circle $x^2 + y^2 - 3x + 2y = 0$<br>Are the points A(1,-1) B(3,-7) C(4,10) and D(5,2) inside or outside the circle: $x^2 + y^2 - 3x + 4y = 12$? |

**CONCLUSION**: The facilitator goes around the computer laboratory to supervise students work.

**APPENDIX 9**

**Statistical Analysis**

```
RELIABILITY
  /VARIABLES=VAR00001 VAR00002
  /SCALE('ALL VARIABLES') ALL
  /MODEL=SPLIT.
```

## Reliability

**Notes**

| | | |
|---|---|---|
| Output Created | | 09-OCT-2018 22:49:06 |
| Comments | | |
| Input | Active Dataset | DataSet0 |
| | Filter | <none> |
| | Weight | <none> |
| | Split File | <none> |
| | N of Rows in Working Data File | 40 |
| | Matrix Input | |
| Missing Value Handling | Definition of Missing | User-defined missing values are treated as missing. |
| | Cases Used | Statistics are based on all cases with valid data for all variables in the procedure. |
| Syntax | | RELIABILITY /VARIABLES=VAR00001 VAR00002 /SCALE('ALL VARIABLES') ALL /MODEL=SPLIT. |
| Resources | Processor Time | 00:00:00.02 |
| | Elapsed Time | 00:00:00.02 |

```
[DataSet0]
```

## Scale: ALL VARIABLES

**Case Processing Summary**

| | | N | % |
|---|---|---|---|
| Cases | Valid | 40 | 100.0 |
| | Excluded[a] | 0 | .0 |
| | Total | 40 | 100.0 |

a. Listwise deletion based on all variables in the procedure.

**Reliability Statistics**

| | | | |
|---|---|---|---|
| Cronbach's Alpha | Part 1 | Value | 1.000 |
| | | N of Items | 1[a] |
| | Part 2 | Value | 1.000 |
| | | N of Items | 1[b] |
| | Total N of Items | | 2 |
| Correlation Between Forms | | | .652 |
| Spearman-Brown Coefficient | Equal Length | | .790 |
| | Unequal Length | | .790 |
| Guttman Split-Half Coefficient | | | .790 |

a. The items are: VAR00001

b. The items are: VAR00002

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | |
|---|---|---|---|---|---|
| | | F | Sig. | t | Df |
| SCORES | Equal variances assumed | 17.448 | .000 | 11.502 | 138 |
| | Equal variances not assumed | | | 11.502 | 112.606 |

**Independent Samples Test**

| | | t-test for Equality of Means | | |
|---|---|---|---|---|
| | | Sig. (2-tailed) | Mean Difference | Std. Error Difference |
| SCORES | Equal variances assumed | .000 | 17.0714 | 1.4842 |
| | Equal variances not assumed | .000 | 17.0714 | 1.4842 |

**Independent Samples Test**

| | | t-test for Equality of Means | |
|---|---|---|---|
| | | 95% Confidence Interval of the Difference | |
| | | Lower | Upper |
| SCORES | Equal variances assumed | 14.1367 | 20.0062 |
| | Equal variances not assumed | 14.1308 | 20.0120 |

T-TEST GROUPS=EXPT(1 3)

/MISSING=ANALYSIS

/VARIABLES=SCORES

/CRITERIA=CI(.95).

**T-Test**

| | EXPT | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| SCORES | GEOGEBRA | 70 | 56.714 | 10.6637 | 1.2746 |
| | CONTROL | 70 | 42.471 | 36.0531 | 4.3092 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | |
|---|---|---|---|---|---|
| | | F | Sig. | t | df |
| SCORES | Equal variances assumed | .125 | .724 | 3.170 | 138 |
| | Equal variances not assumed | | | 3.170 | 80.981 |

**Independent Samples Test**

| | | t-test for Equality of Means | | |
|---|---|---|---|---|
| | | Sig. (2-tailed) | Mean Difference | Std. Error Difference |
| SCORES | Equal variances assumed | .002 | 14.2429 | 4.4937 |
| | Equal variances not assumed | .002 | 14.2429 | 4.4937 |

**Independent Samples Test**

| | | t-test for Equality of Means | |
|---|---|---|---|
| | | 95% Confidence Interval of the Difference | |
| | | Lower | Upper |
| SCORES | Equal variances assumed | 5.3574 | 23.1283 |
| | Equal variances not assumed | 5.3018 | 23.1840 |

## T-Test

**Group Statistics**

| | EXPT | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| SCORES | WEBBASED | 70 | 39.643 | 6.3629 | .7605 |
| | CONTROL | 70 | 42.471 | 36.0531 | 4.3092 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | |
|---|---|---|---|---|---|
| | | F | Sig. | t | df |
| SCORES | Equal variances assumed | 1.486 | .225 | -.646 | 138 |
| | Equal variances not assumed | | | -.646 | 73.294 |

**Independent Samples Test**

| | | t-test for Equality of Means | | |
|---|---|---|---|---|
| | | Sig. (2-tailed) | Mean Difference | Std. Error Difference |
| SCORES | Equal variances assumed | .519 | -2.8286 | 4.3758 |
| | Equal variances not assumed | .520 | -2.8286 | 4.3758 |

**Independent Samples Test**

| | | t-test for Equality of Means | |
|---|---|---|---|
| | | 95% Confidence Interval of the Difference | |
| | | Lower | Upper |
| SCORES | Equal variances assumed | -11.4808 | 5.8236 |
| | Equal variances not assumed | -11.5489 | 5.8917 |

```
UNIANOVA SCORES BY EXPT SEX
 /METHOD=SSTYPE(3)
 /INTERCEPT=INCLUDE
 /POSTHOC=EXPT(SCHEFFE LSD)
```

/EMMEANS=TABLES(EXPT) COMPARE ADJ(LSD)

/EMMEANS=TABLES(SEX) COMPARE ADJ(LSD)

/EMMEANS=TABLES(EXPT*SEX)

/PRINT=DESCRIPTIVE

/CRITERIA=ALPHA(.05)

/DESIGN=EXPT SEX EXPT*SEX.

## Univariate Analysis of Variance

[DataSet1]

**Between-Subjects Factors**

| | | Value Label | N |
|---|---|---|---|
| EXPT | 1 | GEOGEBRA | 70 |
| | 2 | WEBBASED | 70 |
| | 3 | CONTROL | 70 |
| SEX | 1 | Male | 120 |
| | 2 | Female | 90 |

**Descriptive Statistics**

Dependent Variable: SCORES

| EXPT | SEX | Mean | Std. Deviation | N |
|---|---|---|---|---|
| GEOGEBRA | Male | 57.675 | 9.6460 | 40 |
| | Female | 55.433 | 11.9357 | 30 |
| | Total | 56.714 | 10.6637 | 70 |
| WEBBASED | Male | 39.175 | 6.2722 | 40 |
| | Female | 40.267 | 6.5360 | 30 |
| | Total | 39.643 | 6.3629 | 70 |
| CONTROL | Male | 37.313 | 6.1506 | 40 |
| | Female | 49.350 | 54.3706 | 30 |
| | Total | 42.471 | 36.0531 | 70 |
| Total | Male | 44.721 | 11.8734 | 120 |
| | Female | 48.350 | 32.6015 | 90 |
| | Total | 46.276 | 23.1542 | 210 |

**Tests of Between-Subjects Effects**

Dependent Variable: SCORES

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 14310.779[a] | 5 | 2862.156 | 5.974 | .000 |
| Intercept | 445483.544 | 1 | 445483.544 | 929.827 | .000 |
| EXPT | 10771.240 | 2 | 5385.620 | 11.241 | .000 |
| SEX | 677.358 | 1 | 677.358 | 1.414 | .236 |
| EXPT * SEX | 1913.240 | 2 | 956.620 | 1.997 | .138 |
| Error | 97737.202 | 204 | 479.104 | | |
| Total | 561760.000 | 210 | | | |
| Corrected Total | 112047.981 | 209 | | | |

a. R Squared = .128 (Adjusted R Squared = .106)

## Estimated Marginal Mean

## 1. EXPT

**Estimates**

Dependent Variable: SCORES

| EXPT | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|
| | | | Lower Bound | Upper Bound |
| GEOGEBRA | 56.554 | 2.643 | 51.343 | 61.766 |
| WEBBASED | 39.721 | 2.643 | 34.509 | 44.932 |
| CONTROL | 43.331 | 2.643 | 38.120 | 48.543 |

**Pairwise Comparisons**

Dependent Variable: SCORES

| (I) EXPT | (J) EXPT | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| GEOGEBRA | WEBBASED | 16.833* | 3.738 | .000 | 9.463 | 24.204 |
| | CONTROL | 13.223* | 3.738 | .001 | 5.853 | 20.593 |
| WEBBASED | GEOGEBRA | -16.833* | 3.738 | .000 | -24.204 | -9.463 |
| | CONTROL | -3.610 | 3.738 | .335 | -10.981 | 3.760 |
| CONTROL | GEOGEBRA | -13.223* | 3.738 | .001 | -20.593 | -5.853 |
| | WEBBASED | 3.610 | 3.738 | .335 | -3.760 | 10.981 |

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

**Univariate Tests**

Dependent Variable: SCORES

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Contrast | 10771.240 | 2 | 5385.620 | 11.241 | .000 |
| Error | 97737.202 | 204 | 479.104 | | |

The F tests the effect of EXPT. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

## 2. SEX

**Estimates**

Dependent Variable: SCORES

| SEX | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|
| | | | Lower Bound | Upper Bound |
| Male | 44.721 | 1.998 | 40.781 | 48.660 |
| Female | 48.350 | 2.307 | 43.801 | 52.899 |

**Pairwise Comparisons**

Dependent Variable: SCORES

| (I) SEX | (J) SEX | Mean Difference (I-J) | Std. Error | Sig.[a] | 95% Confidence Interval for Difference[a] | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| Male | Female | -3.629 | 3.052 | .236 | -9.647 | 2.389 |
| Female | Male | 3.629 | 3.052 | .236 | -2.389 | 9.647 |

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

**Univariate Tests**

Dependent Variable: SCORES

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Contrast | 677.358 | 1 | 677.358 | 1.414 | .236 |
| Error | 97737.202 | 204 | 479.104 | | |

The F tests the effect of SEX. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

**3. EXPT * SEX**

Dependent Variable: SCORES

| EXPT | SEX | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound |
| GEOGEBRA | Male | 57.675 | 3.461 | 50.851 | 64.499 |
| | Female | 55.433 | 3.996 | 47.554 | 63.313 |
| WEBBASED | Male | 39.175 | 3.461 | 32.351 | 45.999 |
| | Female | 40.267 | 3.996 | 32.387 | 48.146 |
| CONTROL | Male | 37.313 | 3.461 | 30.489 | 44.136 |
| | Female | 49.350 | 3.996 | 41.471 | 57.229 |

## Post Hoc Tests

## EXPT

**Multiple Comparisons**

Dependent Variable: SCORES

| | (I) EXPT | (J) EXPT | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval |
|---|---|---|---|---|---|---|
| | | | | | | Lower Bound |
| Scheffe | GEOGEBRA | WEBBASED | 17.071* | 3.6998 | .000 | 7.948 |
| | | CONTROL | 14.243* | 3.6998 | .001 | 5.120 |
| | WEBBASED | GEOGEBRA | -17.071* | 3.6998 | .000 | -26.195 |
| | | CONTROL | -2.829 | 3.6998 | .747 | -11.952 |
| | CONTROL | GEOGEBRA | -14.243* | 3.6998 | .001 | -23.366 |
| | | WEBBASED | 2.829 | 3.6998 | .747 | -6.295 |
| LSD | GEOGEBRA | WEBBASED | 17.071* | 3.6998 | .000 | 9.777 |
| | | CONTROL | 14.243* | 3.6998 | .000 | 6.948 |
| | WEBBASED | GEOGEBRA | -17.071* | 3.6998 | .000 | -24.366 |
| | | CONTROL | -2.829 | 3.6998 | .445 | -10.123 |
| | CONTROL | GEOGEBRA | -14.243* | 3.6998 | .000 | -21.538 |
| | | WEBBASED | 2.829 | 3.6998 | .445 | -4.466 |

**Multiple Comparisons**

Dependent Variable: SCORES

| | (I) EXPT | (J) EXPT | 95% Confidence Interval |
|---|---|---|---|
| | | | Upper Bound |
| Scheffe | GEOGEBRA | WEBBASED | 26.195* |
| | | CONTROL | 23.366* |
| | WEBBASED | GEOGEBRA | -7.948* |
| | | CONTROL | 6.295 |
| | CONTROL | GEOGEBRA | -5.120* |
| | | WEBBASED | 11.952 |
| LSD | GEOGEBRA | WEBBASED | 24.366* |
| | | CONTROL | 21.538* |
| | WEBBASED | GEOGEBRA | -9.777* |
| | | CONTROL | 4.466 |
| | CONTROL | GEOGEBRA | -6.948* |
| | | WEBBASED | 10.123 |

Based on observed means.

The error term is Mean Square(Error) = 479.104.

*. The mean difference is significant at the .05 level.

## Homogeneous Subsets

**SCORES**

| | EXPT | N | Subset | |
|---|---|---|---|---|
| | | | 1 | 2 |
| Scheffe[a,b] | WEBBASED | 70 | 39.643 | |
| | CONTROL | 70 | 42.471 | |
| | GEOGEBRA | 70 | | 56.714 |
| | Sig. | | .747 | 1.000 |

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 479.104.

a. Uses Harmonic Mean Sample Size = 70.000.

b. Alpha = .05.

```
NPAR TESTS
  /M-W= Attitude BY SEX(1 2)
  /STATISTICS=DESCRIPTIVES
  /MISSING ANALYSIS.
```

## NPar Tests

[DataSet1]

**Descriptive Statistics**

| | N | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Attitude | 210 | 69.61 | 6.899 | 51 | 98 |
| SEX | 210 | 1.43 | .496 | 1 | 2 |

## Mann-Whitney Test

**Ranks**

| | SEX | N | Mean Rank | Sum of Ranks |
|---|---|---|---|---|
| Attitude | Male | 120 | 101.68 | 12201.50 |
| | Female | 90 | 110.59 | 9953.50 |
| | Total | 210 | | |

**Test Statistics[a]**

| | Attitude |
|---|---|
| Mann-Whitney U | 4941.500 |
| Wilcoxon W | 12201.500 |
| Z | -1.054 |
| Asymp. Sig. (2-tailed) | .292 |

a. Grouping Variable: SEX

```
NPAR TESTS
  /M-W= Attitude BY EXPT(1 2)
  /STATISTICS=DESCRIPTIVES
  /MISSING ANALYSIS.
```

## NPar Tests

[DataSet1]

**Descriptive Statistics**

| | N | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Attitude | 210 | 69.61 | 6.899 | 51 | 98 |
| EXPT | 210 | 2.00 | .818 | 1 | 3 |

## Mann-Whitney Test

**Ranks**

| | EXPT | N | Mean Rank | Sum of Ranks |
|---|---|---|---|---|
| Attitude | GEOGEBRA | 70 | 67.01 | 4691.00 |
| | WEBBASED | 70 | 73.99 | 5179.00 |
| | Total | 140 | | |

**Test Statistics[a]**

| | Attitude |
|---|---|
| Mann-Whitney U | 2206.000 |
| Wilcoxon W | 4691.000 |
| Z | -1.018 |
| Asymp. Sig. (2-tailed) | .308 |

a. Grouping Variable: EXPT