UNIVERSITY OF EDUCATION, WINNEBA

EFFECT OF MICROSOFT MATHS SOLVER ON THE MATHEMATICS PERFORMANCE OF SENIOR HIGH SCHOOL STUDENTS

ASAMOAH JUSTICE

2023

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(202113961)

A THESIS IN THE DEPARTMENT OF MATHEMATICS EDUCATION, FACULTY OF SCIENCE EDUCATION, SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PHILOSOPHY IN MATHEMATICS EDUCATION

AUGUST,2023

DECLARATION

STUDENT'S DECLARATION

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

Signature: ……………………………………………..………………

Date: ………..…….……………………………………..…………..

SUPERVISOR'S DECLARATION

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

Name of Supervisor: DR. Gloria Armah

Signature: …………………………..………………………………………

Date: …………………………………..……………………………………

ACKNOWLEDGEMENT

My sincere gratitude goes to my supervisor Dr. Gloria Armah for her patience, support, contributions and time spent in helping me despite her busy schedules. I extend a sincere gratitude and to my fathers, Rev Haystines Asante, Rev Eastward Bernard, Rev. Felix Asamoah and my lovely mother Mrs. Beatrice Asamoah for their tremendous support during the time of this research work. I also extend my gratitude to all the respondents as well as the authors and publishers of the various literature used.

Finally, I am grateful to my wife, Mrs. Martha Ataa Asamoah, who has been a backbone and a source of encouragement for me in my education pursuit. Akyede, as I called her, you are one in a million. To the entire members of Pillars of Christ World Outreach, I say a big thank you for your prayers and encouragement. God bless you all.

DEDICATION

I dedicate this research work to my dear wife, Mrs. Asamoah Ataa Martha for her unflinching love, provision, and dedication to seeing me come out successfully.

TABLE OF CONTENTS

Content **Page**

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The aim of the study was to investigate the effect of Microsoft math solver on the Senior High School students' performance in Quadratic Equation. The study employed mixed method design. A purposive, convenience and simple random was employed in selecting the sample for the study. A total sample of hundred and twenty (120) students were selected for the study from Bechem Senior High Schools (SHS) in Ahafo Region, Ghana. The participants were categorized as control group of fifty-eight (58) students and experimental group of fifty-eight (58) students. Three instruments were used to collect data on the effect of math solver on students' performance in Quadratic equation. A test (pre-test and posttest) was conducted. Questionnaires were given to the experimental group. Four students were interviewed after the intervention. The analysis of data was done using independent t-test with alpha value (α) = 0.05. The experimental group received teaching instruction using the Microsoft math solver while traditional lecture method was used to teach the control group by another instructor. Results revealed that there were significant differences, calculated t-value of 11.446 with degree of freedom of 114. This value was statistically significant at 1% significant level. The mean difference between the two groups was -30.07. This outcome indicated that indeed there was effectiveness in the treatment administered showing performance between control and experimental. This suggested that mathematics teachers and curriculum or textbook developers should introduce the use of the computer assisted instruction in teaching and learning of Quadratic Equation to improve students' performance in mathematics education.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter comprises the introductory part of the study which houses the background to the study and statement of the problem, the theoretical framework underpinning the study, the research questions, and hypotheses of which the research sought to answer, the purpose and significance of the study, and the delimitation of the study as well as the organization of the entire research work.

1.1 Background to the Study

Mathematics is one of the core subjects in schools, all over the world, which students are expected to study throughout their educational lives from the considerably basic level through to the secondary. According to Murugan and Rajoo (2013), Mathematics was designed to produce competent people with knowledge of mathematics in their everyday life and enhance effective problem-solving and decision-making among individuals.

Students' performance in mathematics is often considered necessary for the success of the students and the country. Therefore, the training and preparation of students to do well in mathematics have become a fundamental goal of education in most countries (Butakor, 2016). Several education systems all over the world, require students to have basic mathematical knowledge at early grade levels to progress to upper classes, secondary school, and further to tertiary institution

(Zakaria, Chin, & Daud, 2010). For instance, in the Ghanaian context, Senior High Students who undertake the West African Senior School Certificate Examination (WASSCE), are required to get a minimum of C6 (which is from 50% - 54%, representing a pass) in their core mathematics to gain admission into any tertiary institution in the country.

In a more recent time, the Trends in International Mathematics and Science Study (TIMSS,2019) which also utilizes nationally representative samples of fourth- and eighth grade students to test students' performances in mathematics and science, reports that students' performance in mathematics is falling. Students have to drop the mathematics courses and opt for the courses considered to be much easier and which students feel they can pass because of the difficulties associated with the study of mathematics. In the Ghanaian context, mathematics is one of the compulsory subjects at all levels in preuniversity education. This is intended to improve mathematical literacy and steer the country towards economic growth and development.

Moreover, due to its importance, the Government of Ghana is committed to ensuring the provision of a high-quality mathematics education (Agyei & Voogt, 2011). Various attempts have been made to improve the performance of mathematics in schools. The Government of Ghana in collaboration with various stakeholders in the education sector has introduced several initiatives to promote effective teaching and learning of mathematics, to make the subject enjoyable (Ampadu, 2012). According to Addae and Agyei (2018), the latest of these initiatives was the mathematics curriculum review in September 2010, buttressing the importance that the country attaches to mathematics education. Although the applicability of mathematics is wide and its importance undeniable, a lot of students consistently perform poorly in the subject. As a result, Ghana loses its economic advantage over other countries, attributed to the fact that its students lag behind their counterparts in Mathematics and Science.

Mathematics Performance (MA) has become a great concern for researchers, policymakers, educators, teachers, parents, and students globally. The mathematics performance of students from Korea and Japan has been high as compared to their counterparts. Evidently, they have been in the top-performing groups, represented in international academic assessments, including Programme for International Student Assessment (PISA) (Organisation for Economic Cooperation and Development, 2004). On the other hand, American students were observed to perform poorly in international assessments irrespective of the good educational support systems in their schools (Shin, Lee & Kim, 2009).

Shin et al. (2009) pointed out that one key outcome that determines the effectiveness of an educational system in a country is academic performance. However current educational researchers are concentrating more on comparative studies on academic performance as means to ascertain factors that will improve students' academic performance in their nations. Available statistics from the West African Examination Council (WAEC) in Core Mathematics performance revealed that performance is not encouraging looking at the following percentages of candidates who passed the paper.

Table 1.1: statistics from the West African Examination Council (WAEC) on core mathematics performance

Year	2006	2007	2008	2009	2011	2012	2013	2014	2015	2016	2017	2018	2019
%Passed	32	25	26	29	44	50	37	48	24	34	42.73	38.33	65.3

Source: MOE ESPR, 2019; figures are in percentages.

N/B: There is no result for 2010 because the educational system was changed from 3 years to 4 years so students did not sit for exams that year.

The persistent below average performance of students in the Core Mathematics paper calls for concern since a pass in the discipline is a basic requirement for any student who would want to progress from the secondary level to post-secondary or tertiary levels.

Several reasons have been identified to be underlying factors of underperformance in mathematics among high school students (Saritas & Akdemir, 2009). In addition, several factors have been developed to explain the reason for the overall poor performance recorded in mathematics at all grade levels. A major factor could be that the approach to teaching has fallen short of achieving its desired objectives as far as students' performance is concerned. A study has revealed that the method of teaching has a great influence on performance. Mucherah (2008) noted that poor teaching methods employed by teachers in teaching also influence students' performance. It is assumed (in many policy documents, amongst others European Commission, 1995; ERT, 1997; Panel on Educational Technology/PCACT/PET, 1997) that a shift from teacher-controlled towards more student-controlled arrangements of the learning process can be facilitated by ICT.

Pelgrum and Polmp (2008) considered western economies could be characterized as 'knowledge' because cognitive activities have been taken over by computers and other ICT applications making ICT part and parcel of the citizenry of the advanced countries. Ghana, like most of the developing countries, cannot afford to be left behind in this era of "educational technology". Therefore, the Government of Ghana placed a strong emphasis on the role of ICT in contributing to the country's economic development. Besides, the Government of Ghana in collaboration with other stakeholders of education has targeted a large share of their budgets to make computers more available in schools (Mangesi, 2007). As part of the collaboration, the Government of Ghana with the help of the Government of India has established the Kofi Annan Centre of excellence in Information Technology. This center seeks to promote education and usage of ICT in line with the country's developmental agenda. The Curriculum Research and Development Division, (CRDD, 2007) also acknowledged the importance of ICT in our modern world and believes that it is imperative for every young person to be competent in the use of ICT, therefore, the teaching and learning of ICT have been enshrined in the education system. Thus, the teaching and learning of ICT will start from the basic level. To make this idea effective, ICT teaching syllabuses have been designed for pre- tertiary levels of our educational system. The government of Ghana has invested huge sums of money in procurements of computers and the establishment of computer labs in most Colleges of education (Ghana ICT4AD Policy, 2003).

The new curriculum in mathematics encourages teachers to make use of the calculator and the computer to help students acquire the habit of analytical thinking and the capacity to apply knowledge in solving practical problems (Ministry of

Education, Science, and hSports [MOESS], 2007) but it is still unclear whether these computers are being used effectively by teachers in their instruction. Until now the potentials of ICT have hardly been utilized in education (Pelgrum & Plomp, 2008). In Ghana, the traditional method of teaching is used during mathematics instruction. There is a call to examine the effectiveness of the ICT to the poor mathematics performance. According Merriam-Webster (n.d.), Computer-Assisted Instruction (CAI) is the use of the computer as a tool to facilitate and improve instruction. It is an interactive technique whereby a computer is used to present learning materials and monitor the learning that takes place (Iqbal, 2009). Other terminologies used for computer-aided instruction are Computer Assisted Learning (CAL), Computer-Based Instruction (CBI), Computer Enriched Instruction (CEI), Computer Managed Instruction (CMI) etcetera. Nwafor (2015) pointed out that CAI are lessons delivered through Computers without constant teacher instruction. Computer-Aided Instructions are now commonplace, and they are becoming more diverse. Some CAI includes computer visualizations of objects, guided drills, and exercises. The Encyclopedia Brittanica (2014) pointed out that the use of Computers in educational instructions provides one-on-one interaction with students, as well as an instantaneous response to answers. In the opinion of Igwe (2003), Education has improved through the process of Computer Assisted Instructions.

An American philosopher, psychologist, and education reformist, John Dewey, stated in the early 1900s that, if we teach today as we taught yesterday, we rob our children of tomorrow (Dewey, 1916). Studies have indicated that an up-to-date method of teaching, computer-aided instruction (CAI) can be a valuable supplementary aid used to improve student performance. "The need for improvement of student performance has been the focus of many plans in education for many years" (Patterson, 2005, p.311). "Teachers are challenged daily by students who don't seem interested in learning" (Muir, 2000, p.135). The need to improve all student performance warranted the necessity to research and thus develop a possible method of improving student performance through improving student motivation. "The more the student is motivated to learn, the more involvement there will be in the learning process" (Reis, & McCoach, 2002, p.113). Motivating students through the use of computer technology is one strategy often utilized in education. The use of computer technology to supplement traditional instruction is not a recent development. Computer-based teaching and learning produced positive effects in the classroom. Students seemed to be motivated by learning through Computer-based approach (Forcier, 1999). Educational technology had a large impact on student performance (Reis, & McCoach, 2002 p.125).

Traynor (2003) argued that CAI programs increase student learning by increasing motivation. Muir (2000) believed strongly in the push for change in educational learning through technology. If we are serious about educating every child, we must venture to absorb every child in meaningful, engaged learning. Regardless of whether we want children to learn to be learners, or whether there are specific content and skills we value and want students to learn, we must use teaching strategies that more closely match how our students learn (Muir, 2000). Educators needed to rethink the way they taught based on the changes in technology that contributed to 21^{st}-century culture (Coates et al., 2007). Prensky (2010), American writer, speaker, and inventor of the term "Digital Native," believed that by teaching students in the manner in which they have grown up learning, students would be motivated to learn and thus an increase in student academic performance would occur.

Algebra which has general applications in science and engineering is used to help solve complex problems in supplement other mathematics aspects. Algebra is part of mathematics. Algebra plays an important role in the curriculum in almost all disciplines, such as engineering, science, business, economics, computer science, and information system. Algebra concepts are arranged in a systematic, logical, and hierarchical manner from the simplest to the most complex. In other words, understanding and mastery of a concept are a requirement to recognize the further concept. Therefore, naturally the mastery of Algebra is essential in learning. However, many students make algebra a trouble in the learning process. Algebra as part of mathematics has an abstract object that most students are not able to imagine the object. Based on the researcher's experience in the tuition on the second-year students in the department of mathematics in the Presbyterian senior high school, Bechem, knowing that most of the weaknesses of students are only unable to perform simple calculations. This problem is a challenge for teachers to find out alternative solutions in learning algebra not only to attract and motivate students, but more to provide prospects for students to develop skills in understanding, reasoning, and problem-solving. Learning which applies the use of computer can be a solution to these problems. Several computer programs can be used as a tool for interactive and dynamic learning to help students master the ability to solve algebraic problems in academia and all aspects of life.

To enhance mathematics performance in Senior High Schools, it is paramount to integrate ICT software that are geared toward the performance of such goals. Microsoft Mathematics program is free software made by Microsoft Corporation that has a symbolic computing system and works based on mathematical expressions. Microsoft Mathematics as mathematics computing software is appropriate to utilize in assisting students to solve the problem of Algebra, Statistics, Calculus, and Trigonometry. In Mathematics learning, many kinds of software can be used such as a) SPSS, which is software that is used for analyzing statistical data. b) GeoGebra, is a software that is used for geometry, algebra, and calculus in geometry, c) Microsoft Mathematics solver, it is a software that is used for arithmetic problems, matrices, statistics, linear algebra, trigonometry, and some problems involving physics and chemical formulas.

A study by Rizki and Widyastuti (2019) reveals that the media in form of Mathematics materials by using Microsoft Mathematics solver are feasible to be used as learning media to increase students' learning motivation. Another research by Suryacitra and Oktavia (2019) concludes that the use of the Microsoft Mathematics program can improve students' accuracy in solving the multiplication problems of two matrices. This software by its modules is designed to make the teaching and learning of Algebra very simple for both teachers and learners.

1.1.1 Statement of the Problem

The positive performance of students with respect to mathematics represents one of the desired outcomes in any educational system. Individuals all around the world encounter different challenges with respect to various disciplines of study, and mathematics is not an exception. The growing decline in mathematics performance (with few making progress) worldwide is of concern to stakeholders (TIMSS,2019). In Ghana, for instance, the growing inconsistencies in mathematics performance, as reflected in the country's Basic Education Certificate Examination (B.E.C.E) and West Africa Senior School Certificate Examination (W.A.S.S.C.E), leave much to be desired (Bofah & Hannula, 2015). Although the year 2019 saw a significant improvement in mathematics performance rate in the WASSCE taken by senior high students in the country, mathematics performance has generally not been encouraging.

Considering the negative trend with respect to performance in mathematics, researchers in the country have given the issue much attention so as to conduct studies on the subject matter in order to get to the root cause of these inconsistencies in the mathematics performances. To this end, various new models of education are evolving in response to the new opportunities that are becoming available by integrating ICT, and in particular Web-based technologies, into the teaching and learning environment (Bateman,2008, as cited in African Virtual University ,2012). A study on the relationship between contextual factors and mathematics performance by Ampadu, Butakor and Cole (2017) revealed that the variations in mathematics performance of students is mainly attributed to factors within the school. The study posited that the poor performance of Ghanaian students in mathematics is at least partially the problem of teacher's inadequate preparation, emphasis placed on lower rather than higher thinking skills, conflicting use of homework, failure to actively engage students in learning, lack of progress of girls, lack of usage of ICTs, among others. Another research by Ampadu (2012) on student's perceptions of their teachers teaching of mathematics revealed that students' perceptions of their teachers varied, as the results established that both teacher-centered and student-centered approaches were used by mathematics teachers. The study revealed also that teacher's ability to implement ICT into teaching impacted positively and negatively on students learning experiences. In addition to the above, Butakor (2016) also revealed that factors like students' gender, educational aspirations, self-confidence in mathematics, value for mathematics, and frequent use of some ICTs were significant positive predictors when it comes to mathematics performance. A further study by Asiedu-Addo, Apawu and Ansah (2016) revealed that the usage of ICTs in the teaching and learning of mathematics influences students' performance in mathematics. In this study, it was posited that most teachers agreed or strongly agreed to the positive effects the use of ICT has on students learning outcomes. Upon the growing need for technology use in mathematics, much research has not been conducted in this field and according to Agyemang and Mereku (2015), before Ghana and Africa can fully integrate technology into teaching and learning, there has to be adequate data on ICT use.

A clarion call is now placed on teachers of mathematics to introduce appropriate technological tools into their teaching and to encourage students to use them in learning the subject. The problem is that while secondary mathematics performance in Ghana is low, and current literature calls for better interventions to increase math performance through the integration of ICTs (Agyemang & Mereku, 2015), little is known about the effectiveness of computer-assisted programs designed to increase math understanding in the context of specific mathematics topics.

In the foreign context, Eglash et al., (2013) investigated students use of computer assisted instruction and mathematics performance and revealed that students use of computer assisted instruction in mathematics have an effect on their capability of learning and understanding of mathematics related to the mastery of the subject and mathematics utility. Furthermore, the study revealed a relationship between students' perception of reform use of computer assisted instruction in their mathematics classroom and mathematics efficacy. Shin et al. (2009) conducted a study into student and school factors affecting mathematics performances, whereby a comparison between Korea, Japan and USA was made. The finding of the study revealed that factors such as student and school level, competitive learning preference, mathematics interest, school disciplinary climate, student –teacher relations, the use of computer assisted instructions etc. constitute some of the predictive factors of students' performance in mathematics. Students worked after school or in alternate classroom settings with computer-based learning programs as supplements to instruction reported the largest gap in math performance at the high school level (De Witte et al., 2014; Wilder & Berry, 2016). Lai et al.,2012 studied computer assisted learning programs and findings had a favorable result for programs such as My Math Lab (MML), ALEKS, and more in the university level , but much hasn't been delt with at the senior high level. However, available studies lack information on the application of computer-assisted learning programs at the high school level and on specific topics.

Although a lot has been researched into the use of Microsoft Maths Solver on students and its impact on mathematics performance in Ghana as positive, these studies have not adequately explored the effect of Microsoft Maths Solver which account for various performance of students in mathematics. Moreover, these studies explore the Microsoft Maths Solver in mathematics of students from a generalised perspective without looking at it from specific dimensions of various mathematical topics in senior high like algebra, trigonometry, geometry, set problem, calculus etc. Again, Microsoft Maths Solver as instructional tool used in those mathematical concepts that influence students' mathematics performance have not been investigated thoroughly, especially in Ghana. It is upon this backdrop that researcher has chosen to investigate the effect of Microsoft Maths Solver on the mathematics performance of SHS students in Quadratic Equation.

1.2 Purpose of the Study

The purpose of the study was to find out the effects of Microsoft Maths Solver as a strategy on the academic performance of (SHS) students in mathematics.

1.3 Research Objective

The objectives of this research are to:

1. Examine the effect of Microsoft Maths Solver on SHS students' performance in Quadratic Equation.
2. Determine the perception students have on the use of Microsoft Maths Solver in the learning of Quadratic Equation.
3. Examine the gender difference in the performance of SHS students in the learning of Quadratic Equation using Microsoft Maths Solver.

1.4 Research Question

The following research questions will guide the study:

1. What is the effect of Microsoft Maths Solver on SHS students' performance in Quadratic Equation?
2. What perception do students have on the use of Microsoft Maths Solver in the learning of Quadratic Equation?
3. What is the gender difference in the performance of SHS students in the learning of Quadratic Equation using Microsoft Maths Solver?

1.5 Hypothesis

H_0:

1. There is no significant difference in the academic performance of Senior High School Students taught with Microsoft Maths Solver and those taught with the conventional method in mathematics.
2. There is no significant difference in the academic performance between males and females who were taught Quadratic Equation with Microsoft Maths Solver.

1.6 The Significance of the Study

The aim of any good educational system is to inculcate into learners values, which would enable them to become useful to society. Since society is dynamic, the development of new strategies and techniques by educators has greatly improved teaching methods.

Mathematics teachers and educators have been inspired by these desires to carry out research work in various aspects of the subject to improve teaching and learning.

The researcher believed that this study would bring to light how students have conceptualized the concepts of quadratic equation using Microsoft math solver. This will help enhance the efforts being made by education stakeholders to help improve upon the problem of poor performance of students in mathematics at the Basic and the SHS levels. The findings' hope is to encourage mathematics teachers to modify their teaching style to meet current trends for students to benefit from what they are taught and end up becoming useful to themselves and to the nation as a whole. Students will also become confident and self-motivated in their learning when they understand the concepts they are studying.

It was further anticipated that students will benefit from this study since the findings will help them redirect their learning to be able to fit into the information age and make meaning of whatever information they come into contact with. Students will again develop interest and become more courageous in solving any quadratic related problems. Most importantly, the results of the study were projected to contribute immensely to knowledge and update those that have been done earlier and serve as resource material for all stakeholders and others who would like to research further into this area of national interest.

1.7 Delimitation

The study is delimited to the students of two schools in the Tano South Municipality of the Ahafo Region of Ghana. Two intact classes in the second-year class were used for the study. The main rationale for using the second-year students was that the topic for the study was within the scope of the first-year mathematics curriculum and by then the second years would have dealt with such topic.

1.8 Limitations of the study

In Educational Research, large data cases increase reliability of the information that is gathered. Therefore, it would have been proper to cover the entire form two senior High School students of Tano south, Municipality, Bechem, but due to the organization of the schools in the municipality of which are further away from each other making reaching out difficult and in view of other constraints such as time and funds, the study was restricted to cover only two intact classes in the second-year class of Presbyterian Senior High School, Bechem.

1.9 Organization of the Study

The study is divided into five main chapters. Chapter One, the introduction, discusses the background and statement of the problem, the purpose, the research objective, the research questions and hypothesis that the research sought to answer, and significance of the study, and the limitations and delimitations of the study and the overall organization of the research. Chapter Two presents a thorough review of the literature on the effect of computer-assisted instruction. Chapter Three also presents the methodology applied in the study; the population of the study, sampling and sampling techniques, research design, how data is collected and analyzed. Chapters four and five is summarize, discuss and draw conclusions and recommendations on the results of the study

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter deals with the review of related literature of the study. The theoretical framework of the study as well as what other researchers have written on the effectiveness of computer-assisted instruction on SHS students' performance in mathematics are discussed. The section also gives a kind synopsis of gender differences as far as mathematics performance is concerned and also extends to the attitude of students toward mathematics that has resulted in a different side of mathematics performance over years.

2.1 Theoretical Framework

The theoretical framework is a collection of theories that support research (Ofori & Dampson, 2011). Therefore, the theory supporting this study is the Constructivist theory of teaching and learning mathematics. In Constructivist learning theory, the learner is the source of meaning. This means that the knowledge already exists and is out there, but it is the learner's responsibility to discover it. According to this theory, learners do not just receive information inertly but continuously generate new knowledge based on previous knowledge in conjunction with the new experiences they had (Hmelo et al.,2007).

Jean Piaget is the main pioneer of constructivism and is credited with its development. Constructivism focuses much on a learner's ability to mentally construct meaning of their own environment and to create their own learning (Quay, 2003). Knowledge from a constructivist perspective is viable and adaptive. Piaget stated that for new knowledge to be constructed in the learner's mind, cognitive conflict is essential (Kretchmar, 2019). Cognitive conflict is caused by disequilibrium and the need to maintain equilibrium which according to Piaget steers all learning (Kretchmar, 2019). Therefore, cognitive conflict is essential for new knowledge construction. New information can fit into existing mental structures through assimilation, which is mostly an unconscious process. However, when knowledge or experiences contradict prior knowledge or experience the learner must accommodate what is known. From the constructivist approach, learning only occurs through the process of accommodation (Kretchmar, 2019).

As a teaching practice, constructivism is associated with different degrees of nondirected learning. Constructivists believe that all humans can construct their own knowledge in their own minds through a process of discovery and problem-solving. During this process, students use background knowledge as well as skills learned from the teacher to discover new information (Tam, 2000). This process aligns with Microsoft math solver instructional model that includes the rotation of two groups. During the approximately time group instructional session, the teacher focuses on building understanding, reasoning, and communication skills. During the approximately time personalized software session students receive additional instruction and scaffolded practice with routine and non-routine problems using Microsoft math solver adaptive software program, which promotes problem-solving and discovery learning (Scholastic Corporation, 2014). Piaget and other constructivists emphasize much on learning as an active process. Meaning that by reflecting, analyzing, questioning, and working on problems learners develop their structures of knowledge. Piaget also emphasizes how important prior knowledge is in the learning process. Constructivists emphasize that prior knowledge is the foundation on that new knowledge is built. With these ideas, a constructivist classroom is learner centered (Kretchmar, 2019). The idea of a learner-centered classroom also aligns with Computer Assisted Instruction, which promotes student agency by giving students access to their recent performances and instructional zones. By continuously correcting data and sharing that data with the students, students can witness their progress, which gives them a voice in their own learning (Scholastic Corporation, 2014). Constructivism infers that students should be more responsible in the learning process and that they learn through interactions between their experiences and ideas (Tam, 2000). Social constructivism as outlined by Lev Vygotsky complements Piaget's cognitive constructivism therefore many believe that learning is a cognitive and social process.

Social constructivism focuses more on how culture, language, and social interaction aid in knowledge construction. Vygotsky differentiates between the construction of spontaneous concepts, which are developed during everyday activities, and the construction of scientific concepts, which are developed in more formal settings such as the classroom (Kretchmar, 2019**).** With computer-assisted instruction, students receive individualized instruction and rewards that assist in motivating the learner to achieve more. Tam (2000) related constructivism to the construction of technology-supported learning environments. The author explored how constructivism theory and education technology combined to transform learning through technology from a highly industrialized mass production model to one that emphasizes the subjective construction of knowledge and meaning derived from individual experiences (Tam, 2000). In the constructivism framework, classrooms provide learners with the opportunity to observe, work, explore, interact, and raise questions that align with Microsoft Maths Solver in the ways described. This learner-centered approach allows learners to uniquely construct knowledge based on their experiences through active participation of students in using Computer Assisted Instruction in learning mathematics. This contradicts behaviorism in which the learner is considered a subject as opposed to an active participant (Singh & Yaduvanshi, 2015).

2.2 The Computer-Assisted instruction

Computer-assisted Instruction integrates computers for positive results in the educational process for mathematics, where students can identify their deficiencies and performance level through mutual interaction with the software (Demir & Basol, 2014). Another similar name for this is that it is used by practicing educators and interventionists in a computer-based supplementary instructional support program (CSISP). Integrated with RTI theory, CSISP allows teachers to tailor instruction to students' individual needs and track progress accurately. CSISP delivers highly and correctly-targeted instruction and practice, which allows students to gain knowledge and confidence that the knowledge gained is correct (Burns et al., 2012).Much like CSISP, computer assisted learning can refer to software used in the general education classroom that is not specifically tailored to an intervention (Demir & Basol, 2014). Universities have studied computer-assisted learning programs and findings have favorable results for programs such as My Math Lab (MML), ALEKS, and more (Lai et al.,2012). Computer-assisted learning programs also bring the focus back to the student. During a time when there is a disproportionate number of students to teachers, these programs increase the individualization of the educational process (Demir & Basol, 2014). This is also important in schools that have a large population of students with learning disabilities or economic disadvantages (Vilardi & Rice, 2014). This also makes computer-assisted learning ideal for online schools, as the programs can target key weaknesses and give the students rich feedback (Demir & Basol, 2014). MML and Math XL, the secondary counterparts, offer multimedia instructional videos and resources, and practice exercises where students can determine how many problems to practice, homework assignments, and tests. The program allows students to try on homework and practice problems before assigning a new problem. This allows time for students to find their mistakes. Once an incorrect answer registers in the program, it gives suggestions to the student on how to obtain a correct answer (e.g., formulas, explanations). After some attempts, it shows the correct answer. Outside of a test, it allows the selection of a similar problem to try again. There are also helpful tools that can help a student with a problem. In the homework and study plan, students can get guided steps to solve a problem using the' Help Me Solve This' button. This takes them through the problem systematically and allows them to type in their answer for each step. This allows students to find their own mistakes and will make the mistake memorable to not repeat them again (Kodippili & Senaratne, 2008). Computer-assisted instruction also allows students to organize and direct their education and remediation of concepts. As the programs adapt to the learner, the student can realize any deficits in their learning and organize studying based on the program feedback. Benchmark assessments are given or the computer tracks the student as they move through assignments to flag areas of improvement. This gives students a sense of ownership in their education. Additionally, more disadvantaged youths experience equal educational opportunities, which may include better opportunities than presently offered in their environment. Disadvantaged students often suffer from a lack of access to high-quality educators, strong textbooks, and other beneficial resources for their education. Due to these benefits and others, many schools opt to invest resources and funds into computer-assisted Instruction programs (De Witte et al., 2014). N. Pulkein (personal communication, October 25, 2016), the head of the RTI program for a nationally based online school, explained that these benefits are also why the company has chosen an entire suite of software options for math intervention from the kindergarten level through high school. A distinctive aspect of online schools includes being uniquely equipped to use computer-assisted technology in their respective learning management systems. As the students are currently online, technology does not act as a roadblock for students accessing the programs and properly interacting with them. The online school has vetted an assortment of programs to use with students and claims to see strong gains for those students who engage in the program. The program used at the secondary level is Pearson's Math XL, which is a sister program to MML and a family of the CAI (N. Pulkein, personal communication, October 25, 2016). Kodippili and Senaratne (2008) concluded that while there was no significant difference between those students who used MML and those who did not use MML regarding performance in college algebra, there is a significantly higher percentage of grades in the A, B, and C range for those who completed the online homework. This is one of a handful of studies that used MML but are all at the university level. When asked about empirical evidence regarding the Math XL program, it was indicated that it had not been presented with evidence, but that it aligned with their textbook, as it was created by the same publisher (N. Williams, personal communication, October 25, 2016). The preceding reinforces the idea of a lack of peer reviewed empirical data to support the use of computer-assisted learning in traditional or online classrooms. Despite the lack of evidence, hosts of online secondary schools are implementing programs without empirical evidence as to which ones truly benefit students or whether the academic gains justify the steep prices. To determine true academic gains or losses, more research should be performed regarding the use of computer-assisted learning. While it may be more convenient and require fewer faculty, not much is known about the outcomes from an academic standpoint of mathematics.

In addition to the lack of research at the secondary level, it should be noted that more postsecondary educational institutions use a similar computer-assisted learning program for remedial or developmental math courses. The rationale behind this includes a wide variety of reasons such as self-paced instruction, lack of available faculty to teach the course, grading challenges with large student populations, and a wide variety of student educational backgrounds. At the university level, the course management system is the most utilized feature that allows the instructor to design the program course. Although some schools use a prescribed shell, other schools do allow some freedom in course design. Students can then take advantage of the various helpful tools in the software to complete assignments successfully. This is also graded quickly by importing scores and lowering the burden on teachers. This in turn allows larger class sizes to ease the financial burden on universities. Even if a student does not directly require a computer-assisted learning program for intervention, he or she will likely encounter it in postsecondary education (Vilardi & Rice, 2014).

2.3 Effective Integration of Technology in Mathematics Instruction

Technology can play a role in enhancing mathematical thinking, student and teacher discourse, and higher-order thinking by providing the tools for exploration and discovery (Bitter & Hatfield, 1998). Research has revealed that using computers for higher-order thinking has a positive effect on performance, but using computers for just drill and practice, a lower-order skill, has a negative effect on academic performance (Wenglinsky & Educational Testing Service, 1998). This suggests that technology itself positively affects academic performance, but it depends upon how the technology is used. This section will explore the different instructional approaches to using technology to improve student performance.

Instructional technology is defined as mechanical, technical, or electronic tools that may be used to improve the learning environments in mathematics classrooms (Johnson, 2005). This definition of technology emphasizes technology as a tool and resource, which suggests that the way technology is implemented in a learning environment, can improve learning outcomes. A common thread in the research presented above is that when technology is integrated into problem-solving environments and used to make meaning in mathematics, student improved performance is realized.

As technology first became widely available in the 1980s, Becker and others (1990) conducted a large, two-year nationwide study to provide a detailed credible look into the effects of computer use in the mathematics classroom. The study explored mathematics instruction in grades five through eight in more than ninety classrooms. They found that mathematics teachers were less likely than English teachers and elementary teachers to use computers regularly to support student learning. Both elementary teachers and mathematics teachers who used computers were most likely to use them for skill remediation through games. Bitters and Hatfield (1998) reported that computers were often an add-on used when time permitted. It was not consistently used to support a meaningful approach to learning. These studies, though somewhat dated, indicated that much inconsistency in how computers were used in mathematics classrooms was evident.

More recently, research has focused on connecting the quantity of computer use to student performance. For example, Middleton and Murray (1999) conducted a study of 107 teachers and scores from over 2000 of their fourth- and fifth-grade students and found that teachers' quantity of technology use impacted mathematics performance with a positive correlation between increased use and student performance. This study, however, did not distinguish between the type of technology (computers, video tutorials, or presentation software) used related to the higher mathematics performance scores or whether the teacher's used technology for skill or concept development (or both).

Increased quantity of use does not always influence student performance. Papanastasiou and Ferdig (2006) found that quantity or overall comfort did not contribute to increased student performance. Instead, they reported only word processing had significant effects on students' mathematics performance. Other instructional activities such as spreadsheet creation and the use of educational software had positive effects, but these effects were not statistically significant (p=0.02 and 0.08 respectively). This study used data from the 2000 Program for International Student Assessment (PISA). Scores from 35 randomly selected students indicated that students who reported being very comfortable with computer use did not necessarily exhibit high mathematics performance. They suggested this finding was due to the nature of computer use. For example, students who used the computer to draw, paint, use art programs or play games performed better. Papanastasiou and Ferdig (2006) concluded, "the passive or mechanical use of the computer alone does not highly correlate with an increased academic growth" (Papanastasiou & Ferdig, 2006).

Research on the comparison of CAI and traditional paper-and-pencil has suggested that the connection between computer use and performance is weak, especially when used for just skill practice or procedures (Guerrero et al., 2004; Lin et al., 1994; Tienken & Maher, 2008; Tienken & Wilson, 2007). Guerrero (2004) argued that the use of technology to teach mathematics could undermine students' computational skills. When technology is used well in middle grades mathematics, it can have positive effects on students' attitudes towards learning and conceptual understanding. Evidently, the proper use of technological resources remains the key to improved student performance.

In 2008, Tienken and Maher reported a study on eighth-grade students who practiced skills using paper and pencil and those who practiced skills using CAI In measures of the 121 students, the CAI group showed minimal gains over the paper-and-pencil group. However, in a previous study, Tienken and Wilson (2007) measured the use of technology for active learning. Active learning was defined as a) when learners construct their meaning; b) new learning builds on prior knowledge; c) learning is enhanced by social interaction, and c) meaningful learning develops through "authentic tasks" (Cooperstein & Kocevar-Weidinger, 2004). In this study, the authors found that the CAI group performed significantly better than the control group. Both studies examined the effects of using technology to teach skills but the instructional approach was different. In Tienken and Maher's (2008) study, students participated in computerized drill and practice, and in Tienken and Wilson's (2007) study students used computerized drill and practice and then used a presentation software to present their learning to the class. The latter was more of a constructivist approach. These findings have implications for technology use and demonstrate that the mere integration of CAI in instruction does not necessarily improve learning. However, when technology is used for active learning in combination with skills practice, it can have positive effects on student performance (Tienken & Maher, 2008; Tienken & Wilson, 2007).

The effects of using technology for active learning were found in both third- and ninth graders in studies by Xin (1996) and Scheiter et al. (2010). In both cases, students engaged in mathematics problem solving enhanced by computer animation. Students who learned to solve problems in the computer-enhanced environment performed better on similar and unrelated problems.

Just as knowing how to integrate technology effectively into instruction is important, Handal,et al. (2006) noted the importance of selecting appropriate CAI materials. After reviewing over 500 mathematics education websites, they proposed that:

a) online mathematics resources should be written at the appropriate reading level; b) graphics should be organized, uncluttered, and not distracting; c) the applet should contain a feedback component so students know when they have made errors; d) and directions should be clear and easy to understand. Not surprisingly, the researchers also noted that online resources created by professional organizations typically offered the best instructional design.

Overall, the literature suggests that the amount of time students use a computer does not matter as much as the types of activities students engage in while on a computer. When activities focus exclusively on mathematical skills or using computer games as a reward, there seems to be little impact on performance. Instead, the use of technology for active learning seems to positively affect performance. In order to integrate technology into mathematics teaching and learning effectively, teachers should create a technology-based learning environment that provides students with opportunities to experience the process of mathematical investigations through the efficient use of technology. Teachers should also be mindful of the technology they choose and of the purpose, they want technology to play in instruction. In some cases, technology can be used to enhance a topic that students might find uninteresting, help them be successful with procedures, or better understand a concept. When this happens, some would suggest that students' attitudes toward mathematics become more positive (Presland & Wishart, 2004; Reed et al., 2010; Reimer & Moyer, 2005; Tienken & Wilson, 2007; Van Eck, 2006). The next section will discuss the impact of technology on mathematics attitude and some of the complexities regarding this research topic.

2.4 Equity through Computer-Assisted Instruction

Computer technology is often proposed as an option to improve educational opportunities and outcomes, especially with low levels of mathematical proficiency (Barrow et. al, 2009). In the USA, schools with a high percentage of students from low-income households are supported with school-wide initiatives to improve student outcomes and lessen the gap in student performance (Phillips, 2019).

Computer-assisted instruction (CAI) has become a popular education technology as the internet and computer become increasingly popular over the last few decades. The first country to study computer-assisted instruction was the United States in 1958. It was not until the 1990s that CAI caught the interest of the majority (Guo, 2018). At that time universities and companies started working on the development and generalization of computer-assisted instruction software and saw that CAI could meet the needs of the education field (Guo, 2018). Computer-assisted Instruction involves using computers to assist in providing instruction. The software CAI uses presents learners with information and guides the learner through instructional goals and checks their progress along the way. It is important to distinguish CAI from Computer-Based Instruction (CBI) even though there is some overlap. Unlike CAI, CBI also refers to instruction that can fully replace the teacher (Hamilton, 2019). CAI has been found to make learning more engaging by shifting learning from being teacher-centered to student-centered. CAI enhances learning by being an interactive process that helps learners reach designated instructional goals and improve education outcomes (Usman & Madudili, 2020). CAI is characterized by learner-controlled instruction, prompt feedback, self-pacing, and adaptability (Usman & Madudili, 2020). Features of CAI include personalizing information to increase students' interest in the tasks and providing an organized sequence of materials (Sharma, 2017). In addition, there are several features of CAI that have been shown to increase student learning. CAI increases student learning by providing creative context and by providing practice activities that are challenging to students and stimulate their curiosity. Creative context increases student learning by allowing learners to make their own choices about their learning which increases students' motivation (Sharma, 2017). CAI also provides students with a "locus of control" which means that students have more control over their learning experience and the pace at which they teach (Hamilton, 2019). Students can also be confident in their progress because CAI offers frequent and often immediate feedback increasing their locus of control. Locus of control is a concept that refers to how much control individuals believe they have over what happens to them (Keenan, 2020). Some individuals have more of an internal locus of control and others have more of an external locus of control. An individual with an internal locus of control believes that what happens is a result of their own abilities, efforts, and actions. An individual with an external locus of control believes that what happens is outside of their control. It has been found that individuals with more of an internal locus of control are more likely to do well academically (Keenan, 2020). By allowing students to progress through instructional goals at their own pace CAI prevents students from getting bored or lost because a teacher is moving too slow or too fast, respectively (Hamilton, 2019). CAI allows for students to stay on a learning objective if they need to develop mastery before moving to the next objective. Students who master a concept at a faster pace benefit as well because they can move to the next concept sooner (Hamilton, 2019). Customized instruction like this allows for more complete learning and is referred to as Mastery Learning (Ungvarsky, 2020). Technology supports students' mastery of concepts at each level by allowing students to repeat activities until they understand (Saveg-Sanchez & Rodriguez, 2020). Benjamin S. Bloom created the concept of Mastery Learning four years after he developed Bloom's Taxonomy. This was during the same time that efforts were being made to eliminate inequities in education and many other areas (Ungvarsky, 2020). Bloom proposed that the traditional classroom in which teachers lectured, provided students with an opportunity to practice and then assessed before moving to the next concept contributed to differences in academic performance. To help students achieve better results Bloom suggested a more individualized approach, which he named mastery learning (Ungvarsky, 2020). John B. Carroll also believed that all students are capable of learning, some just need more time than others. He is considered a contributor to the concept of mastery learning (Ungvarsky, 2020). The CAI allows students with opportunities to have a feel of what they learn, thereby making them see mathematics as non-abstract.

2.5 Research on Computer-Assisted Instruction

Every Student Succeeds Act (ESSA) calls for districts and schools to use evidence-based activities, strategies, and interventions to increase the impact of investments. With the limited resources in education, it is important that educational activities, strategies, and interventions intended for education improvement are effective (Herman et al., 2017). Computer-assisted instruction (CAI) is a popular choice as countries seek to improve low levels of mathematical proficiency (Barrow, Markman, & Rouse ., 2009). According to Berrett and Carter (2018) CAI "is any type of computer technology designed to display instructional material and monitor learning progress in any educational topic" CAI can offer highly individualized instruction and allow students to work at their own pace which is why it may be more effective than traditional classroom instruction (Barrow et. al, 2009).

2.5.1 Computer-Assisted Instruction in the 2010s.

Researchers focusing on CAI argued that findings of the 1980s and 1990s were irrelevant today in our technologically enhanced world (Roseann, Salminen, Wilson, Aunio, & Dehaene, 2009; Jenks & Springer, 2005). In fact, effect sizes for studies measuring the effects of CAI on performance have improved as the published year increased (Fletcher-Flinn & Gravatt, 1995). For example, in 1985, Fuson and Brinko's (1985) study found no difference between drill-and-practice CAI and flashcards when elementary students were learning basic facts. However, at the time, the CAI interface only displayed the numeric equation with a question mark in place of the answer, and this interface greatly resembled the flashcards used in the study. Today's CAI has interactive tutorials, with virtual manipulatives built into the programs, and targets student misconceptions based on sophisticated answer-pattern-response systems.

CAI has changed dramatically since researchers first began to study the impacts of these learning environments. For example, a 1990 study that investigated the effects of embedding drill and practice in a video game revealed that the game was distracting to some students (Christensen & Gerber, 1990). However, Tsung-Yen and Chen (2009) found that a more visually stimulating interface improved student performance. In their study, third graders participated in a more traditional CAI interface with text-based instructions and few graphics than with a 3-dimensional video-game-like interface. The results revealed students who participated in the video game interface performed better at both lower-level cognitive tests such as matching and higher-cognitive tests such as application (Tsung-Yen & Wei-Fan, 2009). As these studies suggest, improvements in CAI interfaces and video games have led to software that is less distracting and has more potential for monitoring and supporting student learning; however, more research is needed to determine if these effects hold true for struggling students and have the potential to improve their mathematics performance.

2.5.2 Limitations in using Computer-Assisted Instruction

CAI also has several limitations, one of which is the cost of CAI programs (Sharma, 2017). According to Hamilton (2019), two major issues of concern for public school policymakers that relate to cost are the cost of the hardware and software and the cost of training teachers. As with most technology, CAI programs may become outdated which would make the resources devoted to the program a waste. Getting teacher buy-in may also be a challenge. Teachers may fear new technology, may not want to devote extra time to learn to use the program, and may see it as a threat to their job (Sharma, 2017).

2.5.3 Effect of Computer Assisted Instruction on Student's Mathematics Performance

There is a body of literature that discusses the effect of computer-assisted instruction on students' mathematics performance on state standardized tests and computer adaptive performance assessments such as the NWEA, Measures of Academic Progress, and the Houghto Mifflin Harcourt Math Inventory (Scholastic Inc, 2013). However, there is a limited body of research that discusses the effect of computer-based mathematics programs on Senior High School mathematics performance in Ghana.

Shcneyderman (2001) conducted a quasi-experimental study that evaluated the Cognitive Tutor Algebra I Program to explore students, instructional outcomes and attitudes towards mathematics, and teachers' opinions about the program. The study consisted of 658 participants from six high schools. Students in the intervention group were taught using Cognitive Tutor Algebra for a full school year. Students in the comparison group received Algebra instruction using a curriculum not identified by the author. The research questions were 1) Does the program increase academic performance, 2) Does the program improve students' attitudes toward mathematics, and 3) What are the teachers' views on the effectiveness of the program? The outcome measure for mathematics performance was the Florida Comprehensive Test-Norm Referenced Test (FCAT-NRT). The results of the comparison of the mathematics scores indicated that the mean scale scores of students in the intervention and control group did not differ significantly. A modified version of the Fennema-Sherman Scale was used to measure students' attitudes towards mathematics. The results showed that students in the intervention group had significantly higher confidence about learning mathematics than the control group. A teacher questionnaire was used to assess teachers' reactions to the Cognitive Tutor Algebra 1 Program. The responses indicated that all teachers believed that the program had an overall positive effect on student learning.

Wijekumar (2009) conducted a randomized controlled trial to obtain estimates of the effect of Odyssey Math on the mathematics performance of grade 4 students in 32 elementary, intermediate, and charter schools. The study consisted of 2,456 participants who were randomly assigned to intervention or control groups using the same mathematics curriculum. Odyssey Math was used for an average of 38 minutes each week as a partial substitute for the regular mathematics curriculum although teachers were advised to use it for 60 minutes each week. The confirmatory question the study sought to answer was, do grade 4 classrooms using Odyssey Math as a partial substitute for the standard math curriculum outperform control classrooms on the math subset of the Terranova CTBS Basic Batter in a typical setting? The Terranova is a series of standardized performance tests designed to measure student performance in mathematics and other areas (Frey, 2018). The study also sought to answer two exploratory questions 1) What is the effect of Odyssey Math on the math performance differential between male and female students in a typical school setting, and 2) What is the effect of Odyssey Math on the math performance differential between low- and medium/high-scoring students on a math pretest in a typical school setting? The study found no statistically significant difference between classrooms that used Odyssey Math and those that did not on the math subset of the Terranova Basic Battery.

A quasi-experimental design study was conducted to evaluate the effectiveness of the Saxon Math program in Texas elementary schools using archival data (Resendez et al., 2005). The study consisted of participants in the third, fourth, and fifth grades for 38 sites using the Saxon Elementary Math program and 40 matched comparison sites. Comparison sites were matched using the percent of African American, Hispanic, White, economically disadvantaged, limited English proficient, and mobile students. Hierarchical linear modeling and multivariate analysis of covariance were used to answer the following evaluation questions 1) Does math performance improve because of participation in Saxon Elementary Math, 2) Is Saxon Elementary Math associated with improvements for various subgroups, and 3) How does student performance in math differ across users and nonusers of Saxon Elementary Math? The Texas Assessment of Academic Skills (TAAS) and the Texas Assessment of Knowledge and Skills (TAKS), which replaced TAAS in 1992, were used in the analyses of outcome measures. The study concluded that the Saxon Elementary Math program is associated with positive outcomes based on the analysis of longitudinal data.

Houghton Mifflin Harcourt conducted a study in Hardin County Schools because the district was interested in understanding the effects of the Math 180 program on student growth in mathematics. The participants in the study were 212 students who participated in Math 180 and 212 matched comparison students from the same schools. The matched comparison students were identified using propensity score matching. Students were stratified by grade, demographic variables, and NWEA MAP scores. The baseline equivalence test conducted found no significant difference between the groups based on the variables used during stratification. The research questions for the study were 1) what are the effects of Math 180 on student mathematics performance 2) how does Math 180 differentially affect subgroups of students, and 3) what is the association between mathematics performance and program implementation-are changes in Math 180 participants; mathematics test scores associated with variation in program implementation? The measures for the study were Math 180 course software use, Math Inventory scores, and NWEA Measures of Academic Progress (MAP) scores. MAP uses a numerical RIT score to measure students' performance level and compute growth (Northwest Evaluation Association, 2016). The results of the study were that Math 180 students made significantly greater gains than the comparison students based on NWEA MAP scores. As it relates to subgroups the study found that special education students and non-special education students who used the Math 180 program made significantly greater gains than the comparison groups. Lastly, the study concluded that an analysis of Math 180 students' Math Inventory scores revealed that they made significant gains on the assessment between the fall and spring. This section shows that the effect of computer-based learning on students' mathematics performance has been studied in state standardized tests and computer adaptive performance assessments such as the NWEA Measures of Academic Progress and the Houghton Mifflin Harcourt Math performance test. There is, however, a limited body of research examining the effect of computer-based instruction programs on the performance of High School Students in mathematics.

2.6 Computer-Assisted Instruction as a Diagnostic Teaching Tool.

Another key feature of newer CAI is the use of answer-pattern-response to diagnose student learning and to target the needs of specific students. Answer-pattern-response adjusts the difficulty level of questions or instruction based on student's previous responses. One particular program is Success Maker, Math Concepts and Skills 2 (Pearson Digital Learning, 2005). This program uses answer-pattern-response decision-making algorithms to continually assess student performance and provide individualized instruction (Pearson Digital Learning, 2005). According to research presented in a previous section, students, especially those struggling in mathematics, benefit from this type of personalized CAI (Fuchs et aI., 1994; Fuchs et aI., 1997; Ku et aI., 2007; Slavin & Lake, 2008; Slavin et aI., 2009). Although this type of CAI is designed to improve mathematics performance, studies that examined the effects of Success Maker on performance scores show a minimal positive correlation, and results, while positive, have not yielded statistically significant results.

Most studies that explored the use of SuccessMaker and its effect on student performance focused on the number of time students spent on the program. For example, Kirk (2003) found students who received a supplemental CAI (SuccessMaker Math Concepts, and Skills) for an average of approximately 13 hours a school year, scored 21 to 30 scale points higher each year for three consecutive years than the national average on the Terra Nova eTRS assessment 5th edition. Additionally, the gains demonstrated by the sample were more than the average expected gain; however, these findings were not reported to be statistically significant. Manning (2004) also found a positive correlation between Florida state mathematics performance scores and time spent on the SuccessMaker program, but this study did not control for specific student characteristics such as previous mathematics ability. While students who spent more than 30 hours on the program revealed statistically higher scores on their state assessment, it is possible that those students spending more time were already higher achieving and enjoyed mathematics more.

Additional research on SuccessMaker also revealed flaws in methodology, rendering the results less convincing. For example, Gee (2008) focused on time spent on the program, but her results were not measured against a control group. This strategy is problematic because the time students spent on the program was not controlled. In addition, as she noted in her summary, it was unclear if implementation was consistent across all classrooms and all ability groups. As in the previous example, higher-achieving groups of students might have spent more time on the program.

In some cases, however, time spent on the program was not reported. Mathis (2010) examined the effects of the SuccessMaker program on 500 students classified into different subgroups based on race, socio-economic status, and disability. The study yielded two statistically significant results: a significant difference in mathematics performance between Caucasian and African American students and a significant difference between students with disability compared to students without disabilities. None of the results indicated a significant effect of SuccessMaker on mathematics performance. While these results could imply SuccessMaker did not affect mathematics performance it is difficult to determine from these studies because student growth overtime was not measured. Additionally, no data were reported in terms of the fidelity of use of SuccessMaker. In fact, Mathis (2010) found that teachers did not implement the program as it was designed in some cases, and students spent only 60 minutes a week on the program.

Only one study used a pre/posttest design to measure student learning as it related to SuccessMaker. The study examined the effects of SuccessMaker on mathematics performance of fourth- and fifth-grade students in thirteen schools located in the Etowah County (Alabama) School District (Mintz, 2000). Specifically, it examined the program's effects on critical thinking skills as revealed on the Stanford Performance Test 9 and found that students who used SuccessMaker showed lower critical thinking scores as compared to students who did not use the program. Because the study used a pre/posttest design, more confidence can be placed in the finding that SuccessMaker had no impact on critical thinking. However, as Mintz (2000) noted, the assessment used in her study was a grade level assessment so students may have had significant gains but still not have demonstrated the skills necessary to show statistically significant improvement on the state's grade-level assessment. This study leaves unanswered questions about SuccessMaker's ability to improve struggling students' performance.

Current research on SuccessMaker CAI is also inconclusive. While some studies found students who used SuccessMaker made gains in student performance, questions about their methodology weaken their arguments. No studies used a control group, and only one controlled for the performance level of students using the program. Furthermore, the number of time students spent on the program varied greatly from study to study, and some studies did not follow program recommendations for implementation. In addition, none of the studies reviewed measured fidelity of implementation and only one study addressed how SuccessMaker was implemented. This review of research suggests SuccessMaker could be a viable tool for working with struggling learners, but it needs to be implemented using effective practices for working with struggling learners and recommendations for effective mathematics technology integration.

2.7 Comparison of Computer-Assisted Instruction

The CAI instruction as we look into it as an assistive tool for both teachers and students turns to see how it is compared to students understanding in the traditional mood of learning and to the traditional method of teaching mathematics on the side of teachers.

2.7.1 CAI and comprehensive students.

The effects of technology on student outcomes have been studied for over 30 years, and the cumulative results from meta-analyses show CAI has a small positive impact on student performance. Kuliks and Kulik (1991) reported combined effect sizes of 0.24 for studies from 1966 to 1974, 0.36 for studies from 1974 to 1984, and 0.30 for studies from

1974 to 1985. Waxman et al. (2002) determined the combined effect size of 13 quantitative research syntheses conducted between 1975 and 1987, to be 0.42 indicating the positive effects of CAI on student performance. Continuing their efforts to understand the impact of technology on performance, they examined 20 additional studies conducted from 1997 to 2002 and found a similar mean effect size of 0.30 ($p < 0.05$). However, these results should be interpreted cautiously because of the vast differences in the ways that CAI was used, the type of students in each study, and the instructional delivery methods with which CAI was compared.

2.7.2 Computer Assisted Instruction versus Teacher-lead Instruction.

As stated in previous sections, the way technology is integrated into a learning environment impacts student performance. However, when examining the effects of CAI on mathematics performance of the general student population, researchers have focused less on how Cal was integrated and how specific student groups responded to CAI and more on comparing CAI to the instruction given by a teacher. However, research on this topic is inconclusive and provides a mix of results. First, the effects of CAI seemed to be related to the year published. Second, studies that took place over longer periods seemed to reveal that CAI was at least equal to teacher-led instruction. Third, larger-scale metanalyses tended to reveal more favorable effects of CAI Finally no studies distinguished among the types of teacher lead instruction (explicit or contextualized) that were used.

In 1995, Fletcher-Flinn and Gravatt reviewed studies using CAI to teach mathematics. All studies were conducted between 1987 and 1992, and student participants spanned kindergarten through college level. They reported the mean effect size for CAI to be moderate (0.24). The effect size seemed to increase as the year published increased, suggesting that improved technology might have led to improved results. Pearce and Norwich's (1986) and Olusi's (2008) studies provided examples of this increase. In 1986 Piece and Norwich found all students mastered more (multiplication) facts under teacher led instruction, while Olusi's 2008 study reported that students who participated in CAI obtained a significantly higher mean performance score than students who participated in traditional instruction.

In studies that took place over longer periods, such as a year, and when measures were taken to control for other variables such as teacher personality, the impact of CAI had less to do with the instructional medium and more to do with the quality of instruction provided by CAI materials (Fletcher-Flinn & Gravatt, 1995). For example, McDermott and Watkins' (1983) conducted a year-long comparison study and found no differences in CAI and teacher-led instruction. Interestingly, Fletcher-Flinn and Gravatt (1995) found that the variation of the impact of the CAI seemed to be stable across teachers but vary with different CAI. These results have implications for curriculum selection, including careful attention to which CAI might be used.

Large-scale meta-analyses revealed that CAI may improve student performance (Christmann & Badgett, 1997; Slavin & Lake, 2008; Slavin et al., 2009). A recent review of elementary programs showed a mean effect size of 0.19 for the use of CAI on mathematics performance, which was higher than the mean effect size calculated for the effects of mathematics textbook curricula (0.10) on mathematics performance (Slavin and Slavin, 2008). In this review, textbook curricula were defined as instructional materials that were in a paper book format and CAI as instruction delivered through student interaction with the computer. Several studies that used randomized-quasi or randomized experimental designs had higher mean effect sizes (n= 37, mean effect size= 0.29), indicating that in a more rigorous experimental setting CAI still proved to be effective at improving performance.

In their review of middle and high school mathematics programs, Slavin and Slavin (2009) found similar results for CAI's effects on middle and high school student performance. Specifically, they examined CAI core (weighted mean effect size = 0.09 in 17 studies) and supplemental (weighted mean effect size = 0.19 in 18 studies) programs, showing that supplemental CAI had a greater effect on performance than CAI as a core curriculum. Unlike the results of their elementary review, however, Slavin and Slavin found that studies that used randomized-quasi or randomized experimental designs showed little or no effect for CAI on performance.

2.8 The computer assisted instruction Package

In Mathematics learning, many kinds of software can be used such as a) SPSS, which is a software that is used to analyze statistics including median, mode, mean, standard deviation, hypothesis testing, etc., and b) GeoGebra, which is a software that is used for geometry, algebra, and calculus in geometry, c) Microsoft Mathematics, it is a software that is used for arithmetic problems, matrices, statistics, linear algebra, trigonometry, and some problems involving physics and chemical formulas. GeoGebra and Microsoft

Mathematics are software that can be freely downloaded. According to Arief (2019) and Mayasari, et al. (2021)., Microsoft Mathematics is an application created to help students in learning mathematics. Features included in Microsoft

Mathematics are science calculators, 2D and 3D graphics visualization, and algebraic and symbolic computations for elementary mathematical functions and operations. The advantage of Microsoft Mathematics according to Handayani (2019) is that it can be used to solve math and science problems more quickly and easily in teaching important basic concepts. The features of Microsoft Mathematics can solve complex problems in algebra, trigonometry, calculus, physics, and chemistry (Hernawati 2012) The other advantages of Microsoft Mathematics are:

a. calculations in mathematics problems become faster,

b. the accuracy of the results obtained from the calculation,

c. it can be used as an evaluation,

d. it can visualize graphs to facilitate teacher in calculating and preparing questions for students.

It is in line with a study by Rawa. et al. (2020) which shows that the results of training and mentoring activities in using GeoGebra and Microsoft Mathematics are:

1. the participants have succeeded in operating it,
2. they can use it in solving mathematics problems,
3. they can draw 2D, 3D, and animation graphics,

A study by Rizki and Widyastuti (2019) reveals that the media in form of Mathematics materials by using Microsoft Mathematics apps are feasible to be used as learning media to increase students' learning motivation. Another research by Suryacitra and Oktavia (2019) concludes that the use of the Microsoft Mathematics program can improve students' accuracy in solving the multiplication problems of two matrices. Nowadays, Mathematics learning uses computer technologies that have a goal as stated by Oktaviyanthi et al. (2015), the use of ICT has a purpose to make students have the ability in 1) critical engagement while learning Mathematics, 2) communicating, using appropriate and varied multimedia tools (emails, websites, etc.) while learning Mathematics, 3) using ICT efficiently in research and problem solving, and 4) using ICT efficiently for professional development in the teaching of Mathematics. As stated by Mayasari et al., (2020) Mathematics is really needed in the study of science, humanities, and technology. Nining et al., (2019) states that mathematics is the study of quantity, the geometry structure, two-dimensional figures, and changes in numbering. The trigonometric materials are sine, cosine, tangent, secant, cosecant, and cotangent functions. Most of these materials have not been mastered by students, so the appropriate teaching media and methods are needed. Many mathematics students consider it a difficult material. Based on the result of the previous assessment on the trigonometry material for the first year of mathematics students, there are 50% of them pass the minimum standard, with an average score of 6,7. It is also supported by a survey that the student's learning performances are still low, especially in Mathematics. It is based on the opinion of Barid et al., (2019) in PISA that the Indonesian students' mathematics learning performance is in the rank of 61 among 65 participant countries with an average score of 371, in which the international average score is 500. It means that Indonesian learning performance in mathematics is still low. One of the factors that influence it is the lack of use of computer programs in learning. Learning performance in Rahmayanti et al., (2016) is the level of actual ability that can be measured, in form of knowledge mastery, attitudes, and skills achieved by students as a result of what they have learned. This performance can be enhanced by the use of computer programs, which can build creativity and independence. Hidayat in Widyaningrum et al. (2020) states that students can increase their knowledge and thinking abilities. Hughes (2008) One of the ways in improving students' learning performances in the course of Matematika Sekolah 2 on the trigonometric subject is the use of the Microsoft Mathematics program. It is supposed to make their performances better than before. In the trigonometry materials, the students are expected to memorize the special angles and formulas of sine, cosine, and tangent. By using the Microsoft Mathematics program, the students can solve the questions given correctly and save time. The results of a study by Sushkov (2014) reveal that there is a significant difference in the learning performance between the students who taught by using Microsoft Mathematics and those who taught by using conventional learning on the materials of the linear equation system. Purwanti and Pustari (2013). This study finds that students' performance when taught by using Microsoft Mathematics is higher than those when taught by traditional teaching methodologies. Based on the previous studies, this study aims to investigate the students' learning performance by using Microsoft Mathematics media in the course of Matematika Sekolah II.

2.9 Perception of Students towards Mathematics

Experiences through school present a general impression to students who tend to like some subjects and not like others. Whereas some students are always on the lookout for a particular class or subject period, others wish they escape that class; mathematics class has not been an exception. Whereas some students always look out for the mathematics class, others wish they could avoid such classes. As far back as 1977, Hogan (1977), following his study of students' interests in mathematics utilizing a nationally representative of students, found that students lacked interest in certain mathematics topics, and that, there were variations in students'" liking for mathematics. Mostly, a student's interest in a particular subject could be as a result of some factors including how interesting or uninteresting the subject or the tutor is, the ease with which the student can grasp what is taught, what the subject entails, the time of the day the subject is taught, among others. Previous studies have, however, shown that some attitudes of students toward certain subjects are a result of some perceived ideas. These perceptions about the subject lead to the development of some attitudes towards its study. Mathematics is one of such subjects which have had variations in perceptions and attitudes toward its study.

A study conducted by Ekow et al. (2020) on Students' Perception of Mathematics and its Effects on Academic Performance revealed that the students rated Mathematics equally high to all other core subjects due to its importance The revelation also shows students' agreement that Mathematics was important in their daily interaction which indicated a positive perception. They argue that their finding agreed with the views of Atteh et al. (2014)., which collectively opines that due to the importance of mathematics in our daily life and the development of our societies, mathematics is considered a core subject for many countries across the world. In addition, they also indicated a positive perception by students towards Mathematics by stating that they discovered that students enjoy sharing mathematical solution strategies with their colleagues. Due to the enjoyment, students had in sharing mathematical solutions strategies, they showed a positive perception of Mathematics further indicating that Mathematics should continue to be a core subject. Therefore, it cannot be doubted that students have positive perceptions towards Mathematic due to their interest in the continuity of Mathematics being a core subject with the notion that everybody needs mathematical knowledge. The findings of the study proved the findings obtained by Mohamed et al., (2011). who stated that students had a positive perception of Mathematics, but the level of their positive perception is at the medium level. Nevertheless, in their study respondents also indicated a negative perception of Mathematics. In their findings, a negative perception was shown indicating a low interest in the study of Mathematics. Moreover, the findings indicated that students had negative perceptions when they indicated that they do not want to pursue further studies in Mathematics. In addition, negative perception toward Mathematics was identified when students failed to indicate enjoyment in the study of Mathematics due to the topics provided in the mathematics syllabus. The findings revealed that the students are of the view that the topics in mathematics were not as easy as it seems to be. Therefore, the topics in the mathematics syllabus created a negative perception for the students of Mathematics. The findings obtained confirm that of Ifamuyiwa, (2004) which indicates that students had a negative perception of Mathematics. They were of the view that most students perceived mathematics to be difficult and concluded that the students understood that it was their responsibility to learn mathematics and acknowledged mathematics to be a subject that increases in difficulty as they progressed through the grades. Additionally, this is in line with the finding of Fasasi an Yahya (2005)., which states that students had a moderate negative correlation between perception and

Mathematics results thereby concluding that students had a negative perception of Mathematics. The result of the findings indicated that the strength of perception did not significantly affect the students' performance. From the study, it was concluded that students' perception of mathematics has no influence or effect on their academic performance in Ghanaian senior high schools Much was not considered in using CAI to verify the perception of students towards mathematics performance.

2.10 Gender Gaps in Mathematics Performance

Education is globally recognized to be building individuals and accelerating national development. Education for adolescent children increases the chances of giving them a brighter future, improved choices, and opportunities. Early adolescence augurs well for the development of academic interest and attitudes of girls (Bayaga & Wadesango, 2014). Most females have the misconception that being bright is in sharp contrast with being well known (Abotowuro, 2015). High educational performance can be in direct clash with social issues or aspects of adolescence concerning student and teacher interactions, learning opportunities, and performance in mathematics.

Moreover, Fannema and Franke (1992) suggest that studying habits that include working autonomously on significant levels may empower some adolescents to improve in mathematics and science. However, it is more evident and proven that males and females have distinct learning styles and that females exceed expectations when learning mathematics through guidelines and rules. They also make the assertion that adolescents, mostly females, are associated and trained to be more self-determining, and they get more help from parents or guardians and instructors than the males. Because of this reliance when children pursue academic training, females will in general be progressive subject to other people and will in general be increasingly independent. Females are as youthful as grades 6 and 7 rates being popular and the favorite as more progressively significant as being seen as autonomous. Young adolescent males, then again, are more prone to be linked as competent and independent. This is most likely to be the case in our parts of the world as gender has somewhat impacted the attitude students have towards Mathematics in Ghana. This study will prove more.

Josiah and Adejoke (2014) investigated the effects of gender, age and mathematics anxiety of college students on their performance in Algebra. Ex-post-facto research design was adopted implying there was no manipulation of any variable. The participants of the study were mathematics teacher trainees in the Federal Colleges of Education in Lagos and Ogun states of Nigeria. In collecting data from respondents, the study made use of a questionnaire that elicited information on the gender and age of respondents, a mathematics anxiety scale ($r = 0.82$), and participants" performance score in an Algebra course coded MAT 111. The findings indicated that students' performance in the Algebra course was average. Meanwhile, the differences in performance across gender, age, and mathematics anxiety groupings (low, medium, and high) were all found to be non-significant. Participants had just begun the first semester and therefore it is presumed that may have affected the students' performance.

From the international perspective, according to the NCES (2013), there were no significant gender gaps in mathematics in the United States for ages 9 and 13 based on the 2012 assessment. This is a startling conclusion for teachers who have been in the field for many years, as the gender gap was very prevalent in previous studies. The target demographic for ninth- and tenth-grade students is around 14 years of age; when comparing this to the given ages from the NCES, the students fall between the 13- and 17-year-old age ranges. At the age of 17, the gender gap is only 4 points, which is a statistically significant difference from the 8-point gap in the 1970s. The gender gap is closing in U.S. STEM education. The NCES (2013) used data from the NAEP to track student performance at the ages of 9, 13, and 17 to investigate long-term trends. Arslan et al. (2012) further supported this claim by showing that there was no statistically significant difference between males and females in sixth through eighth grade in mathematics performance scores; however, they did find that attitude scores toward mathematics differed greatly between genders. The authors concluded that females should be encouraged to pursue mathematics education, as they have the ability, but as seen in the study, have less confidence regarding their performance. To further support this the OECD examined performance by gender in the 2018 PISA results. Males only performed 9 points higher than females, which were found to not be statistically significant. An interesting finding was that there was a reading gap of 24 points between the two genders. Even though historically the gender gap is more traditionally thought 43 to exist in math or science. However, the attitudes of males and females toward STEM careers were shown to be different. While 3 in 10 boys with a strong aptitude for mathematics declared they were interested in engineering or science-based profession, only 1 in 10 girls indicated the same. While the performance gap is not a gender factor, attitude is a significant factor for females (OECD, 2019). In addition, women continue to be underrepresented in bachelor's, master's, and doctoral programs in STEM fields, according to Beekman and Ober (2015). Beekman and Ober (2015) investigated the results of the NCES in their study, which was conducted in Indiana, and confirmed that the gender gap is quite small to nonexistent, as females score comparable to males on testing for math performance; however, they did agree that girls and young women should be encouraged to pursue STEM fields, as there will be an increasing need in the coming years for jobs in those fields. In conclusion, as gender gaps for mathematics performance have closed over time, the present study did examine gender as a variable in comparing math performance between those in intervention and those not in the intervention.

2.11 Summary

In closing, this review of literature discussed the theoretical framework and literature related to computer-assisted instruction in mathematics performance. It is already known that technology offers countless opportunities to connect with those outside the school walls. With computer-based learning in classrooms, these connections are at students' fingertips. In the classroom, teachers are replacing visual aids or presentation handouts with documents accessible on each student's computer or mobile device. Because technology devices can be used anywhere, students are likely to engage more often with their academics. Students can study and work and study outside the classroom and have been forced to do it during times of crisis. The more time students spend focused on handheld devices, the more they are capable of learning. Student performance is measured by what students can do independently. What better way to prepare students with knowledge and self-assurance than to guide them in the direction of a student-centered curriculum? Increased academic performance is the overall result teachers, parents, and administrators are looking for. Research on computer-assisted instruction has shown it is effective in increasing academic performance scores. School systems have invested heavily in computer-assisted technology. However, the research literature on the subject leaves an entire sub-group of the population unaccounted for. Based on that conclusion, this research focuses on how the proven benefits of computer-based learning that is Microsoft maths solver relate to or may benefit Senior High School mathematics performance in Ghana.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Overview

This chapter provides a detailed description of the methodology that was used in the study. Research methodology, according to Kothari (2004), is a way to systematically solve the research problem. The chapter covers the research design, the target population, sample and sampling techniques, construction of research instruments, a pilot study conducted to ascertain the reliability and validity of the research, data collection techniques and data analysis procedure, treatment process, and ethical considerations for the study are discussed.

3.1 Research Design

A research design is an overall plan for collecting data in order to tackle the objectives of the study (Fraenkel & Wallen, 2000). Similarly, the ultimate goal of a good research design is to guide the researcher on the type of data to collect, and how to collect, process, and analyze them in order to answer the research questions or test the research hypothesis (MacMillan & Schumacher, 2001 p166), This study used a mixed method research design. This is when both qualitative and quantitative research methods are used at the same time in a study. Quasi-experimental was used as a primary method with qualitative data embedded within it. Quasi-experimental research is a design that allows researchers to answer critical questions about the relationship between variables by determining whether there are significant differences between variables (Butin, 2010). Specifically, a non-equivalent quasi-experimental design was employed because intact classes of unequal number of students were used and the respondents were not randomly selected and allocated to the groups (Creswell, 2008).

The quasi-experimental research design involving pre-test and post-test was used to investigate the effect of the use of Microsoft Math Solver as an instructional approach in teaching quadratic equation on the performance of students. According to (Gall, Borg, & Gall, 2003), a quasi-experimental non-equivalent pre-test and post-test control group research design is one of the important research designs for investigating cause and effect relationships between two or more variables.

Quasi-experimental is used often in educational research because it is often impossible and sometimes unethical to randomly assign students to settings. In general, the strength of quasi-experimental research lies in its practicality, more feasible, and generalizability. However, the quasi-experimental design lacks random assignment which contributes to a reduction in internal validity and causal claims become quite difficult to make. Also, without proper randomization, a statistical test can be meaningless (Shuttlework, 2008).

At the Senior High School level, it was very difficult to be allowed to use a true experimental design in Ghanaian classroom settings for this study. This was because no school would allow a researcher to disorganize classes assigned to students who were already in their various classes into different academic programs for the purpose of research. Due to this, a random assignment of students to groups was impossible. This implies that other research designs that involve randomization were deemed inappropriate and unethical to use for this study.

Consequently, the variables of this study were categorized into independent variables and dependent variables. There were two independent variables in this study, which are the approaches used in teaching and learning quadratic equation, thus, the Microsoft Math Solver approach and the traditional approach. The dependent variable for this study was students' scores on Quadratic equation performance Test (QEPT) while the possible covariate of this study was students' scores on the readiness test for Quadratic equation concepts. These scores were analysed to establish whether a significant difference exists between the control and experimental group or not. In summary, the quasi-experimental design chosen for this study was the non-equivalent pre and post-test with treatment. Two non-equivalent intact classes of SHS form two students were used in the study. These comprises Microsoft math solver learning group and the Traditional/ Control Group. The basic design of the study showing how each group was involved is shown in Figure 1

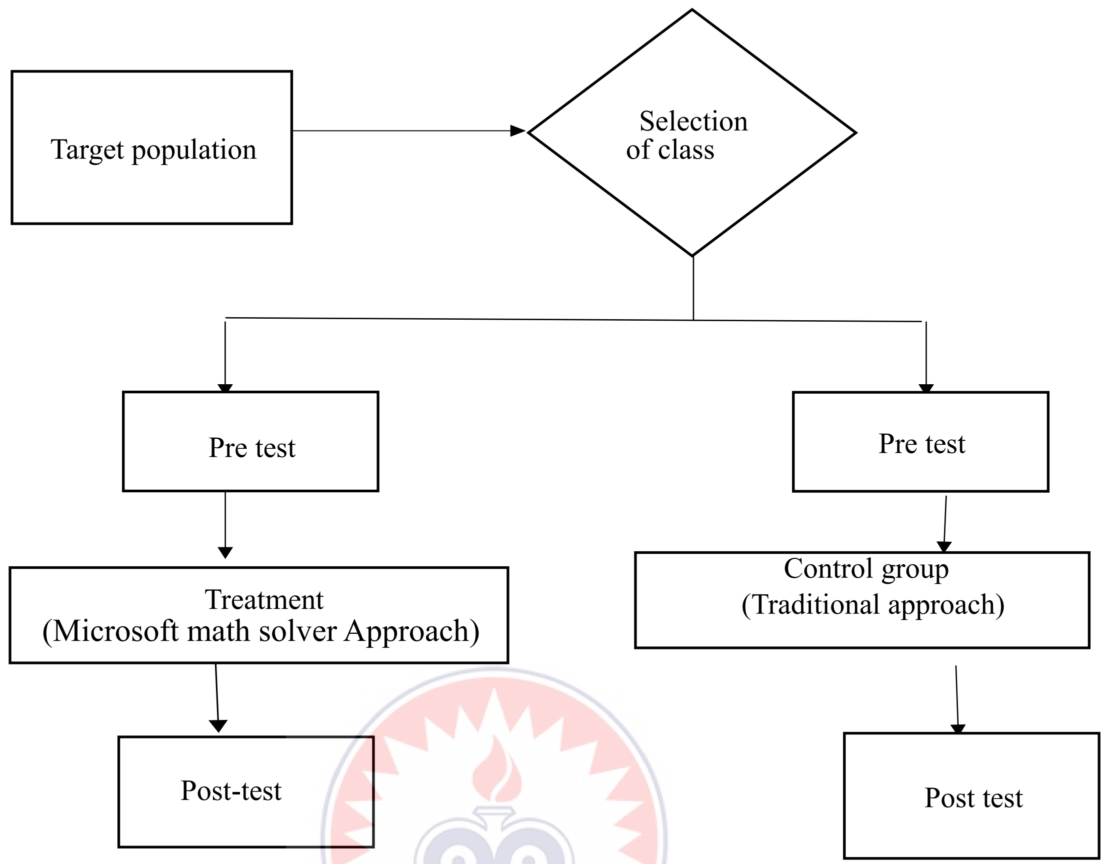

Figure 1: Basic design of the study

It can be deduced from Figure 1 that the basic design of the study consisted of four phases. These phases were pre-test stage, treatment stage, post-test and administering qualitative instruments (i.e., interview guide). The first phase was the pre-test which was carried out simultaneously on all the groups before administering the treatment. The second phase was the treatment stage of which the experimental group was taught using Microsoft Math Solver approach while the control group was taught using traditional teaching methods. Next, the third phase was the post-test to both groups after three weeks of treatment. After the respondents went through the three phases, the test results were evaluated to determine whether

Microsoft Math Solver as an instructional approach affected student performance in quadratic equation or not.

3.2 Population

A research population refers to individuals or objects collectively. These well-defined collections of individuals and objects possess similar characteristics or binding traits Creswell (2009). A convenience sampling technique was used to select the school due to the easy access of the school to the researcher. Tano South Municipal is one of the 260 Metropolitan, Municipal and District Assemblies in Ghana, and forms part of the 6 of Municipalities and Districts in the Ahafo Region. The Tano South Municipal was carved from the Tano District and by a Legislative Instrument LI 1765 of 2004, the Tano District was split into two. The municipality has five senior high schools of which one is private.

The Municipal capital Bechem, is on the Sunyani-Kumasi Road. The Municipality lies in the southern part of the Ahafo Region, within the municipality is Bechem Presbyterian Senior High School. The school's vision is to make it a first class one whose products are known to be of high academic excellence, high moral character and have holistic Education. The school is in category B. The school is a mixed school and houses both day and boarding. The target population for this study was all second-year senior high students of the 2022/2023 academic year in the Ahafo Region of Ghana. The accessible population consisted of a set of 443 second-year students at Presbyterian Senior High School in the Tano South Municipality in the Ahafo Region of Ghana. The rationale for the focus on this school was that I found this school most accessible which from a practical standpoint facilitated the conduct of the study especially regarding data collection.

3.3 Sample and Sampling Procedure

A purposive sampling technique was used to select the two classes (A and B). Creswell (2009) stated that purposive sampling is employed because of the special characteristics of the participant in facilitating the purpose of the research. In purposive sampling, the units of the sample are selected not by a random procedure but are intentionally picked for the study because of their distinctive characteristics. In all, two intact classes were selected for the research, one from the class A program and the other from the class B program by using the purposive sampling technique. The classes were A and B, the reason for choosing these classes was that most of the mathematics teachers were of the view that class A does far better than class B class hence the study to verify how wide the difference with the implementation of the treatment. The reason for selecting the intact classes from each programme was that all the lessons were taught during the instructional time. Also, the intact classes were used for study so that the contents treated would be beneficial to the entire class. Further, the usage of the entire class was to avoid disturbance during the school session. The form two classes were used because the topic treated in the study was within the scope of the form two topics in the mathematics syllabus for SHS and the school would not allow me to teach or reteach this topic in the other forms. The control group had 60 participants and the experimental group was also made up of 60 participants. After the initial mathematics performance test (pre-test), the outcome of the test disclosed that both the students in the control and experiment groups are comparable in aptitudes before the treatment was administered.

3.4 Research Instruments

Per the nature of the research questions, three instruments, that is: a performance test, questionnaire and an interview guide were used in gathering the data for the study. The performance test was used to collect quantitative data while an interview guide and questionnaire was used to collect qualitative data. The qualitative data and its results were used to assist in explaining and assigning reasons for quantitative findings. Each group (control and experimental) was given a pre-test before the treatment. After three weeks, a total of 12 hours of treatment lesson (Microsoft Math Solver) taught by the researcher and traditional teaching approach by the control class tutor was delivered to each group (control and experimental). A post-test was administered to both groups during the fourth week.

3.4.1 Performance Tests (Pre-Test and Post-Test)

The items on the teacher-made performance test were constructed based on the lesson taught and the learning objectives in the SHS mathematics curriculum. The aim of this instrument was to provide a measurement of performance. Teacher-made- performance test was preferred in this study to other types of tests due to the following reasons: it reflects instruction and curriculum; it is sensitive to student's ability and needs; it provides immediate feedback about student progress; and finally, it can be made to reflect small changes in knowledge (O'Malley, 2010).

The pre-test and post-test each comprised 6 essay questions. Finally, students were expected to solve all the questions.

3.4.2 Interview Guide

An interview is a tool for particular questions to be proposed by the researcher who manages the line of questioning so as to acquire a certain response (Creswell, 2009). Interviewing is one of the most influential techniques employed in an effort to comprehend an individual's perspective, belief, and values. As a result of its interactive nature, interviewing has many benefits over other kinds of data gathering methods such as questionnaires (Best & Kahn, 2003; Legard, Keegan & Ward, 2003). Aside the performance test, a semi-structured interview was used to address the research question: 'What are the views of students about the use Microsoft Math Solver approach in teaching and learning quadratic equation?' According to Bryman and Bell (2007), a semi-structured interview follows a list of concerns and questions that the researcher wishes to cover during a period. The reason for choosing the semi-structured interview technique was basically due to the researcher's aim to encourage the interviewees to freely discuss their own views on the Microsoft Math Solver approach of teaching and learning quadratic equation. This method with open-ended questions allowed the researcher to adjust his questions depending on the attributes of the specific student and the given type of views they expressed. Semi-structured interviews provided the opportunity to regulate the order of the questions and the respondents had the possibility to expand their ideas and speak in great detail about diverse subjects rather than relying only on concepts and questions defined in advance of the interview (Bryman & Bell, 2007). In other words, semi-structured interviews were more flexible than standardised methods such as structured interviews or surveys. Also, this semi-structured interview was chosen in this study over other qualitative instruments due to the following reasons: interviewees got the opportunity to check what was meant by a question, and allows for long and complex responses; it had some flexibility in making possible changes in the order of questioning, the questions asked and the topics discussed; it gave chances for probing follow up questioning seeking clarification or further explanation and finally, it provided in-depth inquiry (Merton et al.(1996). However, one general problem when conducting qualitative interviews with open-ended questions is that the interview is characterised by the interest and opinions of the interviewer. Semi-structured interviews are rather organized in terms of what issue would be discussed during the interview, but the follow-up questions would be dependent on the opinions of the interviewer. Another problem that can occur is misunderstandings and misinterpretations of words. This could be no problem within this research since interviews have been conducted in English which students easily expressed themselves. Nevertheless, in order to increase the reliability of the interview results, the items on the interview guide were strictly followed. All interviews were recorded. Subsequently transcribed material was read to the respondents. Statements were amended according to the respondents´ comments. Finally, the material was approved of by the interviewees. The semi-structured guide containing 8 items was used to elicit information on the students' impressions about the use of the Microsoft Math Solver approach to teaching quadratic equation, whether or not they enjoyed learning with the Microsoft Math Solver teaching approach, new things they learned, their challenges and recommendations. This interview helped in assigning and explaining the quantitative results.

3.4.3 Treatments of Group

The Microsoft Math Solver approach was used to teach the experimental group whereas the traditional method of instruction was used for the control group throughout this study. These approaches are described in this section.

3.4.3.1 Control Group: The Traditional Approach

This term was used in this study to refer to the teaching using chalk and board for teachers, pen and paper for students. The teacher gives the input verbally or writes on the board and the learners strictly follow the instruction the teacher gives, and active participation of the students are not encouraged. The instruction involved lessons using lecture/discussion method to teach quadratic equation by their teacher. Teaching strategies relied on teacher explanation and textbook, with no direct consideration of the student's alternative conceptions. The students studied their textbook on their own before the lesson time. The teacher structured the entire class as a unit, solved examples on the chalkboard and defined few keywords. The primary underlining principle was that knowledge resides with the teacher and that it was the teacher's responsibility to transfer that knowledge as fact to students. Most of the instructional time (75%-85%) was devoted to instruction and engaging in discussion stemming from the teacher's explanation, questions and solutions. The remaining time was spent on a worksheet study. Trials and exercises developed specifically for each lesson were used as practice activities. The required solutions reinforced the concepts presented in the classroom sessions. While the students were studying worksheet exercises, the teacher circulated and provided assistance if needed. The students had the opportunity to ask questions, and worksheets were collected and corrected by the teacher. The students reviewed their sheets after correction. This classroom typically consisted of the teacher presenting the right way to solve the problems.

3.4.3.2 Experimental Group: Microsoft Math Solver approach

To promote change in the study of the Quadratic equation, Microsoft Math Solver based teaching approach learning was prepared by the researcher and used with the experimental group lasting three (3) teaching weeks and 2 weeks for the pre and posttests. A Series of treatment activities were planned by the researcher to improve the understanding of the students in Quadratic equation due to the non-performance of the students in the Pre-test. The challenges students encountered when solving questions on Quadratic equation had to be addressed. The activities were therefore put in place and implemented based on the outcome of the pre-test, which revealed that most of the students had problems in the area of understanding Quadratic equation. The treatment process lasted for 3 weeks. The first week was used to administer the test items designed for the pre-test. The first step to identifying students' difficulties through constructivism was to listen to what the students found interesting or difficult about quadratic equation in the pre-test. Until this point, the students had not been provided with the level of choice necessary for students' interests and difficulties to develop as a starting point to address their learning needs. The researcher engaged the students in a roundtable discussion about what they found interesting or enjoyable or difficulties regarding Quadratic equation. This process was not easy, as many students had never had a question such as this posed during their schooling. In the third week, the researcher took the opportunity to introduce the concept of quadratic equation to the students in order to address the difficulties that were mentioned by the students and were identified by the researcher. The researcher based the teaching on the observations made during the roundtable discussion with the students and from the result of the pre-test conducted. The researcher introduced the students to the use of Microsoft Math Solver based teaching in quadratic equation. The step the researcher took was to enhance the classroom environment toward a Microsoft Math Solver approach. For example, the researcher sent the students to an ICT laboratory which was different from the existing physical arrangement (layout) of their normal class which was away from idle rows used for copying notes and lessened the use of pencil and paper. The new classroom layout specifically allowed for workspace and socialization. The students were encouraged to think and explain their reasoning instead of memorizing and reciting facts. In the fourth week, the researcher developed completely new approach to teaching, by designing comprehensive lessons using the Microsoft Math Solver approach. A Microsoft Math Solver classroom required a great deal of effort. The researcher's behavior became more and more interactive although, the researcher was still the master of the subject-based content. Initially, the researcher did not abandon all the previous traditional thematic units, instead how the researcher employed these resources changed. In the fifth week, the students went through another set of questions designed by the researcher to ascertain their understanding of the concept of quadratic equation (Post-Test).

Table 3.1: Structure of the Microsoft math solver lesson plan used with the experimental group

Lesson Stages	Planned Activities (In a Math solver Lesson)
INTRODUCTION (20 min)	✓ The researcher introduced the lesson through; • Questioning to assess learners' prior knowledge of quadratic equation. • Explanation of key terms and concepts of quadratic equation. • Explanation to learners on how the math solver operates ✓ The researcher established difficulties students encountered and the algebraic skills of learners.
BODY (35 min)	✓ Learners arranged in groups ✓ Example sheets was given to groups ✓ Learners discussed solution steps using the math solver ✓ The researcher monitored group discussions, Self-explanation activity and probing took place afterwards. ✓ Reflection;
CONCLUSION (25 min)	• Class work and group discussion of the activity; • Evaluation of success rate; • Reflection on the lesson with more quadratic equation problems • Homework was given.

Table 3.1 shows a Microsoft Math Solver-based lesson plan structure used in the experimental class. The explicit lesson plan used is shown in Appendices A, B and C of this study. The lesson plans were categorized into three (3) stages namely: introduction, body, and conclusion. The introduction stage elaborates on some activities the researcher took to introduce the concept. These involved explanations of key terms and asking students questions in order to assess their previous knowledge of the topic. The body comprised grouping students and sometimes individual, giving out example sheets, engaging students in groups and individual discussion prior to the use of math solver. In the concluding stage, the researcher reflected on the topic and gave students class work in order to evaluate the success rate after the use of the math solver. Finally, the researcher gave students homework to bring the lesson to an end.

Table 3.2: The intervention schedule of activities in the classroom

Week	Activity (ies)	Remarks
Week 1	Pre-test assessment	Every student participated
Week 2	Discussion of the pre-test	Students discussed their difficulties with the researcher
Week 3	Introduction of the concept of Quadratic equation	Students participated in the lesson Student's interaction with the series of intervention activities
Week 4	Practical teaching using Microsoft math solver approach	Successfully done
Week 5	Assessment of intervention (post-test)	Every student participated

3.4.4 Validity and Reliability of the instruments

The validity of a test instrument is the extent to which the items in an instrument measure what it is set to measure. Validity is the exactness and precision of deductions based on the findings from the research (Mugenda & Mugenda, 2003). If a test does not serve its intended function well, then it is not valid. The validation of the instruments was carried out to check the correctness of the data collection instruments during the pilot study. This checks the appropriateness of the data collection instruments thus performance test, questionnaires and interview guide. With regard to content validity, the test was constructed based on the instructional objectives of the lessons taught and the specific objectives in the SHS mathematics curriculum to ensure content validity. Also, comments were made about the content of the research instruments by my supervisor and were found to be acceptable. Test items were also given to some of the SHS mathematics tutors to crosscheck and contribute to the content areas that were tested in this study in order to further ensure that the content that was chosen was within the approved domain of the study for the SHS students concerned. Moreover, sixty-one (61) students were selected from one of the second-year classes in a sister SHS ("Bechem Business College" Senior High School) and were asked to answer the test items, mainly to detect a lack of clarity in the phrasing of the questions, and to give an indication for the time needed for its completion. This helped to refine test items. The interview guide and the questionnaires were also examined, and corrections were made by my supervisor. Some M.Phil. Mathematics Education students also read through the interview guide and the questionnaires, and made suggestions that were incorporated before use. On the other hand, reliability is the extent to which items in an instrument generate consistent responses over several trials with different respondents in the same setting or circumstance (Fraenkel & Wallen, 2000)

A Reliability test was carried out with the purpose of testing the consistency of the research instruments so that research instruments would be improved by revising or deleting items. To determine the reliability of the instrument a pilot study was conducted. Piloting determines whether questions and directions are clear to respondents/subjects and whether they understand what is required from them. Piloting was done to determine the feasibility of using a particular research instrument in a major study. It provides an opportunity to try out the instructions for completion of the instrument, especially if it is being used for the first time. Piloting entails a trial administration of a newly developed instrument in order to identify flaws and time requirements (Shilubane, 2010). The researcher piloted the instrument on a small sample of 61 form two SHS students of "Bechem Business College" High School. The piloting was done in this school because it has the same characteristics as one sampled for the study. One of the advantages of conducting a pilot study is that it might give advance warning about where the main research project could fail, where research protocols may not be followed, or whether proposed methods or instruments were inappropriate or too complicated (Vanet al., 2001). The instruments for the study were analyzed for consistency with the help of some mathematics education senior members in UEW-Winneba before they were piloted using one mathematics facilitator and 61 second-year mathematics learners at "Bechem Business College" S.H.S. The feedback of the pilot helped to improve the quality of the test instruments in terms of content coverage, content validity and reliability. According to Mugenda and Mugenda (2003), the coefficient is high when its absolute value is greater than or equal to 0.7: otherwise, it is low. A high coefficient implies a high correlation between variables indicating a high consistency among the variables. No changes were deemed necessary in instruments because the researcher realized that questions students could not answer were not due to the ambiguity of questions but due to their low conceptual knowledge.

3.5 Data Collection Procedure

The research instruments were administered by the researcher to the respondents. A consent letter was attached to the introductory letter duly signed by the Head of the Mathematics Education Department at the University of Education, Winneba was given to the headmaster of Presbyterian Senior High School, the participating school. The headmaster willingly agreed to the request and gave me an acceptance letter. The acceptance letter opened the gate for data collection. A date was then fixed for the commencement of the study. A week before the main study, the pre-test was administered, marked, and analyzed to determine the entry level of each group, readiness and difficulties students faced in solving Algebra 1(quadratic equation). The main study took three weeks. Each week, the researcher and the facilitator met the students in each class (control and experimental groups) twice for lessons, subjecting the experimental group to the Microsoft Math Solver approach and the control group to the traditional approach. The groups of students were taken through the treatment. Lessons were designed on quadratic equation.

During the teaching and learning stage, students were given two assessment questions in class to assess their short-term learning in each class lesson and were done for both control and experimental groups. These class exercises were marked by the researcher. Although, the scores in the class exercises were not added to the final scores of the post-test for the data analysis, yet the class exercises helped them in the post-test.

The test item for data collection was in the form of pre-test and post-test. Each lasted for 1hour 20minutes. After the administration of the post-test in the last week, a 20-minute interview was also conducted with four students from the treatment group to find out their views and perceptions about the Microsoft Math Solver teaching approach. Simple random sampling was employed to select four students for the interview session. The interviewees were assured of confidentiality and given code names in order to prevent the exposure of their identities. Prior to each interview session, the interviewees and the researcher agreed on the time and venue for the interview. The permission of each interviewee was also sought before the interview sessions were recorded.

3.6 Data analysis plan

Data gathered using administered questionnaires were computerized into SPSS version 23 for analysis.

Results Presentation:

- *Results on bio-data:*

  Data on Bio-data was gathered through the administered questionnaires. Results were presented using pie-charts where outcomes displayed were the frequency and percentages.

- *Effects of Microsoft math solver on students' academic performance in quadratic equation:*

Data gathered through post intervention performance test was analysed to address this objective. Initial section provided results using percentage and frequency values in a frequency table. This was then followed by descriptive statistical result using mean, standard deviation, minimum and maximum values. The assumptions guaranteeing the usage of independent t-test was run followed by the actual independent t-test which was used to ascertain the level of statistical significance in the differences in mean scores between the treatment and control groups.

- *Perceptions of students on the use of Microsoft Maths solver in the learning of Quadratic equation.*

Questionnaire and interview guide were used to address this objective. Cronbach's alpha reliability test were produced for the questionnaire outcomes to check the level of internal consistency reliability between each group of variables. In all, 3 constructs were used with each having at least 7 sub-categories. Descriptive results (mean, standard deviation, minimum value and maximum values) were run to present the preliminary results on the objective. Pearson's correlation coefficient was run to ascertain the level of linear association between each pair of variables used in each case of the three constructs used to measure the objective.

Interview guide outcome was also discussed to augment the findings of the questionnaire. This was done using thematic analysis.

- *Gender difference in the performance of SHS students in the learning of quadratic equation using Microsoft Math Solver.*

Performance test results presented for the first objective was run using cross-tabulation where outcome was run with gender as a cross tabulation variable. This provided outcomes (frequency and percentages in frequency table), followed by descriptive statistics results showing mean, standard deviation, minimum and maximum values. Assumptions underlining independent t-test were run to pave way for the usage of independent t-test to check the level of significant difference between the mean scores between males and females.

3.6.1 Test of Assumption for the independent t-test

The independent t-test is a parametric test and therefore there were some assumptions that needed to be met before it was used to analyse quantitative data. The data that are collected in this study warranted the use of independent sample t-test due to the following motives. The scores from the performance test are interval scale and continuous. Again, the distributions of the data for both pre-test and post-test scores are approximately normal. Another assumption that needed to be met before the t-tests was used, was homogeneity of variance.

In addition, interview data were collected from the students in the experimental group after the post-test to answer the research question "What are the perceptions of students about the use of Microsoft Math Solver approach in teaching and learning quadratic equation?" The interview guide focused on students' experiences and opinions on the use of Microsoft Math Solver and reflected their views on their participation in the lesson. All interviews were audio-taped, transcribed and analysed. Verbatim quotations were used to support the discussions.

3.7 Results for test of Reliability

The researcher first tested the level of reliability of the various constructs used to measure perception using Cronbach's alpha as shown below:

Table 3.3. Cronbach's alpha Reliability test

Variable	Sub-Constructs	Items	Cronbach's Alpha	Cronbach's alpha based-on standardized items
Assessment	Assessment	07	0.975	0.978
Feelings	Positive feelings	04	0.975	0.977
	Negative feelings	04	0.981	0.981

Source: Field Study Area, February, 2023

Cronbach's alpha (α) reliability test value for the seven (7) items used to measure assessment of the participant students on their views on the use of **Microsoft** math solver in the learning of quadratic equation was 0.975 implying excellent internal consistency. The four (4) items used to measure positive assessment of the participants on Microsoft Maths Solver in the learning of quadratic equation also recorded Cronbach's alpha (α) reliability test value of 0.975 whiles that of negative assessment of the participants on Microsoft math solver in the learning of quadratic equation was 0.981. These values imply excellent internal consistency reliability for the various items used to measure the various sub-categories of perception of the students on the use of Microsoft math solver in the learning of quadratic equation.

3.8 Analysis of the Pilot Study Result

The post intervention was conducted using 61 students. The classes used were intact classes (31 and 30), hence the researcher adopted the purposive sampling technique. The first group consisting of 31 members formed the treatment group whiles the 30 which is the second group formed the control group. In all, out of the 61 students, 42 (68.9%) were males constituting the majority whiles the remaining 19 (31.1%) were females. A large number of the participants were at least 16 years old 47 (77%). The age range of the participants ranges from 13 to 22 years.

The researcher then intervened with use of Microsoft math solver to teach quadratic equation. The participants (the treatment group) were exposed to the treatment technique within 1 hour, 30mins and were allowed to ask questions for 15 minutes. After the intervention, the participants were asked to rate some identified perceptions of students towards Microsoft math solver. The findings indicated that the ratings for satisfaction, comfortability, engagement and insightfulness of lessons, time sufficiency, rating the lesson as well planned and useful learning strategy recorded very high responses indicating that majority rated them as agree and strongly agree. For instance, out of the 31 participants in the treatment group, 20

(64.5%) agreed that they felt comfortable and were satisfied with the lesson's effectiveness, for engagement and insightfulness, 25 (80.6%) agreed to it, time sufficiency recorded that 17 (54.3%) agreed while 19 (61.3%) agreed to the rating that the lesson was well planned and was a useful learning strategy. The participants were then asked to rate their level of feelings for the Microsoft math solver. The results were positively skewed towards agreed and strongly agreed for excitement or feeling challenged. Thus, 26 participants out of 31 (83.9%) agreed whiles 3 strongly agreed to the assertion that the lesson was exciting or felt challenged. 22(71%) of the participants also indicated that they were proud of themselves.

Attempt was made to check the gender variation in the results after the post-performance test was conducted. The treatment group consisted of 21 males and 10 females. The results indicated that the number of males 18 (58.1%) that recorded excellent marks (at least 80%) were about thrice the number of females 6 (19.4%) that recorded marks within that same range.

3.9 Trustworthiness of the Qualitative Data

In ensuring trustworthiness in the qualitative data, the researcher established credibility through the method of triangulation. Combining multiple data sources such as interviews with students and teachers, alongside observational data, enhances the credibility of the findings (Patton, 2015). Thus, information was corroborated from different sources such as interviews and questionnaires to develop more comprehensive understanding of the study.

Transferability was enhanced to ensure trustworthiness. This included information about the specific software used, the characteristics of the student population, and the educational setting (Creswell & Poth, 2018). The researcher provided detailed descriptions of the research context and participants to ensure the applicability of the findings to other educational contexts.

Dependability in the qualitative data was established to ensure trustworthiness. This includes detailed descriptions of data collection methods, analysis techniques, and any modifications made to the research protocol (Lincoln & Guba, 1985). The researcher established this through transparent documentation of research procedures.

3.10 Ethical considerations

Shamoo and Resnik (2009) defined ethics in research as the discipline that studies standards of conduct, such as philosophy, theology, law, psychology or sociology. In other words, it is a method, procedure or perspective for deciding how to act and for analyzing complex problems and issues. Protection of participants and their responses are assured by obtaining informed consent, protecting privacy and ensuring confidentiality. In doing this, the description of the study, the purpose and the possible benefits are mentioned to participants. The researcher permitted participants to freely withdraw or leave at any time if they deemed it fit.

CHAPTER FOUR

RESULTS/FINDINGS AND DISCUSSIONS

4.0 Overview

This chapter presents the results for the study, its analysis, as well as discussions on the findings. The first part provided demographic information on the respondents while the second section presents results on the effects of Microsoft math solver on students' academic performance in quadratic equation. Results on the perception of students on the use of Microsoft math solver in the learning of quadratic equation are also presented with results on the gender difference in the performance.

The results are presented under the following themes in response to the research questions posed:

1. Demographic characteristics of respondents.
2. Research question one - The effect of Microsoft math solver on SHS students' performance in quadratic equation
3. Research question two – The perception students have on the use of Microsoft math solver in the learning of quadratic equation.
4. Research question three - The gender difference in the performance of SHS students in the learning of quadratic equation using Microsoft math solver.

4.1 Demographic Characteristics of Respondents

Out of the sampled 120 students, 116 fully participated in the data gathering process.

The result indicates 96.7% respondent rate. Absenteeism was a reason for the inability to gather complete information from 4 of the sampled participants. The bio-data results are displayed below:

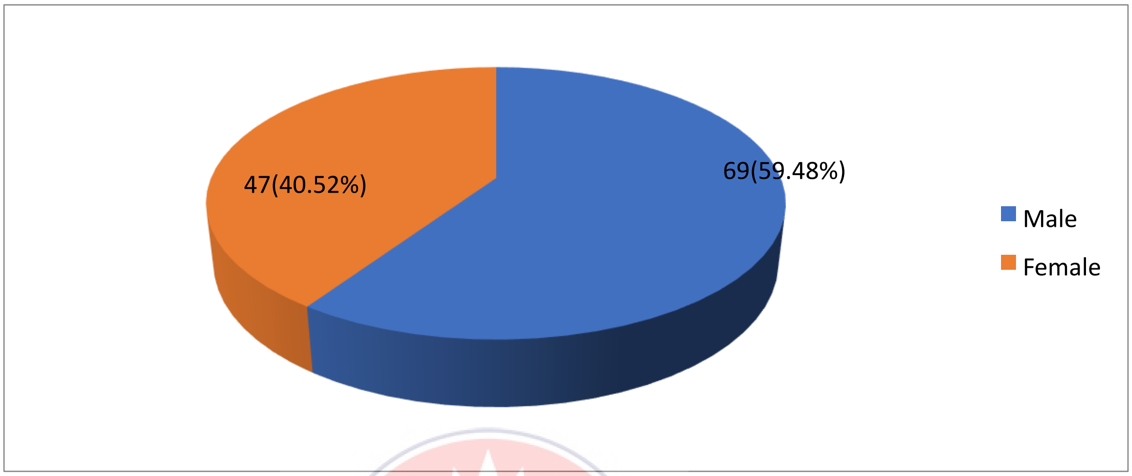

Figure 2: Gender of Participants
Source: Field Study Area, February, 2023

Results on gender as displayed in Figure 2 shows that 69 of the participants (representing 59.48%) were males implying males dominate the sampled participants used for the study. Female participants were 47 representing 40.52%.

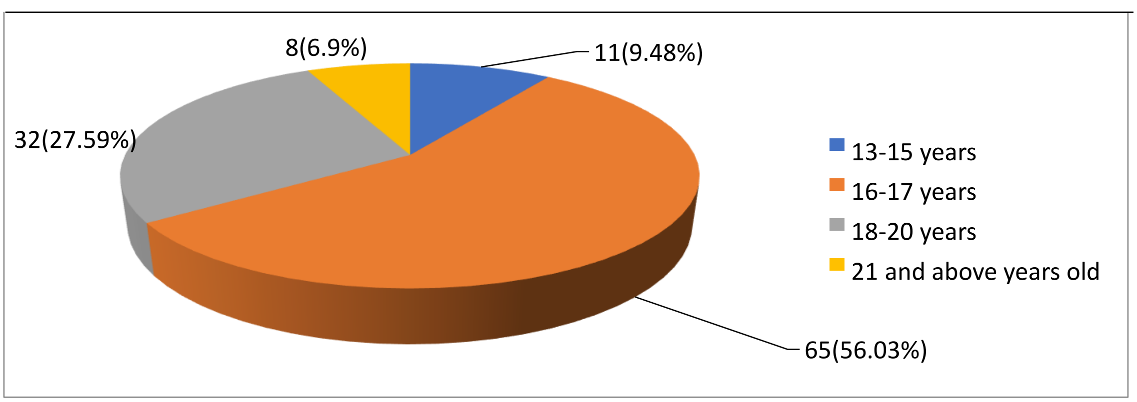

Figure 3: Participants' Age in ranges

Source: Field Study Area, February, 2023

Figure 3 indicates that 65 of the participants were in the age range of 16 to 17 years representing 56.03%. This outcome represents the majority of the participants. Participants in the age range of 18 to 20 years were 32 representing 27.59%. 11 participants representing 9.48% were at most 15 years of age whiles 8 participants agreed to be at least 21 years of age.

4.2 Effects of Microsoft math solver on SHS students' performance in quadratic equation

The first specific objective aimed to examine the effect of Microsoft math solver on SHS students' performance in quadratic equation. The participants were tested using performance test after the lesson. The results are as displayed below:

Table 4.1 Pre-test Result

	Control Group		Treatment Group	
Mark range	**Frequency**	**Percentage**	**Frequency**	**Percentage**
11-20	18	31.03%	12	20.69%
21-30	12	20.69%	10	17.24%
31-40	03	5.17%	05	8.62%
41-50	10	17.24%	10	17.24%
51-60	04	6.90%	06	10.34%
61-70	08	13.79%	11	18.97%
71-80	03	5.17%	02	3.45%
81-90	00	0.0%	02	3.35%
91-100	00	0.0%	00	00%
Total	**58**	**100%**	**58**	**100%**

Source: Field Study Area, February, 2023

Result from Table 4.1 indicates that 18 participants (31.03%) from the control group recorded marks lower than 21 whiles 12 (20.69%) from the treatment group recorded similar results. 12 participants from the control group recorded marks in the range of 21 to 30 whiles 10 (17.24%) participants in the treatment group recorded same. 3 participants (5.17%) from the control group recorded marks in the range of 31 to 40 whiles 5 participants (8.62%) in the treatment group recorded same. The results for marks in the range of 41 to 50 pulls parity in both groups as 10 participants (17.24%) from both groups recorded marks in that range. In all, the majority of marks recorded from both groups in the pre-intervention stage were below 50 indicating below average performance.

Independent t-test was run to check the whether the groups are comparable prior to intervention. The result is as shown below:

Table 4.2 Independent t-test of Pre-test result

	Levene's Test for Equality of Variances		t-test for equality of means						
				df	Sig. (2-tailed	Mean Diff.	Std. Error Diff.	95% confidence interval of the difference	
	F	Sig.	t					Lower	Upper
Equal variances assumed	.002	.964	-1.178	114	.241	-4.62	3.92381	-12.39	3.15
Equal variances not assumed			-1.18	113.96	.241	-4.62	3.92381	-12.38	3.15

Source: Field Study Area, February, 2023

Table 4.2 shows that the Levene's test outcome is not statistically significant since it recorded a p- value of 0.964. This implies we use the first row to interpret the results. The outcome indicates a t-test value of -1.178 with degree of freedom of 114 and level of significant at 0.241. The outcome indicates that the value is insignificant at 5% and hence it can be concluded that there is no statistical significance difference between the mean results from both the treatment and the control groups. This provides a good ground for intervention since the two groups are comparable.

Table 4.3 Post-test Result

	Control Group		Treatment Group	
Mark range	**Frequency**	**Percentage**	**Frequency**	**Percentage**
11-20	03	5.1%	00	0.0%
21-30	05	8.6%	00	0.0%
31-40	10	17.2%	00	0.0%
41-50	09	15.5%	01	1.7%
51-60	14	24.1%	01	1.7%
61-70	10	17.2%	09	15.5%
71-80	07	12.1%	20	34.5%
81-90	00	0.0%	16	27.6%
91-100	00	0.0%	11	19.0%
Total	**58**	**100%**	**58**	**100%**

Source: Field Study Area, February 2023

Table 4.3 indicates that the mark range with the highest number of participants is 51% to 60% for control group whiles 71% to 80% represents the modal range for the treatment group. The outcome indicates that most of the participants in the control group recorded marks below 50% whiles most of the participants recorded marks above 60% for the treatment group. A unique observation from Table 4.3 indicates that no participant in the treatment group had marks below 40% whiles no participant in the control group had marks above 80%.

The descriptive statistical result from the raw outcome is as shown below:

Table 4.4 Descriptive Statistics of Post-Test Results

Descriptive Statistics	Control Group	Experimental Group
Valid cases	58	58
Mean	51.22	81.29
Mode	40	90
Std. Deviation	16.991	11.247
Variance	288.703	126.492
Minimum	18	50
Maximum	83	100
Sum	2971	4715

Source: Field Study Area, February, 2023

Table 4.4 indicates a mean value for the experimental group as 81.29 with standard deviation of 11.247. The mean recorded for the control group was 51.22 with standard deviation as 16.991. The ranges of minimum and maximum marks obtained by members in the control group are 18% and 83% respectively whiles that of the experimental group are 50% and 100% respectively. The outcome indicates that participants in the treatment group perform much better compared to those in the control group. The study however tested the suitability of the independent t-test to warrant its usage to test the level of significance of the variation in the performance test results.

The results are presented below:

In all, the study data satisfied the following assumption.

Dependent variables are continuous scale as the test score were marked in percentages. The independent variables consist of two categories (treatment and control group). There were no significant outliers as indicated by the boxplot for both control group and treatment group shown below:

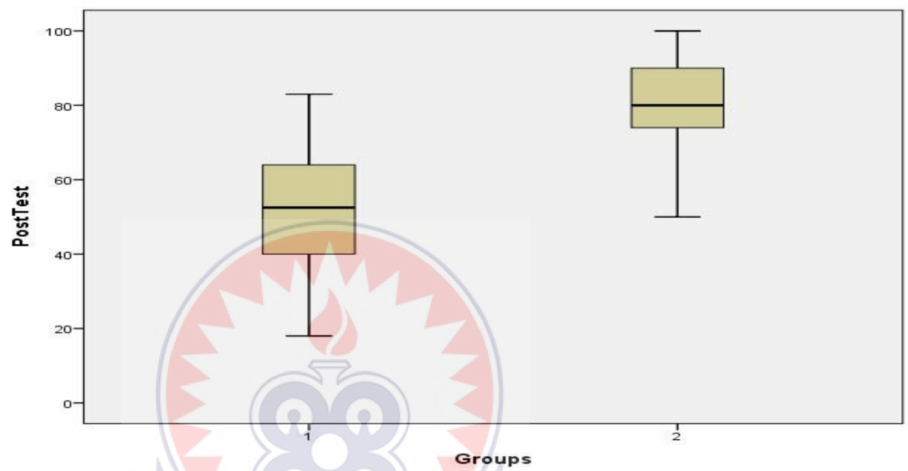

Figure 4.3 Post Test Box Plot (Test for outliers)

where 1= control group and 2 = treatment group

Test for normality is as shown below:

Table 4.5 Test for normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Control Group	0.069	58	0.200*	0.977	58	0.332
Treatment Group	0.081	58	0.200*	0.975	58	0.283

Source: Field Study Area, February, 2023

The Shapiro-Wilk test statistics values for the two groups are 0.977 and 0.975 with p-values as 0.332 and 0.283 respectively for control and experimental groups. Since these p-values are both greater than 0.05, we fail to reject the null hypothesis that both distributions are normally distributed.

The satisfaction of the above assumptions necessitates the usage of the independent t-test and paired t-sample test to check whether the intervention or the treatment was effective or otherwise. The result is as shown below:

Table 4.6 tested the following hypotheses:

Null hypothesis (H_o): There is no statistically significant difference between the mean scores of the control and experimental groups.

Alternative hypothesis (H_1): There is a statistically significant difference between the mean scores of the control and experimental groups.

Table 4.6 Output for independent t-test Test

	Levene's Test for Equality of Variances		t-test for equality of means						
	F	Sig.	t	df	Sig. (2tailed	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the Difference	
Equal variances assumed	11.09	.001	-11.24	114	.000	-30.07	2.68	-35.37	-24.76
Equal variances not assumed			-11.24	114	.000	-30.07	2.68	-35.38	-24.76

Source: Field Study Area, February, 2023

The Levene's test outcome is statistically significant with a p-value of 0.001. Per the rule of thumb, the study used the second row which is "non-equal variances assumed" based on the Levene's test outcome. Table 4.7 indicates a t-value of 11.24 with degree of freedom of114 This value is statistically significant at 1% significant level. The mean difference between the two groups is -30.07. This outcome indicates that indeed there is effectiveness in the treatment administered.

Table 4.7 Paired t-sample test result for the experimental group, before and after

	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig.
				Lower	Upper			(2-tailed)
BF−AF	-30.069	19.659	2.581	-35.24	-24.90	-11.65	57	0.000

where BF. = Before and AF. = After
Source: Field Study Area, February, 2023

The table 4.7 tested the following hypotheses:

Null hypothesis (H_o): There is no improvement in the performance of students in the experimental group after the intervention.

Alternative hypothesis (H_1): There is improvement in the performance of students in the experimental group after the intervention.

Table 4.7 indicates mean difference value of -30.069 implies that indeed the after marks exceeded the before group performance in the administered test by 30.069. This outcome indicates that indeed there is effectiveness in the treatment administered however, rejecting the null hypothesis requires sufficient justification using the p-value, t-value and the confidence interval differences. The t-value calculated as recorded in the table is -11.65 and the critical t-value from the t-distribution table given the confidence level of 95%, degree of freedom of (n-1 = 58-1) of 57 at a two –tailed test is ± 2.0025. The t-calculated (-11.65) is greater than the t-critical (-2.0025) and hence it implies we reject the null hypothesis that “the mean difference between the paired test scores is zero" implying that the mean difference of the paired result is non-zero.

Using the p-value, the conventional significance levels are 0.01, 0.05 and 0.1. However, the recorded inferential p-value as indicated in Table 4.7 is 0.000 which is below the three conventional significance levels. This outcome implies that the null hypothesis can confidently be rejected implying that indeed the mean scores between the paired test scores is significantly different from zero. Thirdly, since the rule of thumb is that should the lower and upper confidence intervals have the same sign and do not cross nor include zero, then we can confidently reject the null hypothesis. From Table 4.7 above, the lower and upper confidence intervals recorded were -35.24 and – 24.90 indicating that both have negative signs and implies do not include zero. This outcome indicates that we can confidently reject the null hypothesis based on the rule of thumb.

The above three justification proves that indeed the mean scores between the before and after test scores is significantly different from zero. This observation implies that the treatment given was effective.

The above proves that indeed the mean scores within the experimental group is significantly different from zero. This observation implies that the treatment given was effective. Thus, the Microsoft math-solver was effective in helping to improve students' performance in quadratic equation. The above finding conforms to varied research findings such as the works of Handayani et al. (2019) which concluded that the use of the Computerized Assisted Instruction to solve mathematics and science problems remain effective as it makes solving quicker and easier. The result is equally in harmony with the findings of Rawa et al. (2020) that GeoGebra and Microsoft math solver exerts significant positive impacts on training and mentoring activities of students. The above findings equally remain in line with the works of Rizki and Widyastuti (2019) and Suryacitra and Oktavia (2019) as the they concluded that the use of the Microsoft Mathematics program can improve students' accuracy in solving the mathematics problems. They also asserted that they are designed to make the teaching and learning of Algebra very simple for both teachers and learners and allows students to organize and direct their education and remediation of concepts.

4.3 The perception of students on the use of Microsoft math solver in the learning of Quadratic equation

The second research objective was aimed at determining the perception students have on the use of Microsoft math solver in the learning of quadratic equation. This was assessed by administering questionnaire to the 58 participants that were in the treatment group. Equally, interviews were also done with 4 students of the said students to get more information relating to their perception on the use of Microsoft math solver in the learning of quadratic equation. The interview responses were used to augment the findings from the research questionnaire distributed.

Discussion of results from the questionnaire distributed:

The questionnaires distributed were grouped into two parts: assessments and feelings. The descriptive statistical results were represented by mean and standard deviation. As such, the construct with mean value 1.0 - 2.4 indicated a negative perception, 2.5 - 3.4 (Neutral attitude), and 3.5-5.0 (Positive attitude) above 3.5 is interpreted as a statement in which majority of the participants unanimously are in agreement with. However, statements with mean values below 2.5 is interpreted as statements that participants "unanimously disagreed" with. Mean values between 2.5 and 3.4 is interpreted as neutral.

The frequency distribution of the first group of results is as shown below:

Table 4.8 Frequency distribution on the views or assessment of Microsoft math solver session

Assessments of math solver training session	SD	D	N	A	SA
I was satisfied with the math solver sessions	0	0	3(5.2%)	29(50%)	26(44.8%)
I was comfortable with the training sessions	0	0	11(19%)	22(37.9%)	25(43.1%)
The sessions were engaging and insightful	0	3(3.5%)	8(13.8%)	21(36.2%)	26(44.8%)
There was sufficient time for practice	0	1(1.7%)	6(10.3%)	26(44.8%)	25(43.1%)
The sessions were well planned and interactive	0	1(1.7%)	5(8.6%)	27(46.6%)	25(43.1%)
Strategies used were useful for learning quadratic equation	0	1(1.7%)	5(8.6%)	22(37.9%)	25(43.1%)

Source: Field Study Area, February, 2023

The results show that majority of the participants 29(50%) agreed that they are satisfied with Microsoft math solver sessions. This was followed by 26 (44.8%) participants that strongly agreed to the statement whiles only 3(5.2%) selected neutral. For the statement to measure how comfortability with the Microsoft math solver training session, most of the respondents 25(43.1%) strongly agreed to the statement. This was followed by 22(37.9%) that agreed to the statement whiles only 11(19%) participants selected neutral.

Majority of the participants 26(44.8%) strongly agreed that the training session is engaging and insightful. This was followed by 21(36.2%) that agreed to the same statement. 8(13.8%) selected neutral whiles 3(5.2%) disagreed to the statement. For the statement aimed to measure time sufficiency for individual practice during the training session, majority of the participants

Majority of the participants 27(46.6%) agreed that the strategies used were useful for learning algebra. This was followed by 25(43.1%) participants that strongly agreed to the same statement. 5 selected neutral (8.6%) whiles only a participant disagreed to the statement.

For the statement to measure participants' agreement or disagreement with whether the training session was well planned and interactive Microsoft math solver session, majority26(44.8%) agreed to it. This was followed by 25(43.1%) that strongly agreed to the statement. 6 participants (10.3%) selected neutral whiles only a participant disagreed to the statement.

The descriptive statistical results are as below:

Table 4.9 Descriptive Statistics on the views or assessment of Microsoft math solver training session

Assessments of math solver training session	Min.	Max	Mean	Std. dv.
Satisfaction with math solver sessions	3	5	4.40	0.591
Comfortability with the math solver training sessions	2	5	4.26	0.785
Engaging and insightful math solver training sessions	3	5	4.24	0.757
Sufficient time for individual practice	2	5	4.27	0.874
Well planned and interactive math solver sessions	2	5	4.29	0.726
Useful strategies for learning quadratic equation	2	5	4.31	0.706
Improvement of understanding of quadratic equation	2	5	4.22	0.796
Overall Mean			4.29	

Source: Field Study Area, February, 2023

Table 4.9 result indicates that satisfaction with Microsoft math solver recorded the highest mean value of 4.40 with standard deviation of 0.591. This indicates that participants were satisfied with the Microsoft math solver in learning and solving quadratic equation. Result from Table 4.9 indicates that the strategies used in lesson delivery using the Microsoft math solver were rated to be very useful in learning and solving quadratic equation as it recorded very high mean value of 4.31 with standard deviation of 0.706. Well planned and interactive Microsoft math solver lesson recorded the third highest mean value of 4.29 with standard deviation of 0.726. Time sufficiency during lesson delivery for individualized practice recorded a high mean value of 4.27 with standard deviation of 0.874. Comfortability with Microsoft math solver as a Computer Assisted Instructions based on the organized learning session recorded an equally high mean value of 4.26 with standard deviation of 0.785. Engaging and insightful organized Microsoft math solver lesson equally recorded a high mean value of 4.24 with standard deviation of 0.757. The Microsoft math solver lesson equally recorded a high mean value of 4.24 with standard deviation of 0.757. The Microsoft math solver lesson as a Computer Assisted Instruction recorded a high mean value of 4.22 with standard deviation of 0.796.

All the variables used to measure assessment or views of Microsoft math solver session recorded mean values above 3.0, preferably in ranges of 4.21 to 4.40. These observations imply respondents rated the stated variables used to measure the views of participants on the Microsoft math solver session to exert positive rippling effects including conformability and satisfaction with lesson delivery, engaging and insightful lesson and interactive lesson useful strategies explored which are relevant for learning quadratic equation and finally helping to improving understanding. From Table 4.9o, the overall mean value recorded was 4.29 indicating majority of the participants have positive views or assessment of Microsoft math solver training session.

The observation in Table 4.9 shows outcomes that remain consistent with the findings displayed in Table 4.5 where independent t-test result indicates effectiveness of the use of math solver in helping improve students' performance in quadratic equation. The above observation is however in line with the assertions of Handayani et al. (2019) that Microsoft math solver can be used to solve mathematics and science problems more quickly and easily in teaching important basic concepts. The above observation is also in harmony with the assertions of Rizki and

Widyastuti (2019) that Microsoft math solver help to increase students' learning motivation. It is equally in consonance with the findings of Rawa et al. (2020) showing that the use of GeoGebra and Microsoft Mathematics guarantees participants understanding and improve performance in solving mathematics.

The researcher equally tested the linear association between the various constructs used to measure the Views or perception of participants on Microsoft math solver session. This was aimed to check the extent to which there exist either positive or negative linear association between the various measurement constructs which could help to ascertain the level of linear relationship that exist between them. The results are as displayed below:

Table 4.10 Pearson's Correlation on the assessment of math solver training session

	Sat.	**Comf.**	**Engage**	**Time Suff.**	**Interact.**	**Strat.**	**Underst.**
Satisfaction	1						
Comfortability	0.87	1					
Engaging	0.88	0.81	1				
Time Sufficient	0.82	0.97	0.83	1			
Interactive	0.91	0.79	0.92	0.83	1		
Usefulness	0.88	0.80	0.91	0.92	0.92	1	
Understanding	0.85	0.92	0.87	0.91	0.83	0.84	1

Source: Field Study Area, February, 2023

Where: *Sat= Satisfaction with math solver, Comf.=Comfortability of math solver training, Engage=Engaging and Insightful, Interact= Interactive and well planned math solver lesson, Strat = Strategies are useful for learning quadratic equation, Underst.= Help improve understanding.*

The outcome as displayed in Table 4.10 indicates that comfortability with Microsoft math solver, Time sufficiency of Microsoft math solver recorded the highest Correlation Coefficient of 0.97. Satisfaction with Microsoft math solver and Time sufficiency of Microsoft math solver recorded the least correlation coefficient of 0.82. The outcomes as displayed in Table 4.9 indicates that all the pairs of constructs used to measure assessment or views of participants on Microsoft math solver recorded very high correlation coefficients in the range of 0.82 to 0.97 indicating excellent linear association between each pair. The result displayed in Table 4.10 conforms to the findings in Table 4.9 as all the various constructs individually recorded mean marks above 4.0. Though correlation is not a causality, the result can be interpreted as existence of excellent linear association between each pair of assessment. As such, since all the above assessment constructs are positive statement, the study could deduce that participants had positive views about the Microsoft math solver Thus, they are satisfied and comfortable with the Microsoft math solver. They equally believed that the Microsoft math solver used was engaging and insightful, well planned and interactive, strategies used were useful for learning Quadratic equation, time was sufficient for individualized practice and as such argued the Microsoft math solver help improved their understanding of quadratic equation.

The findings are in consonance with several empirical findings. For instance, it was established that Microsoft math solver help increase individuals' interest (Guo, 2018; Sharma, 2017), learning to be more engaging by shifting learning from being teacher-centered to student-centered. Usman and Madudili, (2020) also argued that Microsoft math solver enhances learning by being an interactive process that helps learners reach designated instructional goals and improve education outcomes and also enhances learner-controlled instruction, prompt feedback, self-pacing, and adaptability (Usman & Madudili, 2020). It is equally in consonance with the conclusion of Technology supports students' mastery of concepts at each level by allowing students to repeat activities until they understand (Saveg-Sanchez & Rodriguez, 2020). In a related study, it was concluded that Microsoft math solver provides practice activities that are challenging to students and stimulate their curiosity, increases students' motivation, confidence (Hamilton, 2019; Keenan, 2020).

The frequency distribution for the second group of variables used to measure feeling of students about the Microsoft math solver session is as shown below:

Table 4.11 Frequency table on the feelings about Microsoft math solver training session

Feeling	SD	D	N	A	SA
Excited	0	1(1.7%)	17(29.3%)	19(32.8%)	21(36.2%)
Frustrated	21(36.2%)	20(34.5%)	17(29.3%)	0	0
Challenged	0	1(1.7%)	17(29.3%)	12(20.7%)	28(48.3%)
Annoyed	16(27.6%)	25(43.1%)	17(29.3%)	0	0
Confused	25(43.1%)	16(27.6%)	17(29.3%)	0	0
Proud of oneself	0	1(1.7%)	12(20.7%)	24(41.4%)	21(36.2%)
Bored	16(27.6%)	25(43.1%)	15(25.9%)	2(3.4%)	0
Relaxed	0	1(1.7%)	10(17.2%)	26(44.8%)	21(36.2%)

Source: Field Study Area, February, 2023

From Table 4.11, majority of the participants 21(36.2%) strongly agreed that the Microsoft math solver is exciting. This was followed by 19 (32.8%) that selected agreed, 17(29.3%) chose neutral while 20(34.5%) participants selected disagreed. Also, majority of the participants 21(36.2%) strongly disagreed that the Microsoft math solver session was frustrating. This was followed by 20 (34.5%) that disagreed, 17(29.3%) chose neutral while no participant agreed to the proposition.

From the Table 4.11 above, majority of the participants 28(48.3%) strongly agreed that the Microsoft math solver is challenging. This was followed by 17(29.3%) that selected neutral, 12(20.7%) choose agreed whiles a participant selected disagree.

From the Table 4.11 above, majority of the participants 25(43.1%) disagreed that the Microsoft math solver session is annoying. This was followed by 17 (29.3%) that selected neutral, 16(27.6%) choose strongly disagree whiles no participant agreed to the proposition.

From the table, majority of the participants 25(43.1%) strongly disagreed that the Microsoft math solver session is confusing. This was followed by 17(29.3%) that choose neutral, 16(27.6%) selected disagree whiles no participant agreed to the proposition. From the table above, majority of the participants 21(36.2%) strongly agreed that they are proud of themselves after the Microsoft math solver session is exciting. This was followed by 24(41.4%) that selected agreed, 12(20.7%) choose neutral while a participant selected disagree.

From the table majority of the participants 25(43.1%) disagreed to the statement that the Microsoft math solver session is boring. This was followed by

16(27.6%) participants that strongly disagreed to the statement, 15 (25.9%) selected neutral whiles 2(3.4%) participant selected agreed.

From the table above, majority of the participants 26 (44.8%) agreed that they were relaxed throughout the Microsoft math solver session. This was followed by 21 (36.2%) that selected agreed. 10 (17.2%) choose neutral while a participant selected disagree.

The descriptive result is as shown below:

Table 4.12 Descriptive Statistics on the feelings about Microsoft math solver training session

Items	Minimum	Maximum	Sum	Mean	Standard deviation
Excited	2	5	234	4.16	0.768
Frustrated	1	3	112	1.93	0.814
Challenged	2	5	241	4.16	0.914
Annoyed	1	3	117	2.02	0.761
Confused	1	3	108	1.86	0.847
Proud of myself	2	5	239	4.12	0.796
Bored	1	4	119	2.05	0.826
Relaxed as lesson was successful	2	5	241	4.03	0.858
Overall mean				**3.04**	

Source: Field Study Area, February, 2023

Table 4.12 results indicates that participants feeling being challenged as well as excited recorded as assessment of participants feeling pulls parity with the highest mean value of 4.16 whiles recording standard deviations of 0.914 and 0.768 respectively. This was followed by participants being proud of themselves which recorded mean value of 4.12 with standard deviation of 0.796. Feeling relaxed as lesson was successful recorded a mean value of 4.03 with standard deviations of 0.858. All the 4 positive statements used to rate participants' feelings recorded mean marks above 4.0 implying participants believed the Microsoft mathematics solver used exerts positive rippling effects on their perceptions about quadratic equation.

On the other hand, Table 4.12 outcome indicates that being confused recorded the least mean value of 1.86 and standard deviation of 0.847 among all the as a negative statement regarding participants' feeling. This was followed by being frustrated that recorded a very low mean value of 1.93 with standard deviation of 0.814. Being annoyed recorded a low mean value of 2.02 with standard deviations of 0.761 whiles being bored whiles lesson was on-going recorded an equally low mean value of 2.05 with standard deviation of 0.826. The outcome indicates that the Microsoft mathematics solver used does not actually exert much negative feelings on the participants. This result was not surprising as the 4 positive statements used to measure the participants' feelings recorded high mean values. The overall mean value recorded was 3.04 indicating above average level rating of feelings of participants relating to Microsoft math solver training session organised.

Table 4.13 Pearson's Correlation on the feelings about Microsoft math solver training session

	Excit.	**Frust.**	**Chall.**	**Annoyed**	**Conf.**	**Proud**	**Bored**	**Relax**
Excit	1							
Frust.	-0.977	1						
Chall	0.933	-0.906	1					
Annoyed	-0.915	0.937	-0.862	1				
Conf.	-0.911	0.953	-0.876	0.902	1			
Proud	0.944	-0.935	0.866	-0.872	-0.885	1		
Bored	-0.895	0.920	-0.848	0.976	0.889	-0.864	1	
Relax	0.924	-0.909	0.840	-0.846	-0.857	0.973	-0.816	1

Source: Field Study Area, February, 2023

Where excit.= Excitement, Frust.= Frustrated, Chall.= Challenged, Conf.= Confused. Relax= Relaxed.

The findings indicate that there exist highly negative linear association with a positive statement pairing with a negative statement as discussed above. This indicates that one individual cannot have both negative and positive sentiments about the Microsoft math solver at the same time. For instance, the result displayed in Table 4.13 indicates that being frustrated and excited recorded the highest negative linear correlation coefficient of −0.977. The least negative linear association was recorded between being relaxed after a successful lesson and feeling of being bored with the entire lesson as the pair recorded linear correlation coefficient of −0.816.

The findings as displayed in Table 4.13 indicates that each two pairs or one directional rating of feelings of participants (either two pairs of negative statements or two positive pairs of statements) recorded highly positive correlation coefficients.

For instance, excited and challenged recorded coefficient of 0.933, feeling excited and proud recorded a correlation coefficient of 0.944 whiles excited and relaxed after the success of the lesson recorded correlation of 0.924. Equally, feeling frustrated and annoyed recorded correlation coefficient of 0.937, feeling frustrated and confused recorded 0.953 whiles feeling frustrated and feeling bored recorded correlation coefficient of 0.920. The outcome indicates that a participant either have positive feelings or negative feelings about the entire Computer Assisted Instruction (CAI) and not mixed feelings. However, the outcome as displayed in Table 4.9 and Table 4.12 indicates positive perceptions (assessment and feelings) seem to dominate the negative perceptions.

The above findings conform to the findings of several recent empirical studies as it was concluded that CAI prevents students from getting bored or lost because a teacher is moving too slow or too fast, respectively (Hamilton, 2019; Ungvarsky, 2020).

Discussion of results from the Interview Guide conducted:

The researcher (here-in referred to as the interviewer) conducted interviews with four students (here-in referred to as interviewee) to assess their perceptions on the Microsoft math solver used during the intervention stage. The results are discussed below:

Participants were asked to state how they prefer to learn (whether alone or in a group) and to state why. Some respondents selected group learning whiles some selected learning alone. Respondents that selected preference for learning alone argued that it helps in learning fast and guaranteed focused learning unlike groups learning characterised by disturbances from some group members. Those that selected preference for group learning justified their stands by arguing that group learning ensures that average students serve as mentors for low performing students and it promotes team learning.

Participants were further asked whether they enjoyed learning Quadratic equations before the current academic year. This was aimed to ascertain whether or not increase in students' interest and motivation towards learning the topic after the intervention was as a result of the Microsoft math solver used. Participants were divided in terms of responses relating to the question as some stated that they actually enjoyed learning quadratic equation as it was very simple and straight forward topic. Those who agreed that they did not enjoy learning quadratic equation argued that mathematics in general is difficult and quadratic equation is not an exception. Participants were then asked whether they have been introduced to Microsoft math solver before. All the sampled participants unanimously disagreed to this statement. This finding implies that the use of the Microsoft math solver remains a novel mathematics instructional method the participants have been introduced to and as such will be in the best position to assess its usefulness compared to traditional teaching method.

Participants were further asked to state their experience with the current Microsoft math solver. Responses of participants includes increasing their ideas and ability to solve questions in quadratic equation using the three approaches (factorization method, completing of squares and the use of quadratic formula) relative to the traditional method that exposed them to only one method (the factorization method). Some also argued that the lesson was interactive, user friendly, reduced boredom and ultimately increase their understanding of the topic.

Participants were further asked to indicate the aspect of the lesson (learning of Quadratic equation) with the use of Microsoft math solver went well and supported your understanding. The participants unanimously argued that the entire lesson was well explained and as such boost their understanding of the topic. When asked to indicate the aspect of the intervention lesson (with Microsoft math solver) they find difficult, they argued that all the parts were easy task and hence did not find any as cumbersome or difficult. They were further asked to indicate whether or not the use of the Microsoft math solver helped in changing their thinking about Quadratic equation problems. Participants stated that indeed the use of the Microsoft math solver indeed changed their perception and feelings about quadratic equation and mathematics as a whole. They argued that as compared to the traditional teaching method, the use of the Microsoft math solver provided platform for a more interactive lesson through the use of technology, it encourages students' participation and provides flexible learning to guarantee that key concepts are understood.

Lastly, participants were asked to state how they worked (group or individual) when using the current Microsoft math solver and justify their responses. The participants argued that they initially worked in groups after which they were confident and worked alone. Compared to the earlier findings where some of the participants argued to have preference for group learning, these recent findings indicate that the use of the Microsoft math solver has helped boost the confidence level of participants and as such increase their ability to work in individually. This finding is in harmony with the suggestions of Bloom's taxonomy that places emphasis on individualized practice to boost mastery learning (Ungvarsky, 2020).

The findings discussed from the interview guide conform to the results from the questionnaire and clearly ascertain the effectiveness of the intervention strategy in helping to boost participants' perception about Microsoft math solver positively. As such, the use of the Microsoft math solver has helped to increase participants understanding about quadratic equation. These findings support the conclusions of Berrett and Carter (2018) that argued that the use of Microsoft math solver allows students with opportunities to have a feel of what they learn, thereby making them see mathematics as non-abstract, as well as boosting their understanding.

4.4 Gender Difference in performance of students in learning quadratic equation using Microsoft math solver.

The last research question was aimed at examining the gender differences in the performance of SHS students in the learning of quadratic equation using Microsoft math solver. The intervention performance test results were used to address this objective. The first part provided raw result considering mark ranges whiles the second part provided descriptive statistics to show the gender variations in result.

Table 4.14 Frequency distribution of gender variation in post-intervention (use of Microsoft math solver) performance test

	Male		Female	
Mark	**Frequency**	**Percentage**	**Frequency**	**Percentage**
50-60	0	0%	02	9.52%
61-70	03	08.1%	06	28.57%
71-80	14	37.84%	06	28.57%
81-90	14	37.84%	02	9.52%
91-100	06	16.22%	05	23.81%
Total	37	100%	21	100%

Source: Field Study Area, February, 2023

Table 4.14 result indicates that out of a total male of 37, majority had marks in the ranges of 71 to 90 (thus 71 to 80 and 81 to 90 recorded equal frequency of 14 representing 37.84% each). 6 of the participant males had marks in the range of 91 to 100 representing 16.22%, 3 had marks in the range of 61 to 70 representing 0.81%. No male had marks below 60%. For the female participants, out of 21, equal number of them had marks in the range of 61 to 70 and 71 to 80; thus n= 6 representing 28.57% each. This was followed by 5 participant females that had marks in the range of 91 to 100; The result for the number of females that had marks in the range of 81 to 90 and from 50 to 60 pulls parity with equal number of participants; thus n = 2 representing 9.52%.

The descriptive result is as shown below:

Table 4.15 Descriptive statistics of gender and performance in post-test

Gender	N	Min.	Max.	Sum	Mean	Std. Dev.
Male	37	64	100	3094	83.62	8.87
Female	21	50	100	1621	77.19	13.83

Source: Field Study Area, February, 2023

The result as displayed in Table 4.15 indicates that males recorded a higher mean test outcome of 83.62 with a standard deviation of 8.87 whiles their female counterparts recorded mean test mark of 77.19 with a standard deviation of 13.83. The minimum test result for males was 64 compared to that of females as 50. Independent t-test was used to test for the significance of the mean test outcome based on gender. The data used to analyse the variations in post intervention test as presented in Table 4.6 (independent- t test) is the same and hence all the assumptions tested in table 4.6 remains justified as far as the test is concern. The outcome is as shown below:

Table 4.16 below tested the following hypotheses:

Null hypothesis (H_o): There is no statistically significant difference between the mean scores of males and females.

Alternative hypothesis (H_1): There is a statistically significant difference between the mean scores of the males and females.

Table 4.16 Independent samples t-test for variation in test score between gender

	Levene's Test for Equality of Variances		t	df	t-test for equality of means				
					Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	95% confidence interval of difference	
	F	Sig.						Lower	Upper
Equal variances assumed	6.88	.011*	2.16	56	.035*	6.43	2.98	.4642	12.40
Equal variances not assumed			1.92	56	.065	6.43	3.35	-.4182	13.28

*Where *represent 5% significance level*

Source: Field Study Area, February, 2023,

The outcome as displayed in Table 4.16 indicates Levene's F-statistics value of 6.88 which is significance at 5% significance level. This justifies the usage of the second row (no-equal variance) in interpreting the results according to the rule of thumb. From Table 4.16 the t-value recorded is 1.92 and is not-significance at two-tailed at 5% significance level. This value indicates that indeed there is no significant difference between the mean scores of the two sexes (male and female). The result does not conform to the findings of Frey (2018) that found out that males outperformed their female counterparts in Odyssey mathematics in a typical school. It however conforms to the findings of Josiah and Adejoke (2014) that concluded that though males perform better in terms of mathematics compared to females the outcome is not significant.

4.4 Summary of Chapter

The initial section of the chapter provided descriptive statistical report on the 116 out of the 120 sampled participants. This includes results on gender and age range**.** Results were also presented on the Microsoft math solver on SHS students' performance in quadratic equation. Independent t-test was run for the pre-Test outcome to confirm if the two independent groups are comparable and the outcome indicates they are almost at pair in terms of performance and hence are comparable. Subsequent independent t-test was run for the post test result and the outcome indicates the intervention was successful. The third section of the chapter provided results on the perception of students on the use of Microsoft math solver in the learning of quadratic equation. The first part discussed results from questionnaires distributed whiles the second part provided results on the interview conducted. The overall mean values recorded indicate participants rating their level of perception about Microsoft math solver as positive. This was validated by findings from the interview. The fourth section of the chapter provided results on the gender Difference in performance of students in learning quadratic equation using Microsoft math solver. The independent t-test result indicates that there is no statistical significance difference between mean results between each gender.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMENDATIONS

5.0 Overview

This chapter discusses the summary of the findings where key outcome of the study as discussed in chapter four were highlighted. Conclusions are then provided to cover the entire study. The chapter also provides recommendations to mathematics teachers at the Senior High level, educational policy makers and curriculum developers. Also, suggestions are provided for further studies.

5.1 Summary of the Study

This study assessed the effect of Microsoft math solver on the mathematics performance of senior high school students. It did so with the objectives of examining the effect of Microsoft math solver on SHS students' performance in quadratic equation, determining the perception students had on the use of Microsoft math solver in the learning of quadratic equation. Also, it did so by examining the effect of gender difference in the performance of SHS students in the learning of quadratic equation using Microsoft math solver.

In all, out of the sampled one hundred and twenty students, one hundred and sixteen fully participated in the data gathering process from the -year two students. Three instruments were used for the study: a test, questionnaire, and an interview protocol. The test consisted of constructed response items of which it demanded students to respond to all questions. Participants were given the test before the intervention was introduced. Participants were also assessed after the intervention to ascertain the effectiveness of Microsoft math solver. Four randomly sampled students from the experimental class were also interviewed about their perception on the use of It did so with the objectives of Microsoft math solver in the learning of Quadratic Equation. Questionnaire responses were assessed qualitatively. The interview was conducted a day after the test. Scoring of the test was done quantitatively.

The interview helped the researcher to gain a deeper insight into the participants' perception of the Microsoft math solver in learning of quadratic equation. The conceptual understanding of the concepts demonstrated by participants in both the test, questionnaire, the interview and the ideas required to be able to answer the test items helped the researcher determine participants' levels of understanding of quadratic equation using Microsoft Maths solver.

5.2 Findings

5.2.1 Research Question One

This question was to examine the effect of Microsoft math solver on SHS students' performance in quadratic equation.

It was revealed that students who learned using Microsoft math solver from the analysis of the study demonstrated significant understanding of quadratic equation, thus comparable to the traditional method of teaching and learning quadratic equation, Microsoft math solver demonstrated a positive shift in conceptual understanding of quadratic equation. Participants demonstrated high conceptual understanding of quadratic equation, thus before the introduction of Microsoft math solver and after the session showed participants developing conceptual understanding of quadratic equation. It was revealed that Microsoft math solver helped improved students' performance in quadratic equation.

5.2.2 Research Question Two

The second research question was geared towards determining the perception students had on the use of Microsoft math solver in the learning of quadratic equation. It was revealed during the analysis in the study that respondents demonstrated positive perception on the use Microsoft math solver in the learning of quadratic equation. Participants demonstrated positive feelings regarding the use of Microsoft math solver in the learning of quadratic equation. Participants demonstrated that positive feelings exert positively on their understanding of quadratic equation using Microsoft math solver. Participants could comprehend quadratic equation with the help of Microsoft math solver because of positive feelings for Microsoft math solver usage. It was also revealed that participants demonstrated satisfaction of the Microsoft math solver session, thus the Microsoft math solver session helped them in understanding Quadratic equation.

5.2.3 Research Question Three

This question was to examine the effect of gender difference in the performance of SHS students in the learning of quadratic equation using Microsoft math solver. Regarding gender of students and the role it plays on how students perceive mathematics using Microsoft math solver in quadratic equation; it was revealed that the statement that males are far better than females using Microsoft math solver in learning mathematics was a false statement. Female respondents demonstrated mastery of Microsoft math solver in learning quadratic equation, thus, understanding of quadratic equation using Microsoft math solver was not in consensus that gander really influences how Maths is perceived. Analysis from the study revealed that gender of the student would not make them form perceptions on Maths. Admittedly, being male or female does not change how Maths is perceived by these students, either positive or negative. This implied that the gender of a student does not influence how Maths is perceived using Microsoft math solver. Then again it was revealed that being a male or female generally does not mean one would have a positive attitude towards Maths.

5.3 Conclusion

Technology has permeated and changed almost every aspect of our lives. Education is no exception. There is no doubt that educational technology will continue to play an increasing important role in our classroom teaching in the years ahead. The present review concludes that students were able to learn mathematics with ease when exposed to Microsoft math solver and communicate effectively. Microsoft math solver provided students with immediate feedback and assistance allowing them to explore the concept of quadratic equation on their own pace and gained a deeper understanding of quadratic equation.

In addition, based on the findings that learners had positive perception in learning quadratic equation using Microsoft math solver it was then concluded that, the Microsoft math solver approach develops students to become critical thinkers, self-directed and good self-motivators. Since the Microsoft math solver helped the students construct their own understanding through their interaction with the math solver their critical thinking skills were developed. This helped the learners in becoming self-centered and increased their confident levels.

Furthermore, it was concluded that gender has insignificant impact on how mathematics is perceived using the Microsoft math solver approach. People always have the wrong notion that males perform way much better than females in terms of mathematics. The Microsoft math solver has proven such perception wrong by proving that there is equality in mathematics performance between males and females, hence gender has no significant effect on how mathematics is understood and truly its research proved it right

5.4 Recommendation

On the bases of the finding that, students who learned using Microsoft math solver performed better than those exposed to conventional method in learning quadratic equation, it is recommended that mathematics teachers and curriculum developers should incorporate Microsoft mathematics solver in teaching quadratic equation as a mathematics topic as it will exert positive rippling effects on learners' performance.

The study further recommends that Mathematics teachers in the Senior High Schools should create learning environment that would foster positive perceptions in students towards learning of mathematics when using Microsoft math solver. Also, Mathematics teachers that wish to adopt Microsoft math solver to teach mathematics should ensure the lesson is well planned to allow for individual practice. This will help boost students' participation, reduce boredom as well as increase students desire in learning quadratic equation.

Furthermore, based on the finding; males perform better in terms of mathematics compared to females but the outcome is not significant using the Microsoft math solver, therefore it is recommended that equal attention should be placed on females to males when adopting Microsoft math solver to teach mathematics since both gender has equal ability in grasping mathematical concepts. As such, they should be grouped with males and allow to take the roles of leadership in their groups .and, they should be paired with average students at the initial stage of the lesson delivery process and as those students developed the skills needed to solve the question individually, they can be separated to attempt individual practice.

5.5 Areas for Further Research

The study suggested that new researchers should focus on the use of Microsoft Mathematics solver in solving other mathematics topics aside quadratic equation. They should consider topics such as arithmetic problems, matrices, statistics, and trigonometry. Equally, further studies can focus on the use of other Computer Assisted

Instructions (CAI) such as GeoGebra in solving geometry, algebra and calculus. This will provide empirical findings which can be compared to the findings from this recent study.

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UNIVERSITY EDUACTION, WINNEBA

SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF MATHEMATICS

APPENDICES

APPENDIX A

LESSON PLAN ONE

Subject: Core Mathematics

Topic: Quadratic Equation

Sub-topic: Using Formula Method

Duration: 80minutes

Objectives: By the end of the lesson, student will be able to;

Solve quadratic equation by formula method using the Microsoft Math solver

References: Concise Core Mathematic (1st Edition) for Senior High School students Book (page -)

RPK

Teaching and Learning Activities

Activity 1

Review: Teacher gives group try work to review student RPK.

Solve the follow mathematical problem

Q1. $2x^2+4+6x-x^2+3$

Q2. $6x+2+3x=5$

Q3. $5x^2+x-5+5-5x-4x^2$

Expected response

Q1. $2x^2-4+6x-x^2+3$

Grouping of like

$=2x^2-x^2+4+3+6x$

term add or subtract like term

$=x^2+7+6x$

Q2.6x+2+3x=5

Grouping like term (add or subtract like terms)

$6x+3x-2+2=5-2$

Dividing both side by 9

$\frac{9x}{9}=\frac{3}{9}$

$X=1/3$

Q3. $5x^2+x-5+5x-4x^2$

Grouping of like term

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

Add or subtract like term

$=x^2+6x-5$

Explicit instruction/Teacher Modelling

Activity 2

When students understand algebraic and linear equation and knows how to solve, he/she how needs to relate it to solving quadratic equation using formula method and solve it.

- Teacher guides students to mention some of the methods used to solve quadratic equation.

Example 1:

- Using factorization method
- Using formula method
- Using method of completing square

Teacher guides students to solve follow the selected problem from the worksheet given using (Microsoft Math Solver)

Example 2: $x^2 +5x+6=0$

Expected response from the interface of MS Maths solver:

All equations of the form $ax^2+bx+c=0$ can be solved using the quadratic formula:

$$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

The quadratic formula gives two solutions, one when $\pm$ is addition and one when it is subtraction

$x^2+5x+6=0$

This equation is in standard form: $ax^2+bx+c=0$ substitute 1 for a, 5 for b, and 6 for c in the quadratic formula

$$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

$$x = \frac{-(-5) \pm \sqrt{5^2-4(6)}}{2}$$

Square 5

$$x = \frac{-(-5) \pm \sqrt{25-4(6)}}{2}$$

Multiply -4 times 6

$$x = \frac{-(-5) \pm \sqrt{25-24}}{2}$$

Add 25 to -24

$$x = \frac{(-5) \pm \sqrt{1}}{2}$$

Take the square root of 1 $x = \frac{-5 \pm 1}{2}$

Now solve the equation $x = \frac{-5 \pm 1}{2}$ When$\pm$ is plus (+) add -5 to 1

$x = \frac{-4}{2}$ divide -4 by 2

$x = -2$

Now solve the equation $x = \frac{-5\pm1}{2}$ When$\pm$ is minus (-). Subtract 1 from -5

$x = \frac{-5-1}{2}$

$x = \frac{-6}{2}$ divide -6 by 2

X=-3

The equation is now solved

X=-2 and X=-3

Example 2: Solve the quadratic equation using the quadratic formula

$2x^2+12x+40=0$

Expected solution:

Type $2x^2+12x+40=0$ in the' type problem

All equations of the form $ax^2+bx+c=0$ can be solved using the quadratic formula:

$x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$.

The quadratic formula gives two solution, one when $\pm$ is additon and one when it is subtraction.

$2x^2+12x+40=0$

This equation is in standard form: $ax^2+bx+c=0$ substitute 2 for a, 12 for b, and 40 for c in the quadratic formula, $x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$

$$x = \frac{-12 \pm \sqrt{12 - 4(2)(40)}}{2(2)}$$

*Squ*are 12.

$$x = \frac{-12 \pm \sqrt{144^2 - 4(2)(40)}}{2(2)}$$

Multiply -4 time 2

$$x = \frac{-12 \pm \sqrt{144 - 8 + 40}}{2(2)}$$

$$multiply\ -8\ times\ 2$$

$$x = \frac{-12 \pm \sqrt{144 - 320}}{2(2)}$$

Add 144 to -320

$$x = \frac{-12 \pm \sqrt{464}}{4}$$

Take the square root of -176

$$x = \frac{-12 \pm \sqrt{464}}{4}$$

Multiply 2 time 2

$$x = \frac{12 \pm \sqrt{464}}{4}$$

Now solve the equation $x = \frac{-12 \pm 4\sqrt{29}}{4}$ *when* $\pm$ *is plus. Add -12 to* $4\sqrt{29}$

$$x = \frac{-12 \pm 4\sqrt{29}}{4}$$

By divide -12+$4\sqrt{29}$*by 4*

X=-3+$\sqrt{29}$

Now solve the equation $\frac{-12\pm\sqrt{29}}{4}$ *when* $\pm$ *is minus subtract 4i*$\sqrt{29}$ *from -12.*

$$x = \frac{-12 \pm 4\sqrt{29}}{4}$$

Divide -12-$4\sqrt{29}$ *by* 4

X= -$\sqrt{29}$ *-3*

The equation is now solved

X=-3+$\sqrt{29}$

X=-3-$\sqrt{29}$

Teacher ask students to mention some of the main ideas using the formula method.

Teacher the listens and assists students who may encounter difficulties.

Guided practice/Interactive Modelling

Activity 2

Teacher puts students into groups of five allows students read, explain and ask questions among themselves as the teacher observes the students and correct them when necessary.

Students are to comprehend the following examples using the (Microsoft math solver*)*.

Example: solve the quadratic equation below using quadratic formula: $x^2-5x-8=0$

Students in their group read and understand the given quadratic equation by needed to help solve the problem using quadratic formula.

Teacher guides students to read from the solution and discuss among themselves what the detailed solution entails using the formula

Expected response

All equations of the form $ax^2+bx+c=0$ can be solved using the quadratic formula: $x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$

The quadratic formula gives two solutions, on when $\pm$ is addition and one when it is subtraction

$n^2 - 5n - 8 = 0$.

This equation is in standard form: $ax^2 + bx + c = 0$

Substitute 1 for a,-5 for b and -8 for c in the quadratic formula, $x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$

$$x = \frac{-(-5)\pm\sqrt{(-5)^2-4(-1)(-8)}}{2(1)}$$

$$x = \frac{-(-5)\pm\sqrt{25-4(-8)}}{2}$$

Multiply by -4 times -8

$$x = \frac{-(-5)\pm\sqrt{25+32}}{2}$$

Add 25 to 32

$$x = \frac{-(-5)\pm\sqrt{57}}{2}$$

The opposites of -5 is 5

$$x = \frac{5\pm\sqrt{57}}{2}$$

Now solve the equation $x = \frac{-(-5)\pm\sqrt{57}}{2}$ When $\pm$ is plus (+). Add 5 to $\sqrt{57)}$

$x = \frac{\sqrt{57)}+5}{2}$

Now solve the equation $x = \frac{5\pm\sqrt{57}}{2}$ When $\pm$ is minus (-) subtract $\sqrt{57}$ from 5

$x = \frac{5-\sqrt{57}}{2}$

The equation is now solved.

$x = \frac{\sqrt{57)}+5}{2}$

$x = \frac{5-\sqrt{57}}{2}$

Teacher guides students to comprehend difficulties in understanding the solution.

Teacher observes students as the compare and discuss their solution to other groups using the solved solution to see whether they are on their right path.

Example: solve the quadratic equation below using quadratic formula:$x^2+10x+21=0$

Students in their groups read and understand the given quadratic equation by allowing one student explain it in his/her own way and then identifying what need to be done.

Teacher guide students to watch videos relating to form

Independence Working Time

Activity 3

Teacher asks students to read, explain and identify the situational type for the given quadratic equation.

Trial question for students to comprehend and come out with what to be done.

Q1. Solve the quadratic equation using the quadratic formula: $n^2 -5n-8=0$

Students are supposed to type $n^2 -5n-8=0$ at the type math problem portion.

Student is supposed to follow the using the quadratic formula method critical.

Expected answer from their various interface $n^2 -5n-8=0$

Summary/ review assessment and closing

Teacher assists students from each group to give summary of what it learned using quadratic formula to solve quadratic equation in Microsoft math solver

Expected responses

- Type your question in the “type your problem” box using the algebra calculator
- Click on the solve button
- Click on the using quadratic formula method.
- Critically follow the steps for careful understanding.

Teacher guides students to take a 5minutes quiz at the “QUIZ” section of the math solver as an evaluation task.

Quadratic Equation

$2x^2 +12x-20=0$

Expected response

$2x^2+12x-20=0$

$$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

The equation is in standard form $ax^2+bx+c=0$, by comparison, **a**=2, **b**=2 and **c**=-20.

Substitute the value of a, b and c in the quadratic formula: $x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$

$$x = \frac{-12\pm\sqrt{12^2-4(2)(-20)}}{2(2)}$$

$$x = \frac{-12\pm\sqrt{144-160}}{4}$$

$$x = \frac{-12\pm\sqrt{304}}{4}$$

$$x = \frac{4\sqrt{19}\ -12}{4}$$

$$x = \frac{4\sqrt{19}\ +12}{4}$$

$$x = 4\sqrt{19}\ +12$$

$$x = \frac{4\sqrt{19}\ +(-12)}{4}$$

$$x = \frac{4\sqrt{19}-12}{4}$$

$$x = -4\sqrt{19}\ -12$$

Hence: $x = \sqrt{19}\ -12$ and

$$x = \sqrt{19}\ -12$$

APPENDIX B

LESSON PLAN TWO

Subject: Core Mathematics

Topic: Quadratic Equation

Subtopic: Using Factorization Method

Duration: 80min.

Objective: By the end of the lesson, the student will be able to: Solve a quadratic equation using factorization method.

References: https//mathsolver.microsoft.com/en/algebra-calculator.

Teaching and Learning Activities

Activity1: Teacher gives students an exercise to review their RPK.

Solve the quadratic equation using the method of completing square: $x^2+10x+21=0$

<u>Expected Answer</u>

$X^2+10x+21-21=0-21$

$X^2+10x+21-21=0-21$

$X^2+10x =-21$

$X^2+10x+25=-21+25$

$X^2+10x+21=4$

$(x+\frac{b}{2})^2$

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

$\sqrt{(x+5x)^2}=\sqrt{4}$

X+5x=2

X+5x=2

X=2-5

X=-3

X=-2-5

X=-7

X= -3 and x=7

Explicit Instruction/Teacher Modelling

Activity2: Teacher guides student to solve and follow the selected problems from the worksheet given using (MS Math solver).

Example 1: Solve the quadratic equation using the method of factorization: x2+9x+18=0

Expected Response

X^2-9x+18=0

Student type in the equation into the 'type the math portion'

Teacher guides students to carefully follow the solution from the interface

To solve the equation, factor x^2-9x+18 using formula x^2+ (a+b) x +ab=(x+a) (x+b).

To find **a** and **b**, set up a system to be solved ab=-9, ab=18 since ab is positive, **a** and **b** have the same sign. Since a+b is negative, **a** and **b** are both negative. List all such integer pairs that give product 18. [-1, -18], [-2, -9], [-3, -6] calculate the sum for each pair that gives sum -9, 9=-6, b=-3.

Rewrite factored expression (x+a) (x+b) using the obtained values, (x-6) (x-3)

To find equation solutions, solve x-6=0 and x-3=0, x=6, x=3.

- Teacher asks students to mention some of the main ideas using the factorization method.
- Teacher then listens and assists students who may encounter difficulties.

Guides practice

Activity3

- Student read, explain and ask questions among themselves as the teacher observes the students [who may encounter some challenge] and make corrections when needed.
- Student are to comprehend the following examples using the factorization method in (MS Math solver).

Examples 2: solve the quadratic equation below using the factorization method x^2+17x+49=3x

- Students read and understand the given quadratic equation by stating the various element in the equations needed to help solve the problem using factorization method.

- Teacher guides students to read from the solution and discuss among themselves what the detailed solution entails using the factorization method.

  Example 5: Solve the quadratic equation below using the factorization method $8x^2=30+3x$

- Teacher guides students to comprehend difficulties in understanding the solution
- Teacher observes students as they compare and discuss their solution to other students/peers using the solved solution to see whether they are on the right track.

  Examples 6: Using the method of factorization, solve $15b^2+4b-4=0$.

- Students individually read and understand the given quadratic equation by allowing one student to explain it in his/her own way and then identifying what needs to be done.
- Teacher guides students in watching videos relating to solving quadratic equation using factorization method.
- Teacher guides students to explain what they learnt during their watch.

  Independent Working time

  Activity 4: worksheet for student to comprehend an come out with what to be done.

  Q1. Solve the quadratic equation using the factorization method:$2x^2-14=-3x$.

- ✓ Student are supposed to type $2x^2-14=-3x$ at the "type a math problem" portion.
- ✓ Students are supposed to follow the step using the factorization method

  Expected Response from various/interface

  $2x^2-14=-3x$

  Add 3x to both sides $2x^2-14+3x=0$

Rearrange the polynomial to put it in stand form place the terms in order from highest to lowest power $2x^2+3x-14=0$

To solve the equation, factor the left-hand side by grouping. First, left hand sides needs to be written as $2x^2+ax+bx-14$. To find a and b, set up a system to be solved

a+**b**=3

ab=2(-14) =-28

Since ab is negative, **a** and **b** have the opposite signs.

Since a+b is positive, the positive number has greater absolute value than the negative.

List all such integer pair that give product -28.

[-1, 28], [-2, 14], [-4, 7]

Calculate the sum for each pair

-1+28=27, -2+14=12, -4+7=3

The solution is the pair that gives sum 3.

a=-4, **b**=7.

Rewrite $2x^2+3x-14$ as $(2x^2-4x) + (7x-14)$

$(2x^2-4x) + (7x-14)$

Factor out common term (x-2) by using distribute properly.

(X-2) (2x+7)

To find equation solution, solve x-2=0 and 2x +7=0

X=2, x=7/2.

- ✓ Teacher guides students to understand the final answers as the roots of the equation.

Review Assessment and Closing

Activity 5: Teacher assists student to take up Quiz from the Quiz section of the math solver as an evaluation task.

Q1. Solve the quadratic equation using factorization x^2=11x-28.

Q2. b^2+5b=0

Expected Response

a. X^2=11x-28

Expected response from the MS Maths solver interface

X^2=11x-28

Subtract 11x from both sides

X^2-11x= -28

Add 28 to both sides

X^2-11x+28=0

To solve the equation, factor X^2-11x+28 using formula X^2+ (a+b) x+ab=(x+a) (x+b).

To find a and b, set up a system to be solved.

a+b=-11

ab=28

since ab is positive, a and b have the sign. Since a+b is negative, a and b are both negative. List all such integer pairs that give product 28.

[-1, -28], [-2. -14], [-4, -7]

Calculate the sum for each pair

-1-28= -29

-2-14= -16

-4-7= -11

The solution is the that sum -11

a= -7

b= -4

Rewrite factorized expression (x+a) (x+b) using the obtained values.

(x-7) (x-4)

To find equation solutions, solve x-7=0 and x-4 =0

X=7, and x=4

b. $b^2+5b=0$

Expected response from the MS Math solver interface

$b^2+5b=0$

Factor out b

b(b+5)=0

To find equation solutions, solve b=0 and b+5=0

b=0 andnb=-5

APPENDIX C

LESSON PLAN THREE

Subject: Core Mathematics

Topic: Quadratic Equation

Sub-topic: Using Method of completing squares.

Duration: 80min.

Objective: By the end of the lesson, the student will be able to;

Solve a quadratic equation by method of completing of squares using the CAI (MS Math Solver).

References: Concise Core Mathematics (1st Edition) for Senior High School student Book.

Teaching and Learning Activities

Activity 1

Review: Teacher gives student try work in groups.

Question

Solve the quadratic equation using the formula $X^2-4X-5=0$.

Expected Response

$X^2-4X-5=0$

$ax^2+bx+c=0$ is an equation of quadratic form.

Quadratic formula:$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$

From the equation: a=1, b= -4, c= -5.

Putting these in quadratic formula: $x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$

$$x = \frac{-(-4) \pm \sqrt{(-4)^2 - 4(-5)}}{2(1)}$$

$$x = \frac{-(-4) \pm \sqrt{16 - 20}}{2}$$

$$x = \frac{-(-4) \pm \sqrt{36}}{2}$$

$$x = \frac{-(-4) \pm 6}{2}$$

$x = \frac{4+6}{2} = \frac{10}{2} = 5$

$x = \frac{4-6}{2} = \frac{-2}{2} = -1$ $\therefore$ $x_1 = 5$ $x_2 = -1$.

Explicit instruction / Teacher Modelling

Activity 2

Teacher guides students to solve and follow the selected problems from the worksheet given using (Microsoft math solver).

Example 2: solve the quadratic equation using the method of completing squares

$X^2+10x+21=0$.

Expected Response:

$x^2+10x+21=0$

Quadratic equations such as this one can be solved by completing the square. In order to complete the square, the equation must first be in the form $x^2+bx=c$.

$X^2+10x+21=0$

Subtracting 21 from itself leaves 0.

$X^2+10x +21-21=-21$

Subtracting 21 from itself leaves 0.

$X^2+10x=-21$

Divide 10, the coefficient of the x term, by 2 to yet 5.

Then add the square of 5 to both sides of the equation.

This step makes the left-hand side of the equation a perfect square.

$X^2+10x\ 25=-21+25$

Add -21to 25

$X^2+10x+25=4.$

Factor $x^2+10x+25$. In general, when $x^2 +bx+c$ is a perfect square, it can always be factorized as

$(X+\frac{b}{2})^2.$

$(x+5)^2=4$

Take the square root of both sides of the equation

$\sqrt{(x+5)^2} = \sqrt{4}$

Simplify.

X+5=2

X+5=-2

Subtract 5 from both sides of equation.

X_1=-3, x_2=-7

- ✓ Teacher ask students to mention some of the main ideas using the method of completing the squares.
- ✓ Teacher then listens and assists students who may encounter difficulties.

Guided Practice

Activity 3

- ❖ Teacher puts student back to their formal groups.
- ❖ Students read, explain and ask questions among themselves as the teacher observes the students and correct them when necessary.
- ❖ Students are to comprehend the following example using the (Microsoft math solver)

Example: solves the quadratic equation below using method of completing squares: $3n^2$-5n-8=0

Students in their various groups read and understand the given quadratic equation by stating the various element in the equations needed to help solve the problem using method of completing the squares.

- ➢ Teacher guides students to read from the solution and discuss among themselves what the detailed solution entails using the method.
- ➢ Teacher guides student to comprehend difficulties in understanding the solution.
- ➢ Teacher observes students as they compare and discuss their solution to other groups using the solved solution to see whether they are on the right path.

Example: Solve the quadratic the equation below using the method of completing square:$2x^2$+10x+22=0.

Students in their groups used and understand the given quadratic equation by allowing one student explain it in his/her own way and then identifying what needs to be done.

- Teacher guides students to watch videos relating to solving quadratic equation using method of completing squares.
- Teacher guides students to explain what they learnt during their watch.

Independent Waking Time

Activity 4:

Worksheet for students to comprehend and come out with what to be done.

Q1. Solve the quadratic equation using the method of completing the squares:$2x^2+12x+40=0$

Students are supposed to type $2x^2+12x+40=0$ at the "type a math problem" portion.

Students are supposed to follow the steps using the method of completing the squares carefully.

Expected answer from their various interface $2x^2+12x+40=0$.

Review Assessment and Closing

Activity 5:

Teacher assists student to take up "Quiz" from the Quiz section of the math solver as an evaluation task.

QUIZ

$4x^2-8x+3=0$

Expected Response

$4x^2-8x+3=0$

Subtract 3 from both sides of the equation

$4x^2-8x+3-3= -3$

$4x^2-8x= -3$

$4x^2 /4-8x/4= -3/4$

$x^2-2x=-3/4$ (divide -2/2 and square the answer)

$x^2-2x=-3/4+1$

x^2-2x+1=1/4

Factorizing x^2-2x+1, since x^2+bx+c is perfect square, it can be factorized as $(x+b/2)^2$

$(-1)^2$=1/4

$\sqrt{(x-1)^2} = \sqrt{\frac{1}{4}}$

x-1 = $\pm\frac{1}{2}$

x-1=$\frac{1}{2}$

x-1=-$\frac{1}{2}$

Add 1 to both sides of the equation

x=$\frac{3}{2}$

and

x=$\frac{1}{2}$

APPENDIX D

PRE-TEST on Quadratic Equation

The participation in this project is voluntary in which you have to answer the questions to your satisfaction. You have the right to withdraw from the study at any time, which you do not have to give any reason for withdrawing. All information will be treated in strictest confidence. Your anonymity and confidentiality will be maintained in all publications and that no information that could identify you will be given to other researchers or agencies. I have read the information consent form. I agree to participate in the study.

a. **Gender**: Male [ ] Female [ ]

b. **Age**: 13-15 [ ] 16-17 [ ] 19-21 [ ] other [ ].

This test is part of a research on your ability to solve quadratic equation after using CAI (Microsoft Maths solver). Data gather will be used for the purpose of research and therefore be honest.

This is a non-evaluative assessment. Your performance in this exercise will have no effect on your final grade or continuous assessment mark in your course. The assessment is designed to elicit information that will help in understanding how you carry out quadratic equation. Answer all questions. Show all working clearly on the answer booklet. Thank you.

1. The area of as rectangle is $6m^{2.}$ If the length is 1m longer than the width, find the dimension of the rectangle. Show detailed working

2. Find the quadratic equation whose roots are -3/2 and 1/3 showing detailed working.

*3.*Solve the system of equations showing detailed working.

$$X^2\text{-}3xy + 8=0$$

$$3x\text{-}y=4$$

4. Find the values of x for which the function f: $\longrightarrow$ $\frac{x-4}{x^2-7x+6}$ is undefined

5. Given the expression y=ax2-bx-12, find the values of x when a=1 b=2 and y=3

6. If$\sqrt{x^2+1} = 1\frac{1}{4}$, find the positive values of x

APPENDIX E

Post-Test on Quadratic Equation

The participation in this project is voluntary in which you have to answer the questions to your satisfaction. You have the right to withdraw from the study at any time, which you do not have to give any reason for withdrawing. All information will be treated in strictest confidence. Your anonymity and confidentiality will be maintained in all publications and that no information that could identify you will be given to other researchers or agencies. I have read the information consent form. I agree to participate in the study.

c. **Gender**: Male [ ] Female [ ]

d. **Age**: 13-15 [ ] 16-17 [ ] 19-21 [ ] other [ ].

This test is part of a research on your ability to solve quadratic equation after using CAI (Microsoft Maths solver). Data gather will be used for the purpose of research and therefore be honest.

This is a non-evaluative assessment. Your performance in this exercise will have no effect on your final grade or continuous assessment mark in your course. The assessment is designed to elicit information that will help in understanding how you carry out quadratic equation. Answer all questions. Show all working clearly on the answer booklet. Thank you.

1. Find the quadratic equation whose roots are $2\frac{1}{3}$and $3\frac{1}{2}$ showing detailed working.

2. Find the truth set of $\frac{2}{x-2} + \frac{3}{x-1} = 1\frac{1}{2}$, correct to three significant figures showing detailed working.

3. Solve the system of equations showing detailed working.

$$x-6y-5=0$$

$$xy-6=0$$

4. Find the values of x for which the function *f*: $\longrightarrow \frac{2x^2-5x+3}{x(x+3)}$ is zero?

5. The sum of two numbers is 14 and their product is 33. Find the numbers.

6. Solve the equation $x^2-3x-1=0$, living your answer correct to one decimal place

APPENDIX F

Questionnaire for students on their perception in using Microsoft math solver

The participation in this project is voluntary in which you have to answer the questions to your satisfaction. You have the right to withdraw from the study at any time, which you do not have to give any reason for withdrawing. All information will be treated in strictest confidence. Your anonymity and confidentiality will be maintained in all publications and that no information that could identify you will be given to other researchers or agencies. I have read the information consent form. I agree to participate in the study.

The objective for this research is to examine the Effect of Microsoft Maths Solver on SHS students' performance in quadratic equation.

This questionnaire is to examine the perception on the use of Microsoft Maths solver on SHS student's performance in Mathematics.

1. **Gender:** Male [ ] Female [ ].

2. **Age:** 13-15 [ ] 16-17 [ ] 18-20 [ ] other [ ]

Indicate where appropriate by ticking (✓)

SA=Strongly Agree A=Agree N=Neutral D= Disagree SD=Strongly Disagree

.

SN	**QUESTION**	SA	A	N	D	SD
3	I am satisfied with Microsoft math solver session					
4	I'm comfortable in using Microsoft math solver since beginning of training					
5	Presentation was engaging and insightful					
6	Time in the session was sufficient to allow learning and practicing new skills					
7	The session was well planned and interactive					
8	The concern and strategies are useful to learning quadratic equation.					
9	I understand well when using Microsoft math solver in learning quadratic equation.					

Please indicate the feelings you have had while using Microsoft math solver by ticking where appropriate (✓)

SN	FEELINGS	SA	A	N	D	SD
10	Excited					
11	Frustrated					
12	Challenged					
13	Annoyed					
14	Confused					
15	Proud of myself					
16	Bored					
17	Relaxed					

APPENDIX G

Interview guide for students who will be interviewed

This study is being carried out on the topic "Effect of Microsoft Maths solver on Senior High School Students mathematics performance in quadratic equation" as part of the requirements for the award of Master of Philosophy Degree in Mathematics Education. Please response to the interview questions as accurately as possible. Your experience and ideas will make an important contribution to this research. All responses will be held in strict confidence.

The interview will take about 20- 30 minutes and will be tape recorded. You may request the recording to be stopped temporarily or permanently if at any time you feel uncomfortable. As the principal researcher, I will conduct and transcribe the interview. You will be provided with a copy of the interview transcript for review and approval. Your participation is voluntary, and you have the right to withdraw from the project at any time. Thanks very much in anticipation of your cooperation.

1. How do you prefer to learn, alone or in a group? And why?
2. Did you enjoy learning Quadratic equations before this school year? Explain your response.
3. Have you ever been introduced to any Microsoft Maths solver before? If yes, what was the experience?
4. How will you describe your experience with the current Microsoft Maths solver?
5. What aspects of your learning of Quadratic equation with the Microsoft Maths solver went well and supported your understanding? Please explain.

6. What aspects did you find difficult in the lesson with the Microsoft Maths solver?
7. Has the Microsoft Maths solver helped in changing your thinking about Quadratic equation problems? If yes, why do you think so?
8.. When using the current Microsoft Maths solver, how did you work (i.e., independently, with instructor, with another, in groups, etc.) and why?

APPENDIX H

SOLUTION FOR PRE-TEST

Q1. Let x (meters) =the width of the rectangle ….2mks

Then the length= (X+1) ……2mks

Area of rectangle = Length x Breadth….2mks

(X=10) (X)=6...2mks

X^2 +x =6….1mk

X^2 +x-6=0….1mk

X^2+3x-2x-6=0….1mk

X (X+3)-2 X+3) ….1mk

(X-2) (X+3) =0…1mk

X-2=0, x=2…1 mk

X+3=0, X=-3…1mk

But x cannot be negative

∴ the width is 2m and the length (2+1) =3m…..3mks

Q2.

Sum of root =-$\frac{3}{2} + \frac{1}{3}$ …2mks

= $\frac{-9+2}{6}$…1mk

$= \frac{-7}{6}$…1mk

Product of root $= \frac{-3}{2} \times \frac{1}{3}$…2mks

$= \frac{-3}{6}$…1mks

X^2-$(\frac{-7}{6})x + (\frac{-3}{6})$ = 0….1mk

X^2+$\frac{7}{6}x - \frac{3}{6}$ = 0…1mk

$6x^2$ +7x -3 = 0

∴ The quadratic equation is $6x^2+7x-3=0$……1mk

Q3.20mks

$X^2-3xy+8=0$…… (1) …….1mk

$3x-y=4$……. (2) …1mk

From eqn 1; $y=3x-4$…2mks

Put $3x-4=y$ into eqn 2….2mks

$X^2-3x(3x-4)+8=0$…2mks

$X^2-9x^2+12x+8=0$…1mk

Divide through by -4

$-8x^2+12x+8=0$…1mk

$2x^2-3x-2=0$…1mk

$2x^2-4x+x-2=0$ (using the method of factorization) …2mks

$2(x-2)+1(x-2)=0$…2mks

$(2x+1)(X-2)=0$…1mk

$2x+1=0$ or $x-2=0$…1mk

$\frac{2x}{2}=\frac{-1}{2}$ … 1mk $x=2$

$$x=\frac{-1}{2}$$

The solution of the equation is $x=2$ and $\frac{-1}{2}$…2mks

Q4. 20mks

F: $x\rightarrow \frac{x-4}{x^2-7x+6}=f(x)=\frac{x-4}{x^2-7x+6}$…2mks

For $f(x)$ to be undefined, $x^2-7x+6=0$…3mks

$X^2-7x+6=0$…1mk

$X^2-6x-x+6=0$…2mks

$(X^2-6x)(-x+6)=0$…2mks

$X(x-6)-1(x-6)=0$…2mks

$(X-1)(X-6)=0$…2mks

$X-1=0$ …1mk or $x-6$…1mk

x=11mk

x=6…1mk

The function is undefined, if x=1 or 6…2mks

Q5…15mks

y = ax^2-bx-12, a=1, b=2, and y =3

(x^2) – (2) x -12 = 3…2mks

X^2 -2x -12 =3…1mk

X^2-2x-15=0…1mk

X^2-5x +3x – 15 =0…2mks

(X^2-5x) + (3x -15) = 0…1mk

X (x -5) + 3 (x-5) = 0…1mk

(x +3) (x -5) =0…1

X+3 = 0…1mk or x – 5 = 0…1mk

X = -3…1mk x = 5…1mk

The values of x when y = 3 are -3 and 5

Q6…15mks

$\sqrt{x^2} + 1 = 1\frac{1}{4} = \sqrt{x^2} + 1 = \frac{5}{4}$…2mks

$(\sqrt{x^2} + 1)^2 = (\frac{5}{4})^2$…1mk

$X^2 + 1 = \frac{25}{15}$…1mk

$16x^2 + 16 = 25$ …2mks

$16x^2 = 25 - 16$…1mk

$16x^2 = 9$…1mk

$X^2 = \frac{9}{16}$…1mk

$X = \pm \sqrt{\frac{9}{16}}$…1mk

$X = \pm \sqrt{\frac{9}{16}}$…1mk

$X = \pm\frac{3}{4}$…1mk

$= +\frac{3}{4}$ and $-\frac{3}{4}$…1mk each

$\therefore$ The positive value of $x = \frac{3}{4}$…1mk

APPENDIX I

SOLUTION FOR POST – TEST

Q1 $2\frac{1}{3}$ and $3\frac{1}{2}$

Sum of root = $\frac{7}{3} + \frac{7}{2}$ ……….1 mark

= $\frac{14+21}{6} = \frac{35}{6}$…………2 marks

Product of root = $\frac{7}{3} \times \frac{7}{21}$……….1 mark

=$\frac{49}{61}$……. 1 mark

∴ The equation is $x^2 - (\frac{35}{6})\,x + \left(\frac{49}{6}\right) = 0$….2 marks

=$x^2 - \frac{35}{6}x + \frac{49}{6} = 0$……1 mark

$6x^2 - 35x + 49 = 0$……2 marks

Q2

$\frac{2}{X-2} + \frac{3}{X-1} = 1\frac{1}{2}$

$\frac{2}{X-2} + \frac{3}{X-1} = \frac{3}{2}$

$4(x - 1) + 6(x - 2) = 3(2x^2 - x - 2x + 2)$ ….2 marks

$4x - 4 + 6x - 12 = 3x^2 - 9x + 6$…… 2 marks

$3x^2 - 19x + 22 = 0$……. 2 marks

A = 3, b = - 19 c = 22

$X = 19 \pm \frac{\sqrt{(-19)2 - 4\,(3)(22)}}{2(3)}$……2 marks

$= 19 \pm \frac{\sqrt{361-264}}{6} = \frac{19 \pm 9.8489}{6}$….2 marks

. = $\frac{19+9.8489}{6}$ *and* $\frac{19-9.8489}{6}$…….2 marks

. = 4. 80812 and 1.5252…… 1mark

∴ The truth set is x:x = 4.81, 1.53…. 2marks

Q3

X-6y-5 = 0 …. 1 mark

Xy-6 = 0….1 mark

From eqn 1

X = 6y + 5 ……2 marks

Substitute x into eqn 2

(6y +5) y -6 = 0 …… 1 mark

$6y^2+5y - 6 = 0$

3y (2y + 3) – 2 (2y + 3) = 0….1 mark

(3y – 2) (2y + 3) = 0…1 mark

3y – 2 = 0…. 1mark

$$\frac{3y}{3} = \frac{2}{3}$$

Y=$\frac{2}{3}$…. 1 mark

2y +3 = 0…. 1 mark

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

Y = $\frac{-3}{2}$……1 mark

When y = $\frac{2}{3}$, x = 6 ($\frac{2}{3}$) + 5

= 4 +5 = 9   2mks

When y = $\frac{-3}{2}$, x = 6 ($\frac{-3}{2}$) + 5

= - 9 + 5

= -4……2mks

∴ The solution is x = 9 and y = $\frac{2}{3}$ or x = -4 and y = $\frac{-3}{2}$….1 mk each

Q 4

F:x→ $\frac{2x2-5x\mp3}{x\ (x+3)}$

For zeros, $2x^2$-5x +3 = 0….2mks

$2x^2$-2x-3x +3 = 0……2mks

($2x^2$ – 2) (3x -3) = 0….1mk

2x (x -1) – 3(x-1) = 0……1mk

(2x-3) (x-1) = 0.2mks

2x -3 = 0 or x-1 =0….1mk

X = 1…….1mk

$$\frac{2x}{2} = \frac{3}{2} =$$

$$x = \frac{3}{2}$$

= $1\frac{1}{2}$….1mk

The expression is zero if x =1 $\frac{1}{2}$ or x = 1….2mks

Q5

Let the numbers be x and y 20mks

X + y = 14 ……. eqn 1….1 mk

Xy = 33 …. eqn 2…2mks

From eqn 1, x = 14 – y…….2mks

Substitute x into eqn 2

(14 – y) y = 33…1m

$14y - y^2 = 33$…1m

$Y^2 - 14y + 33 = 0$….2 marks

$Y^2 - 3y - 11y + 33 = 0$…. 1 mark

Y (y -3) – 11 (y -3) = 0

(y -11) (y -3) = 0…. 1 mark

y-11=0, y=11……. 1 mark

y-3 = 0, y = 3…… 1 mark

when y = 11, x = 14 -11=3…… 2 marks

when y= 3, x =14 -3 = 11…. 2 marks

∴ The numbers are 3 and 11……2 marks

$X^2 - 3x - 1 = 0$

Comparing $ax^2 + bx + c = 0$ with $X^2 - 3x - 1 = 0$

A = 1, b = -3, c =-1

$X = -b \pm \frac{\sqrt{b2-4ac}}{2(a)}$……. 2 marks

X = -3 $\pm \frac{\sqrt{(-3)2-4\,(1)(-1)}}{2(1)}$….2 marks

X = -3 $\pm \frac{\sqrt{9-(-4)}}{2(1)}$……. 1 mark

X = -3 $\pm \frac{\sqrt{9+4)}}{2}$…… 2 marks

X = -3 $\pm \frac{\sqrt{13)}}{2}$…. 1 mark

X = - $\frac{3 \pm 3.6056}{2}$…. 1mark

X = - $\frac{3+ 3.6056}{2}$ and X = - $\frac{3- 3.6056}{2}$ …. 1 mark each

3.3028 and x= - 0.3028 1 mark each

∴ The solution is x = 3.3 and – 0.3….2 marks

APPENDIX J

INTRODUCTORY LETTER

UNIVERSITY OF EDUCATION, WINNEBA
FACULTY OF SCIENCE EDUCATION
DEPARTMENT OF MATHEMATICS EDUCATION

28th February, 2023

Dear Sir/Madam,

LETTER OF INTRODUCTION: ASAMOAH JUSTICE (202113961)

I write to introduce to you the bearer of this letter, Mr. Asamoah Justice, a postgraduate student in the University of Education, Winneba. He is reading for a Master of Philosophy degree in Mathematics Education and as part of the requirements of the programme, he is undertaking a research titled – ***Effect of Computer Assisted Instructions On The Mathematics Achievement of Senior High School Students.***

He needs to gather information to be analysed for the said research and he has chosen to do so in your institution. I would be grateful if he is given the needed assistance to carry out this exercise.

Thank you.

Yours faithfully,

Dr. Ali Mohammed
Graduate Coordinator

DEPARTMENT OF MATHEMATICS EDUCATION
UNIVERSITY OF EDUCATION
WINNEBA