UNIVERSITY OF EDUCATION, WINNEBA

EFFECTS OF COOPERATIVE LEARNING ON STUDENTS' CONCEPTUAL UNDERSTANDING IN TEACHING ALGEBRAIC WORD PROBLEMS IN SELECTED SENIOR HIGH SCHOOLS IN SOUTH DAYI DISTRICT

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A thesis in the Department of Mathematics Education,
Faculty of Science Education, submitted to the School of
Graduate Studies in partial fulfilment
of the requirements for the award of the degree of
Master of Philosophy
(Mathematics Education)
in the University of Education, Winneba

FEBRUARY, 2023

DECLARATION

Student's Declaration

I, Evelyn Adzo Azumah hereby declare that, apart from references and quotations contained in published works which have been identified and dully acknowledged, this thesis 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 guideline for supervision of thesis as laid down by the University of Education, Winneba.

Supervisor's Name: Prof. Samuel Kwesi Asiedu-Addo, PhD

Signature……

Date…….

DEDICATION

I dedicate the whole work and its achievement to my son, Edinam Bright Mottey Junior.

ACKNOWLEDGEMENT

I wish to express my sincere gratitude to My thesis supervisor, Prof. Samuel Kwesi Asiedu-Addo, PhD, a lecturer at UEW, Department of Mathematics, who has contributed to this project in so many ways, his questions, comments, scrutiny and suggestions have contributed to my knowledge on Cooperative Learning. To the management and mathematics teachers of Peki SHTS and Kpeve SHTS, I say thank you all for the package provided in making this thesis a success. I will also want to thank my husband, Mr Bright Kofi Mottey for all his motivations through-out my education, I will always love and respect you.

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ABSTRACT

The study assessed the effects of cooperative learning on students' conceptual understanding in solving algebraic word problems in selected Senior High Schools in South Dayi District. The study is grounded on the positivist research philosophy with the use of the quantitative research approach. The experimental research design was employed in the study. The study population was limited to two selected Senior High School in the South Dayi District of the Volta Region. The Target population of the study was 730 Senior High two students. A sample size of 200 respondents was determined using the Cochran's formula whiles the sampling technique used was the stratified random sampling. Questionnaire and achievement tests were used as data gathering instruments. Results were presented both descriptively and inferentially. The study concluded that challenges facing students in their attempt to solve mathematics word problems included difficulties understanding the words used in the word problems, difficulties transforming word problems into equations, difficulties applying priority rules as well as challenges simplifying derived equations. Furthermore, the study revealed that the use of cooperative learning strategy in teaching and learning of algebraic word problems helped improve students' attitude and conceptual understanding through breeding positive interdependency between them. Ultimately, the study concluded that cooperative learning exerted positive rippling effects on the students' academic performance in solving mathematics word problems. The study recommends that mathematics teachers in the study area should use cooperative group learning strategy to augment traditional teaching strategy in teaching and learning of word problems so as to enhance students' conceptual understanding and academic performance.

CHAPTER 1

INTRODUCTION

1.0 Overview of the study

This chapter provides the introductory sections of the study. It contains the background of the study, statement of the problem, purpose of the study, research objectives as well as research questions. The chapter also discusses the significance of the study, delimitation, definition of terms and ends with the organization of the study.

1.1 Background of the study

Mathematics is said to be the driving force towards technological advancement. Its usage permeates almost every field of study including physics, chemistry, geology, engineering and medicine (Bruce, 2016). It is accepted universally that a strong foundation in mathematics is a pre-requisite for many careers and professions in today's rapidly growing technological society (Abreh, Owusu & Amedahe, 2018). All over the world, mathematics educators and mathematicians are showing more concern about the teaching and learning of mathematics in both basic and secondary schools because mathematics is a compulsory subject of study to all students in many countries, from primary to secondary level (Bruce, 2016). In many countries including Ghana, mathematics has the greatest number of hours per week for instruction (Abreh, Owusu & Amedahe, 2018). This is so because sufficient knowledge in mathematics equips the students to fit well into various scientific and technological fields in this modern world. However, in recent years, there has been a steady decline in the academic performance of senior high school students in Ghana as evident in the results of the West African Senior School Certificate Examination (example: WASSCE 2016;2018;2021).

Empirical evidence suggests that one of the major topics to which students find problem in is algebraic word problem solving (Adu, Assuah & Asiedu-Addo, 2015).

Algebra is the study of mathematical symbols and the rules for manipulating these symbols; it is a unifying thread of almost all of mathematics (Jupri & Drijvers, 2016). Algebra is the branch of mathematics that helps in the representation of problems or situations in the form of mathematical expressions. Put differently, Chan et al., (2020) asserted that algebra is one of the major topics that require students to adopt logical thinking, which, in turn, challenges the students' skills and allows them to focus on arithmetic operations while focusing on the use of symbols to represent equations and to establish the relationships in mathematical operations. It is argued that algebra is one of the major content domains covered to promote the acquisition of mathematical knowledge and skills in school mathematics (Jupri & Drijvers, 2016). Algebraic problem-solving is a way of thinking and reasoning that allows students to create models, study relationships, and solve problems. However, students only have a little understanding of formulating and solving algebraic problems(Chan et al., 2020). In Ghana, algebra is introduced at the Junior High School level and continued through to Senior High School and tertiary level. At the junior high school, algebra covers topics such as algebraic expressions, linear equations, relations, mapping and functions whiles at the senior high school algebra is taught to all students as core mathematics. According to the mathematics curriculum, the concepts of algebra are to help students establish the relationship between numbers and their usage in real life. In the domain of mathematics, algebra focuses on generalization and interpretation of patterns and relationships (Adu et al., 2015).

The knowledge of algebra is so important that its utility is needed by everyone. A significant aspect of algebra is algebraic word problems. Word problems are the 'textual descriptions of situations assumed to be comprehensive to the reader, within which mathematical questions can be contextualized (Adu et al., 2015).

It is argued that word problems provide, in convenient form, a possible link between the abstractions of pure mathematics and its applications to the real-world phenomena (Jupri and Drijvers, 2016). Algebraic word problems can be defined as the textual description of situations in algebra. Put differently, algebraic word problems are questions that require translating sentences to equations, then solving those equations and a single variable (Nashiru, Alhassan, & Abubakari, 2018). Usually, the variable represents an unknown quantity in a real-life scenario. It is argued that solving word problems is among the main difficulties in algebra for many students all over the world (Jupri and Drijvers, 2016). It is of this that Chan et al., (2020) argued that the difficulties faced by students are more obvious when solving a problem that requires them to transmit a mathematical sentence into a mathematical operation. Meanwhile, researchers highlight the same difficulties such as translating words to algebra or vice versa, misinterpreting the meaning of algebraic expressions, misunderstanding and incorrectly substituting signs, and using wrong algebraic concepts to solve common mathematics problems. According to Jupri and Drijvers, (2016), the main difficulties experienced by students in completing word problems related to algebra are turning problems into mathematical symbolic problems and formulating equations, schemes, or diagrams. It is argued that word problems in mathematics, in general, remains a challenge to many students due to the monotonous or boring nature to which the lesson is taught (Jupri & Drijvers, 2016). It is of this that Bruce, (2016) opined that the

teaching of mathematics is not about dispensing rules, definitions and procedures for students to memorize, but engaging students as active participants through discussion and collaboration among students. Edekor and Agbornu (2020) echoed the above by stating that learning will be more successful if they are given the opportunity to explain or clarify ideas. In terms of pedagogy, the development of education now requires teaching strategies that emphasize student involvement.

According to Steven and Slavin (2018), to achieve success in learning mathematics, students should be given the opportunity to communicate mathematically, reasoning mathematically, develop self-confidence to solve mathematics problems. One of the ways this can be done is through cooperative learning. Cooperative learning can be defined as a teaching method that involves students in learning process in order to understand and learn content of the subject (Sia, 2020). Cooperative learning can also be stated in terms of instructional strategy in which students work together to achieve learning target. Sikukumwa, (2017) opined that cooperative learning method when used as a teaching activity, improves motivation, class participation and academic achievement of students. In cooperative learning, students' study in small groups to achieve the same goals using social skills (Emanuel, Kirana, & Chamidah, 2021). Many studies show that cooperative learning can improve performance, long-term memory and positive attitudes towards mathematics, self-concept and social skills. More opportunities should be given to discussion, problem solving, creating solutions and working with peers (Edekor & Agbornu, 2020; Gull & Shehzad, 2015).

The views of the effectiveness of cooperative learning have received empirical validation over the years. Empirically, Assan-Donkoh et al., (2019) conducted a related

study on the topic "Cooperative Learning Strategy in Teaching and Learning of Circle Theorem in Mathematics: A Case of Nana Brentu Senior High School in Aowin Municipality in Ghana". They concluded that cooperative learning exerts positive effects on students' performance in circle theorem. Though the study was conducted in Ghana, a major identified gap is its geographical scope which was limited to only one senior high school which implies that the findings cannot be generalize to cover all SHS in Ghana. Again, there are several topics of difficulty to students at SHS as per Chief Examiner's report over the years. However, the works of Assan-Donkoh et al., (2019) was limited to only Circle Theorem and hence the findings might differ in the context of a different mathematical topic or topics. These observations imply similar study is worth investigating in another school using varied mathematics topic.

Furthermore, Edekor and Agbornu (2020) also conducted a related study on the topic "Cooperative Learning Strategy and Students Performance in Mathematics in Junior High School in Hohoe Municipality, Ghana". They concluded that the approach remains effective in helping improve students' performance in mathematics. Like the works of Assan-Donkoh et al., (2019), the work of Edekor and Agbornu (2020) was also limited geographically implying result generalization is a major challenge. Ahmed et al., (2020) also conducted a related study on the topic "Students' perception of the application of cooperative problem-solving method and its effect on mathematics performance: the case of secondary schools in Awi-zone, Ethiopia". Like the previously reviewed works, Ahmed et al., (2020) also concluded that indeed cooperative learning strategy helps to improve students' performance in mathematics problem solving. However, the limitation of the works of Ahmed et al., (2020) is that, the findings of cooperative learning based on problem-solving as depicted by the

researchers cannot be generalized to cover other topics in mathematics such as algebraic word problem. The case of geographical limitations of the works of Ahmed et al., (2020) also comes to play as a major loophole which poses a research gap worth investigating into.

1.2 Statement of the Problem

Over the years, performance of Ghanaian students in their external examinations (particularly in Mathematics) at the Senior High Level (WASSCE) has been nothing good to write home about (Abreh et al., 2018). This abysmal performance in mathematics remains a canker and worry for stakeholders of child education and usually reflects in the yearly chief examiners reports over the years. In 2015 for instance, the chief examiners report under its general comments about core mathematics 2 was that 'candidates' performance is not encouraging'. In 2016, the report under the same caption (general comments) stated that 'performance has dropped' (WAEC, 2016). In 2018, 120,519 students representing 38.33% passed implying over 60% failed (WAEC, 2018). In 2019 the report shows that 64.23% of the candidates passed, 65.71% pass rate was recorded in 2020 while 54.11% was recorded in 2021 (WAEC, 2020). The performance trend in mathematics for the past 5 years indicates that there is still more room for improvement. Though there are several topics that were captured as weaknesses of student in the yearly Chief Examiners Report, a mention was made of algebra related topics remaining consistent in the reports for the past 3 years reportage. In 2019 for instance, mention was made of topics such as equations and translating of algebraic word problems into equations. Similar topics of weakness was reported in 2020 Chief Examiners report. Thus, the 2020 Chief Examiners report for Core Mathematics 2 stated on page 311, point four (4), section one (1) that, "candidates were

unable to show evidence of reading values from graphs, translate word problems into mathematical equations and solve problems on mensuration, geometry and cyclic quadrilaterals" (WAEC, 2020).

Studies showed that for many secondary school students around the world, trying to solve word problems is one of the most difficult aspects of algebra (Jupri & Drijvers, 2016; Sikukumwa, 2017; Ying et al., 2020). Applying arithmetical operations, understanding the notion of variables as well as algebraic expressions, understanding the different meanings of the equation, as well as mathematization of word problems are all challenges in initial algebra, according to empirical studies (Jupri & Drijvers, 2016). Others have stated that students' challenge comprehending algebra basic tenets could be seen in their knowledge of mathematical concepts associated with algebra (Sikukumwa, 2017; Ying et al., 2020). From the above, it is clear that the context algebra was taken in general in analysing the extent to which it remains a challenge to students. However, empirical studies narrowed to difficulties faced in solving word problems as a specific form of algebra (thus algebraic word problems) remains inconclusive as a challenge identified can be peculiar to a specific school (or study).

It is argued that cooperative learning strategy helps to improves motivation, class participation as well as students' attitude towards learning (Edekor & Agbornu, 2020) . This was supported by the social interdependence theory that argues that it promotes positive interdependence, face to face interaction as well as guarantee positive attitude of the students towards the learning process (Mukunda, 2019). Research works on the effectiveness of cooperative learning concluded that it remains effective in helping to improve students' understanding of the respective topics (Ahmed et al., 2020a; Isaac

Assan-Donkoh et al., 2019) .For instance Ahmed et al., (2020) asserted that cooperative learning improves positive attitudes towards learning, social relations, high self-esteem and cohesiveness. However, major loopholes in most of the empirical works is that they provided generalized conclusion of cooperative learning in mathematics (example Ahmed et al., 2020). This argument remains a major loophole of empirical related studies as the extent to which the use of cooperative learning strategy helps to improve students' attitude towards leaning of mathematics in topics such as mathematics problem solving and circle theorem as investigated by the past empirically reviewed works (example Ahmed et al., 2020; Assan-Donkoh et al., 2019) might differ from another mathematics topic.

Furthermore, empirical studies that used cooperative learning focused on students' achievements (performance) rather than conceptual understanding (Isaac Assan-Donkoh et al., 2019; Edekor & Agbornu, 2020; Gull & Shehzad, 2015). Also, arguments remain that cooperative learning as a teaching strategy affects students' performance in general. Steven and Slavin, (2018) believed that when students of different cognitive, intellectual and physical levels are exposed to solving a given task, they have the opportunity to interact and work as a team which help ensure overall improved performance. They further argued that cooperative learning can therefore give weak students the opportunity to learn and achieve the maximum (Steven & Slavin, 2018). This assertion was backed by several empirical studies (example Edekor & Agbornu, 2020;Ahmed et al., 2020; Assan-Donkoh et al., 2019). However, most of the empirical studies on cooperative learning were tailored towards specific topics with limited works on topics like algebraic word problems. For instance, Assan-Donkoh et al., (2019) used circle theorem as a topic and concluded that cooperative learning

strategy exerted positive effects on performance while Gull and Shehzad (2015) used geometry and provided similar conclusion.

The above justifications necessitate this recent study aimed to examine the effects of cooperative learning on students' conceptual understanding in solving algebraic word problems.

1.3 Purpose of the Study

The purpose of the study was to assess the effects of cooperative learning on students' conceptual understanding in solving algebraic word problems in selected Senior High Schools in South Dayi District.

1.4 Research Objective

The following objectives guided the study:

1. To identify the difficulties students face in solving algebraic word problems.
2. To access the attitudes of students towards cooperative learning in algebraic word problems.
3. To evaluate students' conceptual understanding and performance in algebraic word problems using cooperative learning.

1.5 Research Questions and Hypothesis

The following research questions helped in achieving the goal of the study:

1. What are the difficulties Senior High School students face in solving algebraic word problems?
2. What is the attitude of students towards cooperative learning in algebraic word

problems?

3. To what extent will the use of cooperative learning help to evaluate students' conceptual understanding and academic performance in algebraic problems?

The study tested the following research hypothesis:

- Null Hypothesis: Cooperative learning exerts significant effects on students' conceptual understanding and academic performance in algebraic problems
- Alternative Hypothesis: Cooperative learning does not exert any significant effects on students' conceptual understanding and academic performance in algebraic problems

1.6 Significance of the Study

The study does not have purely academic benefits only but also relevant to teachers and students and other educational stakeholders:

Students: To students at the Senior High Level (Specifically the selected SHS in the Volta Region) the study will unearth the various challenges they face in solving algebraic problems. Recommendations or suggested remedies or steps to be observed will also be outline for the students to follow and become expert in solving algebraic word problems.

Mathematics Teachers: To mathematics teachers, the various suggested steps will help them in their lesson delivery approaches in teaching algebraic word problems. It will help provide some ease in their lesson note preparation towards teaching the topic as they can just refer to the study suggestions during their pre-lesson delivery preparations. The mathematics teachers will benefit from the

result of this study on how to use cooperative learning in solving algebraic word problems to simulate students' interest in classroom interactions.

Educational Policy Markers or Curriculum Developers of Ghana Education Service: The study can be of immense help to mathematics curriculum developers as they can make reference to the recommendations to help project the usage of cooperative learning strategies in teaching mathematics topics in Ghana

Future Researchers: The study will be significant to future researchers interested in researching related topics. They can make reference to the study scope and point loopholes in it to justify their new studies. They can equally make reference to the major findings for comparison purposes. Equally, they can make reference to the entire study methodology which can provide them guideline for new related studies.

Academicians: The study will also be beneficial to academicians particularly mathematics education students as they can make reference to the study to satisfy their academic goals.

1.7 Delimitations of the Study

The geographical limitation of the study is selected SHS in the South Dayi District of the Volta Region. In all, there are 4 SHS in the district; however, the study is limited to only two SHS due to time constraints. A major delimitation therefore is outcome generalization. However, it is believed that the study findings will cover the selected schools.

The study's contextual scope is algebraic word problems though other topics were also identified as weaknesses of WASSCE candidates in recent WASSCE reportage. A major delimitation however is that results can only cover algebraic word problems which is the topic of this study.

Though there are three forms or levels at the SHS (SHS 1, 2 and 3) the study is limited to only SHS 1. The choice of SHS 1 is due to the fact that the topic under investigation (algebraic word problems) is a SHS One topic according to the WASSCE syllabus. A major delimitation is that it will have been good the study captures students across all the levels in that case, topics of difficulty at all levels will be examined.

The study is purely quantitative in nature with closed ended questionnaire and achievement test as data gathering tools. The closed ended questions in the study will be Likert scaled using assigned values. An advantage of closed ended question is that it allows for easy and quick data gathering. However, a major delimitation of the closed ended format employed in the study is that it does not allows participants to freely express their opinions on issues rather they are limited to select from possible multiple-choice responses.

Administrative bureaucracy: The education sector in Ghana currently is one of the sectors that have several administrative personnel in a hierarchy; school heads, circuit supervisor, district director, regional director, national director. The researcher had to submit an introductory letter to two headmasters and copies to the P.T.A chairpersons of the two selected schools and did follow up on them for several weeks before getting the go-ahead to conduct the study in the two sampled schools. It is worth stating that it

was difficult to meet one on one with these individuals due to their busy schedules relating to meetings and other assigned responsibilities.

Fear of Inclusion: Due to the current Free SHS policy trend, several head teachers are cautious of their actions to ensure they did not go contrary to any government directive. The two head-teachers initially feel hesitant to allow the researcher to use their schools for data gathering. However, with the introductory letter together with photocopy of the researcher's student identity card, it was easy to get the go ahead for data gathering.

1.8 Definition of Terms

- Algebra: Algebra is the study of mathematical symbols_and the rules for manipulating these symbols; it is a unifying thread of almost all of mathematics.
- Word Problems: word problems are the 'textual descriptions of situations assumed to be comprehensive to the reader, within which mathematical questions can be contextualized.
- Algebraic word problems: algebraic word problems are questions that require translating sentences to equations, then solving those equations and a single variable.
- Cooperative Learning: Cooperative learning can be defined as a teaching method that involves students in learning process in order to understand and learn content of the subject. It is a teaching method that uses small, heterogeneous ability groups to maximize the learning of each of those group members.

1.9 Organisation of the study

The study is arranged into six (6) Chapters:

Chapter 1 serves as the introduction of the study. The chapter contains the background of the study, statement of the problem, purpose of the study, research objectives as well as research questions. The chapter also discusses the significance of the study, delimitation, definition of terms and ends with the organization of the study.

Chapter 2 discusses the literature review of the study. It provides conceptual review of the related concepts of the study. The second section provides theoretical literature supporting the study. Discussion was also done on the empirical findings and ends with conceptual framework of the study.

Chapter 3 provides the methodology, materials and methods of the study. The chapter first describes the research design adopted. Other relevant sections are the study area, population, sampling technique, data gathering instruments, as well as data collection procedures. The chapter ends with data analysis plan.

Chapter 4 provides results or findings of the study. This chapter provides tabular and figurative representation of findings which were presented based on the chronological arrangement of the research objectives. Initial part provides results on the demographic characteristics of the study followed by the results from the three specific objectives.

Chapter 5 provides discussion on the significant and novel findings that were identified based on result interpretation. The chapter discussions were done and compared to empirical works to justify their level of conformity or deviation.

Chapter 6 was discussed under the heading ‘summary of findings, conclusions and recommendations. The chapter provides summary of the major findings of the study. It also discusses the conclusion of the entire study as well as recommendations. The

chapter provides the limitations of the study and hence suggestions for future researchers.

CHAPTER 2

LITERATURE REVIEW

2.0 Overview of the Study

The chapter provide review of related literature arranged under the following headings; conceptual review, theoretical review, empirical review and conceptual framework. Initial section provided review of the major concepts related to the study objectives. Theoretical literature that directly explains the main concepts of the study were provided and justified. Summary of past related studies was provided with clear commentary, research gap and critique provided in each case to provide enough grounds for this recent study. Finally, diagrammatic representation of the main concepts was provided under the heading "conceptual framework". The chapter ends with chapter summary.

2.1 Algebraic Word Problems in Mathematics

Algebraic word problems are a mathematical concept in which figures and quantities are represented in equation and formulas using letters as well as other general symbols. This encapsulates one of algebra's characteristics. It encompasses the study of trends, which is the fundamental basis for all mathematical logical connections (Stephens, et al., 2015). Algebraic word problems serve as an introduction to algebra. They are textual representations of situations and problems for which at least one question is posed, with the answers obtained by applying mathematical functions to quantitative data provided in the problem definition (Emmanuel et al., 2021).

Observations in the classroom has revealed a widespread practice that word problems are all about algorithms and also that teaching algebraic word problems is primarily

focused on the mathematical operations in the statement provided regardless of the context (Stephens, et al., 2015). When students first start school, they are taught the fundamentals of algebra, which include developing numeric fluency, uncovering structure in operations, as well as describing numerical relationships. Word problems can be used to investigate conceptual understanding (Emmanuel et al., 2021). Word problems that were framed utilizing real-life situations and circumstances allowed learners to focus on completely understanding the problem first (Stephens, et al., 2015).

Prior to actually looking for manipulative or computational approaches to solve word problems, it is important to first read, decipher, and transform the stated text in their setting into a mathematical language (Emmanuel et al., 2021). Understanding of the sentences, as well as mathematical language comprehension, is required for changing representational form. It is of this that Stephens et al., (2015) outlined the following steps to help solve algebraic word problems:

- Quickly read the statement provided to help determine the nature or word problem the statement represents.
- Identify the question at the end of the statement provided. This is a good step towards finding out what to solve for at the end of the problem which can be one, two or three depending on the nature of problem provided.
- Ensure to use alphabets to represent the unknowns in the statement. In this case, with several unknowns, it is important to use variable to represent the least quantity.
- Second reading of the problem is required for familiarity and better understanding of the problem. This stage will help to identify the key words in the statement that needed to be translated into mathematical symbols.

- Translate the stated problem or statement into equation and attempt solving to find the unknowns.
- Writing the answers taking into consideration the required units stated in the question.
- Result validation: This step requires rearrangement of the question by making use of the values obtained to check if the answers obtained are valid and accurate.

2.2 Students' Attitude towards Learning Algebraic Word Problems

Attitude is a term that refers to a person's viewpoint, acting, as well as behaving. Attitude is a long-term organization of thoughts, sentiments, and behaviours toward important social objects, groups, incidents, or emblems (Julius, Abdullah, & Suhairom, 2018). A person's likes and dislikes are represented by their attitude, which is a multidimensional construct. Attitude is a cognitive, sentimental, and behavioural predisposition toward a specific behavioural intent; this is learned and can be modified through persuasion using a number of strategies. In an individual's feelings, thoughts, sentiments, or envisioned behaviours, attitude is defined as a positive or negative evaluative reaction towards something, occurrences, or initiatives. As a result, students' attitudes toward attempting to solve algebraic word problems are shaped by their likes and dislikes, thoughts and emotions of wanting to get involved in or avoid attempting to solve algebraic word problems (Julius et al., 2018). According to research, attitude has three facets: affective, behavioural, as well as cognitive. This is supported by the multicomponent model of individual attitude. Cognitive is also captured as personal opinions, affective refers to the sentiments, while behavioural knowledge can be past or based on current experience. Individual's attitudes can be straightforward or

multifaceted, reliable or volatile, explicitly or implicitly, temporary or permanent, as well as superficial or basic. It is best summarized when a person expresses his or her sentiments or thoughts about a particular objects or concerns.

It is argued in several studies that errors in attempting to solve algebra problems and lack of knowledge in algebra negatively affects students' attitude towards learning algebra problems. In the work of James and Adewale (2015) the issue of rote learning which resulted in memorization of solutions, erroneous impressions that algebraic problems are difficult and for only the brilliant students and the perception that they are abstract in nature tend to exert negative influence on students' attitude towards algebraic problems in general. Julius et al., (2018) argued that many students developed negative attitude towards algebraic problems due to the fact that they get confused in their attempt to mathematize constructs or sentences (thus forming equations out of a given sentences) which demands accurate interpretation of the sentences and good use of equations coupled with associated variables.

Several outlined causes of negative attitude towards algebra were outlined in the works of Julius et al., (2018) as discussed below:

Personal prejudices Ideas Premised on individualized experience: Julius et al., (2018) argued that majority of students have preconceived ideas as to what algebraic algorithms are meant to reflect, and they frequently base their understandings on such experiences, incorrectly presume that all algebraic equations as well as their symbolic representations are connected. The argument here remains that many students tend to be reliant on familiarities in terms of the visual notations rather than focusing on the specific rules in solving algebraic problems and this affects their attitude towards it.

Insufficient algebra content knowledge of subject teachers: It is a truism that teachers who teach the topic (algebra) must be able to aid students with the good basis on which they can later build a much more sophisticated algebraic understanding. However, Naseer (2016) stated that students sometimes misinterpret alphabets as objects, so this misinterpretation is due to teachers' strategy in presenting early generalization of algebra, which is effected by the algebraic content, which frustrates them and breeds an unfavourable attitude. Julius et al.,(2018) argued that students struggle in understanding and trying to retrieve fundamental concepts, equations, facts, and method, and they also lacked the capacity to visualize problems in mathematics, making them inefficient in logical reasoning and lacking core competencies in solving algebraic problems. Thus, the difficulty stems from a lack of comprehension of symbols and letters, as well as the manipulation of equations in algebra

Students' impatient when solving algebraic problems: According to Julius et al., (2018) students who have a high level of resilience will not quit attempting to solve a problem unless they get the solution. According to Naseer (2016) a major problem causing negative attitude towards algebraic problems is lack of effective or strategic planning on how to solve the problem prior to attempting to solve it. Argued differently, Julius et al., (2018) asserted that solving algebraic problems require patience and careful planning to warrant correct solution. However, impatient on the part of students has resulted into wrong solution which tend to affect their attitude towards mathematics problems that involve algebra.

2.3 Difficulties Students Face in Solving Algebraic Word Problems

Evidence on difficult topics in mathematics all over the world captures algebra as a topic of difficulty (Chan, Ying et al., 2020; Sikukumwa, 2017). It is argued that major and preliminary difficulties faced include poor knowledge of students in application of various mathematical principles. This challenge is captured as dyscalculia which is connected to neurological, central nervous system dysfunction. It is evident that application of mathematics principles is preceded by proper understanding of it and hence major error committed in solving word problems can directly be linked to poor knowledge in mathematics (Sikukumwa, 2017). In a different vein, scholars outlined the fact that in mathematics word problems, major difficulty of students remains mathematizing the problem, thus converting the word problem to mathematics to enable easy solution. Mathematization captures proper understanding of the problem to be able to frame the word problem in equation form bringing to light all the needed mathematical signs and symbols in the equation (Chan, Ying et al., 2020). This problem or difficulty emanates from poor content knowledge and remains a preliminary difficulty as solving to get a correct answer depends on getting the equations right (Chan, Ying et al., 2020; Sikukumwa, 2017).

In the works of Jupri and Drijvers (2016) a major difficulty students face in solving algebraic word problems is application of the various mathematical operations such as addition and or subtraction or multiplication of terms. This also includes usage of the various mathematical properties such as commutative, associative and distributive (CAD) properties, application of priority rules (example the BODMAS rule; bracket of division, multiplication, addition and subtraction rule) (Jupri & Drijvers, 2016).

Empirical evidence also pointed out that many students find it difficult to proceed to solve word problems even after transforming the word structured question into equation (Jupri & Drijvers, 2016). Sikukumwa (2017) noted that difficulties such as inability to properly utilize or deal with (solve) the equations obtained mathematically. Such difficulties result into wrong application of mathematics rules and also difficulties dealing with fractions.

2.4 Concept of Cooperative Learning

Cooperative learning is defined differently by different scholars. Cooperative learning, is defined by Gull and Shehzad, (2015) as an educational strategy wherein teachers divide students into small groups who then come collaboratively to help each other understand academic content. Cooperative learning is defined by Mukunda (2019) as an instructional strategy whereby students work in unism to achieve instructional objectives within the same group that otherwise would be impossible to achieve by engaging on an individualized basis. The advantage of cooperative learning is that it includes supporting students in active learning by providing them with the tools, access, and fairness they need to construct information that makes sense to them. Students can also gain new skills and knowledge by deconstructing established meanings and reconstructing and expanding them through collaborative learning experiences in a social environment (Tran, 2013).

Mukunda (2019) asserted that cooperative learning is a pedagogical approach which uses a structured approach with a series of steps to improve student' conceptual and procedural understanding of the subject matter by requiring students to create, analyze, and apply various ideas on the one hand, while also developing group dynamics on the other. Students with a variety of personal traits, such as cognitive ability, talents, and

socio-cultural backgrounds, can work together to achieve the team's common purpose. According to Zakaria et al. (2013), cooperative learning promotes students to become active contributors in the building of their own learning. Students are also encouraged to interact and communicate with their peers in a cooperative manner through cooperative learning. Cooperative learning develops qualities like fairness, teamwork, mutual respect, accountability, tolerance, and willingness to give up a consensus in this way. Students' self-confidence can be boosted by completing tasks in cooperative learning.

2.5 Elements of Cooperative Learning

Cooperative learning does not suggest that we simply place students at the same desk and expect them to complete their own responsibilities. When organizations are arranged in such a way that members coordinate actions to help one another learn, the result is a cooperative learning setting (Tran, 2013). Five factors must be present in the cooperative classroom to engage students in learning: positive interdependence, face-to-face engagement, individual accountability, interpersonal & social skills, and group processing (Johnson & Johnson, 2008).

2.5.1 Positive Interdependence

The first and most important component of cooperative learning is positive interdependence. When students are placed in groups without positive interdependence, learning settings are not cooperative (Johnson & Johnson, 2008). In cooperative learning scenarios, positive interdependence means that students must work together as a coherent group to attain shared learning objectives. Throughout the process, students must be accountable for their own learning as well as the learning of their peers (Tran,

2013). To put it another way, students must make sure that other members of their group accomplish the duties and meet the academic goals. If pupils do not "swim together" in group learning activities, the lesson would not be cooperative (Johnson & Johnson, 2008). If group members are not reliant on one another and do not share a common interest in completing tasks together, the group's success will suffer. In other words, if a group member fails to finish his or her learning job, the effects of that member's poor presentation will be felt by the other group members. The group's success is directly proportional to the success of each individual. In learning activities, all members in the group must work together and are accountable for the progress or loss of each individual in their team (Tran, 2013). As a result, positive dependency must be built in cooperative learning to assist students in working and learning together. The tasks of readers, summarizers, examiners, note-takers, and encouragers in learning groups should be assigned, according to Johnson and Johnson (2008), to guarantee interdependence operates successfully. Readers read lessons and problems aloud to other members of the group; summarizers summarize the teachings; note-takers document the group's conclusions or reports; and encouragers encourage all members of the group to join in discussions and share their thoughts and feelings. Individuals accomplish greater results under positive goal interdependence, according to Tran(2013), than when they work alone. Individuals recognize that their efforts are necessary in order for the team to succeed, that they cannot "get a free ride," and that they have a distinctive role to play in contributing to the group's efforts where positive interdependence is properly understood. Team members may limit their efforts if they do not believe their efforts are important for the organization's success.

2.5.2 Face-to-face Promotive Interaction

Face-to-face promotional engagement is the second component of cooperative learning. Positive interdependence leads to reciprocal contact among individuals, which boosts the performance and success of each team member. Individuals promote and facilitate each other's efforts to achieve the goals of the group, resulting in positive interaction. Students are needed to converse physically with each other on learning assignments, share perspectives, explain topics, teach others, and show their ideas in cooperative learning (Tran, 2013).

The benefits of face-to-face engagement in cooperative classrooms have been documented in numerous studies. Providing effective assistance to group members, transferring information and materials, offering group members with responses for enhancing the motivation and performance of their assigned responsibilities and tasks, challenging each other's findings, trying to advocate the extra effort to achieve common goals, affecting each other's efforts in achieving the group's goals, acting in a trusting and trustworthy manner, being encouraged to strive for mutual benefit, and exploring different points of view (Zakaria et al., 2013).

2.5.3 Individual Accountability

Individual accountability is the third key component of cooperative learning. Individual accountability is defined as the extent to which the group's success is contingent on the independent learning of its members (Tran, 2014). Where there exists no individual responsibility, few members of the team may do most of the work whereas the rest of the group does nothing. If the group's success is contingent on each member's independent learning, members of the team are encouraged to guarantee that all members of the team master the content being studied. Individual responsibility implies

students seek for help, perform their great job, offer their ideas, study as much as they can, carry their responsibilities properly, contribute to the group's success, and look out for each other. Positive interdependence is known to establish "responsibility forces" that boost members of the groups' individual accountability for completing collective tasks and assisting the work of others (Johnson & Johnson, 2008). When a group's total performance is evaluated and the outcomes are distributed to all members of the team to compared against with a performance standard, the group is held accountable. Individual accountability occurs when every independent member's achievement is evaluated, the results are awarded back to the person and the team to make comparisons against with a performance plan, and the representative is held accountable by group members for having to contribute his or her good share to the team's success.

2.5.4 Interpersonal and Social Skills

The fourth component of cooperative learning is interpersonal and social skills. Students cannot function well if they are grouped together because they lack social skills. If basic cooperative interaction skills are not taught, team members will be unable to do their tasks efficiently (Mukunda, 2019). To help children work well in groups, interpersonal and social skills such as listening carefully, questioning constructively, and negotiating politely must be taught. Techniques like role playing and modelling in group activities can be used to teach interpersonal and social skills. Individual comment as to how often participants participated in specific social skills was much more successful than group feedback in enhancing participants' achievement (Tran, 2013). As a result, the greater the accomplishment and productivity of cooperative groups tend to be, the more socially skilled members are, the more interpersonal interactions are imparted and acknowledged, and the more personal

feedback individuals receive on their application of the skills. Not only does a social skill help people achieve more, but they also help people form more good relationships in groups.

2.5.5 Group Processing

Group processing is the fifth and final component of cooperative learning. Reflecting on a team discussion to help students: identify what members actions were useful and unproductive; and make judgments as to what measures to continue or alter is referred to as group processing (Tran, 2014). Through reflection on the learned experience, group processing helps members enhance their effectiveness in participating to the collective efforts to attain the group's goals. To put it another way, the goal of group processing is to explain and increase the members' effectiveness in contributing to the group's shared efforts to achieve its objectives. According to certain studies, group processing in cooperative learning environment produces a variety of favourable impacts. According to Tran (2014), individuals in cooperative groups with group processing outperformed their peers in terms of academic success and retention. Tran, (2013) asserted that group processing improves success uniformity, positive connections, self-esteem, and favourable views toward the topic area among group members.

In summary, students can attain higher, showcase remarkable learning skills, have more positive relations among team members and among students and the teacher, and have more positive self-esteem and mind-sets toward the subject area if all these basic components of cooperative learning will be included in cooperative learning environment (Johnson & Johnson, 2008).

2.6 Role of the Teacher in Cooperative Learning

Cooperative learning, according to Mukunda (2019) is consistently recognized for its beneficial effects in improving social, inspirational, and cognitive findings, but its execution remains a big challenge. The question about whether or not teachers and schools have the needed resources geared towards successful implementation of cooperative learning is also a major question worth asking. The section below provided the role of the teacher in cooperative learning as it elucidates the resource needs of the teacher in the process.

It is argued that teachers should be educated to redesign their present lessons to be learner centred (Mukunda, 2019). In cooperative learning, the teacher facilitates students' learning rather of just imparting knowledge to them during the teaching process. Instead of teaching from the onset to the finish of the class, the teacher, in cooperative learning class should merely deliver the essential ideas of the course to the students before allowing them to work in groups. The teacher only gets involved when students require clarification of instructions, when the teacher feels compelled to challenge a group's responses, or when the teacher wishes to commend students for an innovative concept or good social skills application. However, in way to engage pupils in active learning, the teacher must be suitably interested in the class (Tran, 2013).

In summary, the following are identified task of the teacher when organizing cooperative learning:

- List goals that needed to be achieved after the entire lesson
- Determining the size of each group

- Determining the composition of each group to ensure average students are mixed with low performing students as well as excellent students. This must be done in such a way that each group should compose of people of different rated level of intelligence.
- Determining the role of each of the group members
- Seeing to arrangement of the classroom to allow for efficient group discussion
- Ensuring all material requirements for the lesson is available
- Explaining the task to the group members and ensuring each person perform the needed task

2.7 Effects of Cooperative Learning on Students' Attitude, Conceptual Understanding and Academic Performance

2.7.1 Effects of cooperative learning on students' attitude in learning mathematics

Cooperative learning involves strategies such as Jigsaw Procedure (JP), Students Team Achievement Division (STAD), Learning Together (LT), Teams-Games Tournament (TGT), Group Investigation (GI), among others. Naseer, (2016) argued that cooperative learning strategy breeds positive interdependency which promotes learning together, exchange of ideas and it help arouse students' learning interest, enhances creative thinking and ultimately improve students' attitude towards learning. They further argued that the strategy gives the students intrinsic motivation to work harder. In the works of Julius et al. (2018) they argued that students enjoy learning in groups which help reduces tension associated with individualized learning hence improve students attitude towards learning.

There is a link between cooperative learning and positive attitudes toward mathematics as the strategy allows students the opportunity to discuss and listen critically to the views and opinions of others (James & Adewale, 2015). Argued differently, Naseer (2016) stated that attitude of students towards mathematical has a positive impact on mathematics performance. This is due to the fact that, positive attitude towards learning exerts impacts on students' motivation towards learning the topic and hence it seems to reflect in their performance.

The importance of attitude in promoting student interest in mathematics cannot be overstated. It is of this that Julius et al. (2018) argued that mathematical problems can be satisfactorily solved by students who have both interest and ability as those with the latter, are usually those that remain eager to learn. Team work guarantees activeness and positive attitude of students towards learning help achieve learning goals. Cooperative learning boost attitude of students which in-turn help improve students' understanding as well as their performance.

2.7.2 Effects of Cooperative Learning on students' Understanding of Mathematics Lessons

Naseer (2016) asserted that cooperative learning motivates students to work together in a small group to accomplish shared goals. Thus, the strategy assists students in enriching and developing their understanding of the contents or topics they study. Argued differently, Julius et al.(2018) stated that peer tutoring (interconnectedness) assists students in improving their understanding as well as academic performance because it helps reduces students' anxiety as they will be more willing to participate in

the learning process. Thus, during peer tutoring, students gain much knowledge and skills by simplification, explanation, and interpretation with their classmates or peers.

Naseer (2016) further argued that individualized attention and self-esteem will improve as a result of cooperative learning in small groups and this also leads to improvement in students' social relationships. As a result, it offers the ability for teammates to become closer and develops assisting and giving behaviour in order to improve social relationships. Thus, the group members engage in talks that supports learning and also help widen their understanding of concepts as involvement of team members remain key using this strategy.

Julius et al. (2018) stated that given the different levels of mathematics conceptual mastery among students, divergent views may arise once students interact with peers as far as cooperative learning is concern. Conflicting viewpoints, according to Piaget's theory, might lead to a cognitive imbalance in students and they tend to use such cognitive process to understand concepts from a new perspective as a result of discussions with more peers. This is supported by Maslow's career education theory which argues that skills and knowledge of individuals should be complemented by attitude and values and thus, career education should consider the varied individualized learning abilities as some understand lesson taught abstractly whiles other through experience.

2.7.3 Effects of Cooperative Learning on Students' Academic Performance in Mathematics

Evident support the fact that cooperative learning remain an effective instructional strategy for improving students' academic achievement in academic research (Ahmed, Melesse, & Wondimuneh, 2020b; Isaac Assan-Donkoh et al., 2019; Edekor & Agbornu, 2020). It is premised on the idea that individualism is discouraged whilst group work is promoted. This encourages group cohesion and active involvement of members to warrant maximum achievement of group's goal. They achieve this by assisting and cooperating with one another, working collaboratively, and supporting one another's efforts (Isaac Assan-Donkoh et al., 2019). It also encourages peer assessment and evaluation which boost performance.

According to Julius et al. (2018), cooperative learning strategy help improve the cognitive skills, social skills and motivates students towards learning, enhances cohesiveness, sharing of ideas which help weak students to also get involve and improve their understanding of topics. Thus, the strategy helps to complement traditional learning strategies which help improve students' attitude towards lessons and hence boost their understanding as well as academic performance. In conclusion, Julius et al. (2018) argued that the strategy ensures active participation relative to non-cooperative learning strategies.

Naseer (2016) argued that cooperative learning strategy boost content knowledge of students, knowledge retention, team spirit through competitiveness, sharing of ideas through interaction with peers. Thus, peer tutoring helps to improve students' academic performance via improved understanding of lesson. Argued differently, Julius et al. (2018) stated that cooperative learning impacts positively on students attitude as well

as their understanding of lessons which are necessary requirements for higher level performance of students academically.

According to Steven and Slavin (2018) the cooperative learning strategy helps complement teacher centred lesson delivery with students' centred to help maximize achievement of learning goals. Thus, students are more daring to ask questions using the cooperative strategy coupled with competitive nature of the strategy which warrant maximization of group effort as well as individual efforts. Ahmed et al. (2020) also argued that the strategy allows group members to motivate each other which leads to better understanding and higher academic performance. It is of this that it is stated that "two heads are better than one" and hence there is a higher likelihood of improved overall academic performance in groups (cooperative learning) relative to non-cooperative learning strategies.

2.8 Theoretical Literature

Two related theories were reviewed and their relevance as far as the study is concern was stated as below:

2.8.1 Social Interdependence Theory

When each individual's aims are achieved under the influence of others' activities, the social interdependence theory is relevant. According to this viewpoint, students can help each other study because they are concern about the team and its members, and group participation provides them with self-identity benefits. posits that tension motivates a person's behaviour, and that as desirable goals are seen, tension motivates behaviours to reach those goals. The benefits and drawbacks of social interdependence

are discussed. It can be beneficial when people work together to achieve common goals, but it can also be harmful when people fight to claim who achieved the goals first.

The social interdependence theory's main concept is that the manner goals are constructed impacts how people engage, and engagement styles determine outcomes. Positive dependency can lead to beneficial interaction, whereas negative interdependence can lead to antagonistic contact. Finally, no interdependence can lead to no engagement (Johnson & Johnson, 2008). Individuals engage in beneficial interaction when they promote and assist each other's endeavour to accomplish responsibilities in order to achieve the group's objectives. It includes elements like mutual aid and assistance, resource sharing, good communication, equal influence, trust, and conflict resolution that is constructive. Individuals engage in oppositional contact when they discourage and hinder each other's efforts to complete activities and achieve their objectives. It includes factors including obstructing each other's goal-achieving efforts, threatening and coercive techniques, inadequate and deceptive communication, distrust, and the desire to win confrontations. Individuals behave alone while working to achieve their goals, with no interchange with one another; individuals focus exclusively on boosting their own performance and achievement, dismissing the attempts of others as worthless.

Social interdependency theory emphasizes on the need for interdependence in learning to help share ideas. On the other hand, the basic premise behind social interdependence is that the interaction of students is defined primarily by how the teacher structures goals in each classroom (Johnson & Johnson, 2008). This theory received empirical justification in works cooperative learning studies over the years. For instance,

Mukunda (2019) argued that “in cooperative learning the point of contention is not the imitation from each other but positive interdependence among the members to find answers to the questions with the same level of cognitive development”. At the same time when students enter the situation with different viewpoints and perspectives can also be benefitted from the potential conflictual interactions through which they learn to value the differences.

The social interdependency theory supports this study as proponents argued that through interdependency (thus via cooperative learning), students are actively engaged in the learning process (thus affects their attitude towards learning), which positively influences their understanding and hence exerts a positive rippling effect on their academic achievement. Moreover, several studies that employed the cooperative learning strategy used this theory to support their studies (example: Edekor & Agbornu, 2020; Johnson & Johnson, 2019).

2.8.2 Constructivist Learning Theory

Cooperative learning is a student learning method that aligns with constructivist learning theory, which states that "learners are in charge of actively creating their own meanings." To date, constructivist philosophy has contributed significantly to the student-centred learning approach. Learning is a social practice in which learners construct information in a social setting before applying it. Learners do not acquire or grant knowledge, according to Tran, (2013), but rather construct it through their interactions with the environment in order to generate their own useful knowledge. Students actively acquire and expand their knowledge during the learning process using observation, reflection, exploration, discovery, and, most importantly, social

interaction. Learners must be active, sociable, and innovative in a constructivist learning setting since they are regarded producers of knowledge rather than passive recipients of knowledge.

The constructivist theory emphasizes the need to pay close attention to the mental activities of the learner. Thus, according to the constructivism learners construct knowledge rather than just passively take in information. The argument in support of this theory is that "in-depth comprehension and understanding of students and their long-term retention of knowledge will be improved if students find their own answers, and discover solutions to problems" (Mukunda, 2019).

This theory supports the study as it emphasizes on attention and mental activities of learners through constructivism which can be exhibited through cooperative learning. In a nut shell, the theory argues that learners understanding of concept is enhanced in the cooperative learning strategy which in tend help develop and enlarge their knowledge through observation. Also, several empirical studies that used the cooperative learning strategies justified their studies using this theory (example Tran, 2014).

2.9 Empirical Literature

This section reviews past related studies as well as provided critique or research gap in each case to justify the current study.

Assan-Donkoh et al. (2019) conducted a related study on the topic "cooperative Learning Strategy in Teaching and Learning of Circle Theorem in Mathematics: A Case of Nana Brentu Senior High School in Aowin Municipality in Ghana". The problem of the study was stated clearly and concise as the researchers attempt to bring the light the

non-usage of appropriate teaching strategy by mathematics teachers. The researchers adopted action research design in their study. The design was appropriate because the researchers wanted to improve students' understanding of Circle theorem using cooperative learning strategy. The population of the study comprised of all SHS 2 Business students of Brentu Senior High Technical School. The instruments used for the data collection were: tests (pre-test and post-test) and questionnaire. They concluded that there is significant difference between the mean scores of students' performance, when students are taught Circle Theorem using cooperative instructional strategies. They concluded that cooperative learning is effective as it creates natural, interactive contexts in which students have authentic reasons for listening to one another, asking questions, clarifying issues, and re-stating points of view. Such frequent interaction among the learners, in turn, increases their participation in the classroom as well as their performance. The paper recommended that, mathematics teachers should employ cooperative learning strategies to improve students' performance to bridge the gap among high, medium and low achievers.

The study was limited to only one senior high school which implies that the findings cannot be generalized to cover all SHS in Ghana. This provides a gap implying similar study is worth investigating in another school. Again, there are several topics of difficulty to students at SHS as per Chief Examiner's report over the years. Their study was limited to Circle Theorem and hence the findings cannot be ascertained to be the same for other topics. This poses the gap worth investigating in the same teaching strategy (cooperative learning) using other topics to see whether the findings will conform or deviate to the findings of this study. The intervention of the study lasted for three weeks of which the first two-weeks were intervention activities while the third week was allocated for group presentations on the circle theorems after the intervention

lesson. The post intervention results of the study showed that the intervention was adequate enough to help achieve the study goals. Even though the main objective of the study was to find if there is a significant difference between the mean scores of students' performance when students are taught Circle Theorem using cooperative instructional strategies was achieved, there is a missing link between the study objectives and the major findings in the study. The specific objectives did not aim at finding students attitudes exhibited in learning of mathematics (circle theorems). However, this was a major finding of the study. Again, the researchers did not state the theoretical framework that supports their study.

Ahmed et al. (2020) conducted a study on the topic "Students' perception of the application of cooperative problem-solving method and its effect on mathematics performance: the case of secondary schools in Awi-zone, Ethiopia". The paper discussed mathematics education provides a foundation for understanding the world, the ability to reason mathematically, an admiration of the beauty and power of mathematics and a sense of enjoyment and wonder about the subject. Specifically, the study sought to find out perception of students on the cooperative problem-solving approach and consequently on their performance. The researchers employed descriptive-survey design in the study. The design was appropriate because it is helpful in important decision-making when data is obtained from a large population and also provides a holistic understanding of the study. The population of the study consists of grade 11 high school students in Dangila preparatory high school, Awi-zone, Ethiopia. The sample size of the study was 105 students and purposive sampling technique was used to select one school from the six preparatory high schools in the zone. The instruments used for the data collection were questionnaire, interview, and focus group

discussion. The results of the study showed that cooperative problem-solving learning experiences contribute to social skills growth, critical thinking skills, where positive interpersonal and social relationships became noticeable and more achievement. Findings further showed that students have a higher confidence level in cooperative problem-solving as compared to working individually.

The study was limited to only one senior high school which implies that the findings cannot be generalized to cover all SHS in Ethiopia. This provides a gap implying similar study is worth investigating in a district, municipal, regional or national perspective to ascertain the real effectiveness of the cooperative problem-solving learning as a teaching method in mathematics. This poses the gap worth investigating in another country to see whether the findings will conform or deviate to the findings of this study. Also, the main objective of the study was to find out perception of students on the cooperative problem-solving approach and consequently on their performance which in turn was achieved as revealed by the results of the study. Another critique is that the researchers did not state the theoretical framework that supported their study and also did not state any recommendations for teachers or policy makers in their study.

Edekor and Agbornu (2020) conducted a study on the topic “Cooperative Learning Strategy and Students Performance in Mathematics in Junior High School in Hohoe Municipality, Ghana”. Specifically, the study sought to find out if there is difference between the mean performance score of students taught with cooperative learning strategy and those taught using traditional method at Junior High School in Ghana. The researchers employed quasi-experimental study methodology in the study. The design remains fit for the study as the researchers did not intervene in assigning the

participants in the various classes into the two groups (thus, intact classes were used as experimental and control groups in the study area). The population of the study consists of all the 6234 Junior High School Two (JHS 2) mathematics in the Hohoe municipality. A total of 266 students constituted the sample for the study, through purposive sampling techniques. The instruments used for the data collection Mathematics Achievement Test (MAT). This is appropriate as the aim was to test student's performance in both pre and post intervention periods. The results of the study showed that students performed better using cooperative learning instructional strategy irrespective of their ability level than those students using traditional method. The result of the study also indicated that both the male and female students benefitted equally from the cooperative learning strategy. The paper recommends that, mathematics teachers should adopt the cooperative learning strategy in order to improve students' performance, social interaction skills and foster meta-cognition in students.

The study was limited to only JHS 2 students in Hohoe municipality in the Volta region of Ghana which implies that the findings cannot be generalize to cover all JHS in Volta Region nor entire nation-Ghana. This provides a gap implying further studies in other districts, municipalities or regions to ensure the study can be generalized to cover the entire nation. This poses the gap worth investigating in other districts or municipality to see whether the findings will conform or deviate to the findings of this study. The main objectives of the study were achieved per the results of the study. Another major critique is that the researchers did not state the theoretical framework that support their study. Furthermore, the study population was 6234 of which the researchers sampled only 266. This number was determined without any empirical justification by using any mathematics sample size formula nor previous researchers' suggestions on sample size

determination. This determination thereby defies the rule of thumb of using at-least 10% of the entire population as a sample in a study.

2.10 Conceptual Framework

The researcher provided conceptual framework to depict the major concepts of the study. This was done with reference to the reviwed literature.

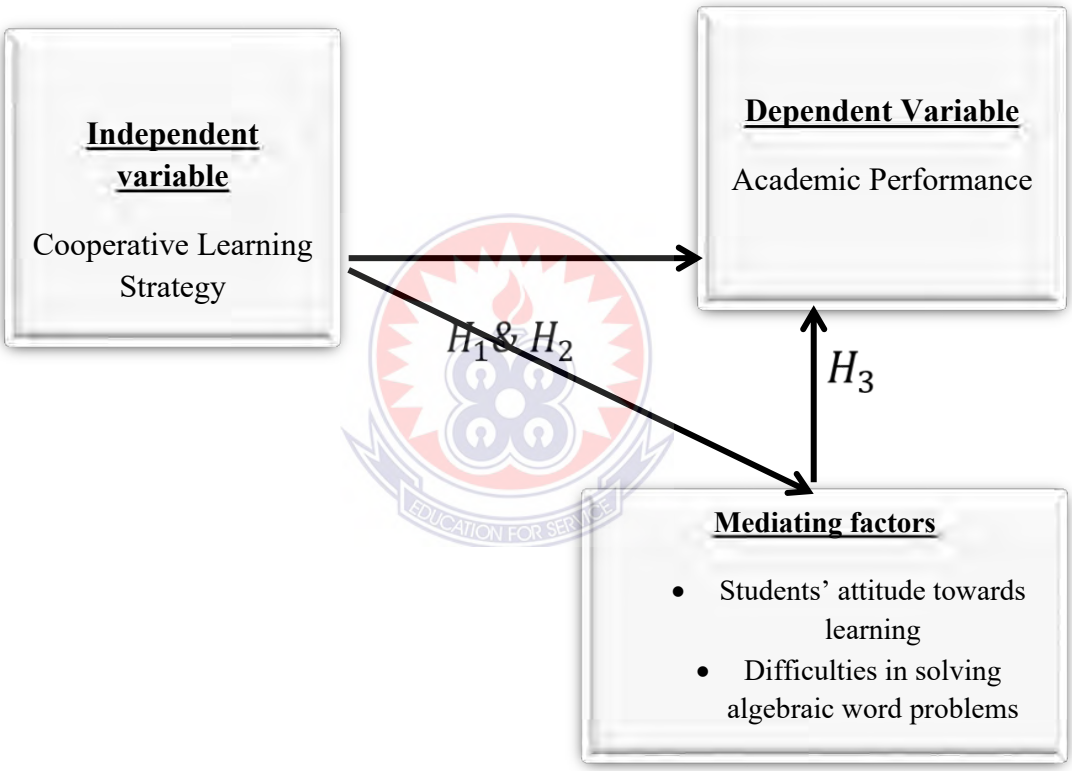

Figure 2: Conceptual Framework

Source: Researcher (2022); based on reviewed literature and research objectives

The conceptual framework above indicates the three main variables which are the dependent, independent variables and mediating terms. It shows that coperative learning exerts direct effects on students attitude towards learning. This conforms to the underpinnings forwarded by Julius et al., (2018) that argued that students enjoy learning

in groups which help reduces tension associated with individualized learning hence improve students attitude towards learning. Several empirical evidences reviewed in the study also provided similar conclusions but with varied mathematics topics. However, a major point of concern is the nature of effect cooperative learning strategy will exert on students' attitude in learning algebraic word problems.

In the above framework, student's difficulties in solving algebraic word problems interfere with the linkage between cooperative learning and students' performance(Jupri & Drijvers, 2016b). Thus, problems such as difficulties in mathematizing the word problems and solving the equation to obtain the correct answer remain major challenges in attempt to solve algebraic word problems. These challenges tend to negatively affect students' performance in the topic (Jupri & Drijvers, 2016b; Sikukumwa, 2017). This leads to the second objective of the study aimed to identify the difficulties students face in solving algebraic word problems.

The framework also shows the direct linkage between cooperative learning strategy and students' understanding of algebraic word problems. Empirically, Naseer (2016) asserted that cooperative learning motivates students to work together in a small group to accomplish shared goals. Thus, the strategy assists students in enriching and developing their understanding of the various content or topic under study. This observation raises the questions of the nature of effect of the use of cooperative learning in helping to improve students' conceptual understanding in teaching algebraic problems. Finally, the conceptual framework as shown above shows a linkage between cooperative learning and academic performance of students which can equally be viewed indirectly through the mediating role of cooperative learning strategy on

students' attitude towards learning as well as effects on students' understanding. Empirically, Naseer (2016) stated that attitude of students towards mathematical has a positive impact on mathematics performance as this is due to the fact that, positive attitude towards learning exerts impacts on students' motivation towards learning, their understanding as well as rippling effect on their academic performance or achievement. This leads to the third and final research question of the study aimed to unravel the extent to which the use of cooperative learning helps to improve students' academic performance in algebraic problems.

2.12 Chapter Summary

Initial part of the chapter provided discussions on the concept of algebraic word problems as a topic in mathematics where definition, relevance to students learning and attitude of students towards learning it were discussed. The concept of cooperative learning was also discussed where definition, elements (or what makes it work) and the role of the teacher were provided. The chapter then provided literature on the effects of cooperative learning on students' attitude, conceptual understanding and performance. Two major theories relevant to the study (thus social interdependence and constructivist theories) were reviewed and their level of significance as far as the study is concern justified. The chapter provided empirical review of key related articles as well as provided gaps on each to justify the stands for this recent study. The chapter then provided diagrammatic representations to link the major concepts of the study under the heading "conceptual framework". The last section of the chapter is the summary of the entire chapter.

CHAPTER 3

METHODOLOGY

3.0 Overview

The Chapter provides the methodology, materials and methods of data analysis of the study. The chapter first describes the research approach, philosophy and design adopted. Other relevant sections include the population, sample size, sampling and sampling technique, data gathering instruments, as well as the instructional design adopted. Identification of the teaching method and strategy used, its implementation, pilot study as well as trying and revising of the strategies were equally captured in the chapter. Validity and reliability of test items, data gathering procedure and ethical consideration were also discussed sub-headings of the chapter. The chapter ends with data analysis plan and chapter summary.

3.1 Research Approach, Philosophy and Design

The study is grounded on the positivist philosophy. Positivist paradigm is broadly any mechanism that restrains itself to the information of experience and exempts philosophical presumptions. Quantifiable facts that result in quantitative tests are necessary for positivism (Leavy, 2019). As a philosophy, positivism is said to be in line with the empiricist theory that information originates from life experiences. This approach is justified for this study as the study adopted mathematical tools, thus Statistical Package for Social Sciences (SPSS) in addressing the objectives of the study. It is argued that positivist philosophy is advantageous as the researcher remains independent from the subject and the absence of consideration for humanistic interests

within the investigation (Leavy, 2019). This current study aims to rely on participant students for information.

The research is quantitative in nature. This approach is justified for the study as data gathered using questionnaire and achievement test were solely quantitative in nature. Closed ended questions were used to ensure questions asked promote mathematical analysis. In such cases, the Likert scale used aided the statistical analysis of results. A major advantage to this approach is that it help provide statistical analysis for inferences (Leavy, 2019; Rahman, 2017). Several empirically related studies equally adopted the quantitative approach (example; Adu & Asiedu-Addo, 2015; Edekor & Agbornu, 2020).

Experimental design was employed in this study. An experimental design is a technique where the investigator modulates the magnitude of explanatory variables and then assesses the results. Experiments are effective ways to assess causation linkages. It is equally used to evaluate effects of actions or activities. True experiments entail manipulating one or even multiple independent variables while carefully measuring the changes in the dependent variable, usually by pre - tests and post-test. It used the treatment group and control group. The control group involves a group selected that will not receive any specific treatment but undertakes the needed activity aimed to solicit information from them; thus, the pre and post testing activities. However, the treatment group is the group that is given special treatment or the group that is used for the experiment whose outcome is compared to the result of the control group.

3.2 Population of the Study

A population is made up of all individuals within a group at a given time frame (Rahman, 2017). In research, population encompasses all the people as a collection or completeness of all things, entities, or persons who meet a number of requirements. Population refers to all people, units, items, and anything that could be thought of and has particular peculiar attributes (Apuke, 2017). It includes every individual and its main characteristics if that it is parametric.

The study population was limited to 2 selected Senior High School in the South Dayi-District of the Volta Region. In the South Dayi District, there are 4 Senior High Schools namely; School A Senior High Technical School, School B Senior High Technical School, School C Senior School and School D Senior High School. The selected schools for the study are; School A Senior High Technical School and School B Senior High Technical School. Researchers recommend that a sample selected should be representative enough to depict the entire population and to warrant generalization of the findings (Apuke, 2017). It is of this that though there are 4 schools in the South Dayi District, the researcher sampled 2 (thus, 50 percent) for the study. The sampled schools cut across the geographical strata of the district. Thus, specifically, attempt was made to sample a school from northern sector of the district and one from the southern part of the district. Thus, School B was selected from the northern sector of the district whiles School A was selected from the southern part. School B is the only SHS in the northern sector and hence remains an obvious choice. In the southern sector, there are 3 schools; School A, C and D. The proximity from the selected school in the northern sector and School A remains the shortest as compared to the proximity from the same place to the other two schools in the southern sector of the district. Hence, the choice of

School A and B was based on the proximity to allow for frequent visitation for data gathering.

The Target population of the study is senior high two students of the two schools. The choice for form two (SHS 2) students was due to the fact that though the topic under investigation is a first-year topic (according to the Ghana Education Service-West African Examination Council (WAEC) syllabus for core mathematics), Covid-19 destructed learning of current second years and hence are learning most first year topics in the second year. The population of second year students in the two schools are 405 and 325 respectively making a total of 730. The distribution of the population relative to the courses or programs of study in the two sampled schools is as shown below:

Table 3.1 Population distribution of SHS 2 Students in the Study Area

	School A			**School B**		
Courses of Study	***Boys***	***Girls***	***Total***	***Boys***	***Girls***	***Total***
General Arts	43	55	98	31	45	76
Visual Arts	46	32	78	29	28	57
Home Economics	45	02	47	00	47	47
Business	32	18	50	30	13	43
Pure Science	22	10	32	25	09	34
Agricultural Science	12	16	28	13	10	23
Technical	55	17	72	40	05	45
Total	**255**	**150**	**405**	**183**	**155**	**325**

Source: School A and School B, 2022 Records

3.3 Sample Size

A sample is a subgroup of an entire population that has been chosen to engage in a study; it is a small percentage of the overall population that has been chosen to take part in a survey or a study (Rahman, 2017). It encompasses the definite fraction of the population which is selected through a methodical way in order to determine the attributes of the entire population (Armstrong & Kraemer, 2015). In a nut shell, a sample includes only a handful of elements chosen from the population and this is done through sampling. Results are generally used to make inference.

Research acknowledged that "always choose the greatest sample size feasible", as a basic rule. This is because, as sample size increases, the better representative it will be; fewer samples, on the other hand, give less exact answers since they generally can barely represent the entire population (Armstrong & Kraemer, 2015). Sample size selection is argued to have several benefits relative to using a census as it is time and economically efficient. However, a major demerit is whether findings from the chosen sample is a reflection of the entire population or otherwise (Armstrong & Kraemer, 2015).

The study used the Cochran's formula to determine the appropriate sample size. The formula and the specific steps used are as shown below:

$$n = \frac{p(1-p)}{\frac{e^2}{z^2}+\frac{p(1-p)}{N}}$$

e = significance level = 5% = 0.05

z = z-value at the chosen significance level, thus z-value at 0.05 = 1.96 (two tailed test)

N= Target population of the study = 730

n= Sample Size to be determined

$$n = \frac{0.2(1-0.2)}{\frac{0.05^2}{1.96^2}+\frac{0.2(1-0.2)}{730}} = \frac{0.2(08)}{\frac{0.0025}{3.8416}+\frac{0.2(0.8)}{730}}$$

$$n = \frac{0.16}{0.0006507705+\frac{0.16}{730}}$$

$$n = \frac{0.16}{0.0006507705+0.000219178}$$

$$n = \frac{0.16}{0.0008699485822} = 183.9 = 184 \text{ approximately}$$

To account for sample size calculation error, the researcher added 2% of the entire population to the calculated figure to help determine the entire sample size for the study: thus, 2% of 730 = 15 approximately. Hence, 184+15 = 199. This was rounded up to 200 to allow for even number and equal number sampling between the two schools.

The study sampled 200 participants in all. To make the sample equal in both study areas as possible, the researcher sampled 100 respondents from each of the two schools (School A and from School B). Thus, 50% of the sample size was selected from each school.

3.4 Sampling and Sampling Technique

Sampling is a procedure of picking a subset of the population to symbolize the total group (Armstrong & Kraemer, 2015). The study employed the stratified random sampling method. In the sampling technique known as stratified random sampling, a population is divided into separate groups known as strata. The groupings or strata are structured depending on the identical traits or qualities of the individuals in the subgroup.

In this study, the researcher used the class divisions in the two schools as the sub-divisions or strata groupings. In all, there were 10 classes in form 2 in the two schools

(School A and School B). The sub-divisions of the classes in the two schools are as shown below:

Table 3.2 Strata or class divisions in the Study Areas

	School A		**School B**	
Courses of Study	***Categories***	***No. of Classes***	***Categories***	***No. of Classes***
General Arts	A and B	2	A, B and C	3
Visual Arts	A and B	2	A and B	2
Home Economics	A and B	1	A	1
Business	A	1	A	1
Pure Science	A	1	A	1
Agricultural Science	A	1	A	1
Technical	A and B	2	A and B	1
Total		**10**		**10**

Source: School A and School B, 2022 Records

Table 3.2 indicates varied courses of study in the two selected schools. The specific number of classes per course varies in both schools depending on the number of students and elective courses of study in the two schools. In sampling, the researcher selected 10 students from each class in the two schools to make the total of 100 from each school. Specifically, the class captains, assistants were automatic members selected in each class whiles the remaining members were randomly chosen.

3.5 Data Collection Instruments

The study adopted questionnaire and achievement test as data gathering instruments. Vivid description of both is as shown below:

3.5.1 Questionnaire

The study employed questionnaire to solicit for data aimed to address the first two objectives of the study. Specifically, closed ended questions were used to warrant quantitative analysis. The questions were divided into sections to reflect the objectives they sort to address. However, the first section was devoted to gather data on participants' bio-data. Thus, section one of the questionnaire solicited data on the participants age (where age ranges; 12-14 years, 15-17years, 18-21 years and 21 years and above, were used) as well as gender (Male or female). Equally, bio-data was solicited on the participants' religion and ethnicity.

The second part gathered data on the major challenges faced by students in their attempt to solve algebraic word problems. 5 closed ended questions were asked under the second section of the questionnaire. The questions were all closed ended in nature. Questions asked were aimed to state the exact nature of challenge students faced while attempting to solve algebraic word problems. Specifically, the questions were focused on whether the problem relates to understanding of the problem, transforming the problem to mathematic equations, determining the exact mathematical operation to use, simplifying the problem or notational errors. The questions were adopted from empirical literature reviewed. Specifically, the works of Ying et al.(2020); Sikukumwa (2017) and Jupri and Drijvers (2016) provided reference points for questions asked aiming at providing information on the challenges students faced in solving algebraic word problems. 5 points Likert scaling was used.

The third section of the questionnaire aimed to gather data to determine the attitudes of students towards cooperative learning in algebraic word problems. Twelve (12) structured closed ended questions were asked under the third section. The questions were adopted from the empirical work of Kasimu and Imoro, (2017), Veloo et al., (2018) as well as Thompson, (2018). Specifically, student's attitude was measured using anxiety or nervousness, enjoyment, confidence and persistence or willingness. 3 questions, each, was asked under each of the constructs stated above. 5 points Likert scaling was used to rate responses with descriptions as shown below:

3.5.2 Achievement Test

The study employed achievement test to solicit for data from the two group of students (treatment and experimental groups). This was aimed to address the third objective of the study. The test was an individual test where each student provided solutions to the mathematical test items given to measure their performance. In all, 10 standard questions with majority adapted from the works of Jupri & Drijvers (2016) and reframed bases on Core Mathematics WASSCE syllabus for Senior High Schools in Ghana, were provided. Each question was accorded and awarded equal marks. Specifically, a question was awarded five (5) marks making a total of 50 marks in all for the 10 questions which was converted to 100percent by multiplying by 2. Marks were added to each step of the solution through to the final answer. Thus, mathematical method used, approach and the final answer were awarded marks. The time frame allotted to the test items was 45 minutes. The two groups were given the test items at separate occasions and invigilated to ensure individualized presentations of answers were given by each participant.

3.6 Instructional Design, Identification and Piloting

3.6.1 Instructional Design

The study adopted the Bloom's Taxonomy. Bloom defined six levels of instructional design within the cognitive domain. From the lowest level, which is simply remembering or recognizing information, up to ever more complicated and abstract cognitive divisions to the highest rank, which is categorized as assessment. The first level is knowledge. Arrange, identify, replicate, describe, list, recall, name, order, explain, recall, reproduce, replicate are all terms used to describe knowledge. The second level is "understanding" and it portrays categorization, depict, to talk about, explain, articulate, locate, discover, report, reiterate, consider, pick, and translate.

Application is the third level that implies to apply, to pick, show, act out, use, illustrate, comprehend, operate, manage, sketch, resolve, use, and write. Analysis (the fourth level) is the process of evaluating, classifying, calculating, comparing, contrasting, criticizing, differentiating, separating, and testing something. Synthesis (the fifth level) is the process of arranging, collecting, composing, building, designing, developing, formulating, managing, organizing, planning, readying, proposing, setting up, and writing. Evaluation (the last level) include appraise, discuss, assess, attach, connect, justify, judge, forecast, rate, assess, choose, endorse, value, and analyse.

The study specifically employed the revised Bloom's taxonomy by Lorin Anderson and Krathwohl as cited by Himmah et al., (2019) to include; remember, understand, apply, analyse, evaluate and create. Specifically, the major instructional designs employed to depict the revised Bloom's Taxonomy is as shown below:

Table 3.3 Instructional Design employed based on Revised Bloom's Taxonomy

Bloom's-Revised Construct	Specific Instructional Design or Strategy
Remember	Cooperative Learning Strategy was planned to ensure students ability to remember and recall processes involved in solving algebraic word problems. This was due to the rigorous lesson processes used.
Understand	The cooperative learning strategy is argued to help students' ability to understand, exemplify algebraic word problems, interpret them and mathematize them for onward solution provision
Apply	The entire instructional design and learning strategy was planned to provide students with the needed knowledge to apply, execute and carry out the various steps in solving algebraic word problems based on knowledge acquired from the cooperative learning strategy.
Analyze	A major objective of the entire lesson delivery and learning strategy was to ensure students overcome pertinent challenges they encounter in solving algebraic word problems.
Evaluate	Assessment of participants was done using individualized achievement test to measure the effectiveness of cooperative learning strategy on their performance in algebraic word problems.
Create	The entire process was aimed to provide succinct understanding on algebraic word problem to ensure participants can frame simple word algebraic word problem related questions themselves and provide solutions to them

Source: Researcher, 2022.

3.6.2 Identifying the Teaching Strategy and Its Implementation

The study specifically employed the cooperative learning strategy. The class or participants were divided into two to form the treatment and control group. This was

done by randomly dividing participants into two. Thus, participants in each school were grouped into two groups of equal numbers; 45 each, making a total of 4 groups comprising of two treatment groups and 2 control groups. The treatment group in each case was then provided a serene classroom environment arranged for cooperative learning.

The researcher adopted the Students Teams Achievement Division (STAD) Strategy for cooperative learning proposed by Slavin in 1995. Hermawan et al., (2020) provided five main phases of Students Teams Achievement Division (STAD); class presentation, creating of teams, giving exercises or task, recording individual progress scores and giving group awards. Detailed steps taken for implementation of the STAD as far as the study is concern is discussed in chapter 4.

In the study, the treatment group (in each case) was sub-divided into learning groups of at-least 5 members. This division was done by the researcher with the support of subject teachers in the two schools to ensure the group composed of both low performing students and average performing students. The groups were supervised effectively to ensure "free rider" issues were minimized. The groups were supervised by the researcher with the support of some mathematics teachers in each school.

Specifically, the following lesson delivery strategies were employed:

- Teacher group students into groups (of at least 5 students per group) which were characterized by diversity of gender and ability. The researcher then explains to the groups the objectives of the lesson to them.
- The teacher appoints one person from each group as a leader in the group.

- The lesson was introduced by the researcher (the teacher) as she leads the class to provide the needed meaning of some phrases and words popularly used in algebraic word problems as well as state what exactly they imply. The researcher led the students to learn how to appropriately mathematize word problems and equally provide appropriate solutions to them. Few other examples were solved with the entire class.
- The teacher gives tasks to each group. During this stage, the researcher provided group tasks to each group and the group was guided to provided appropriate solution with collaboration from group members.
- The students are given time to read the problem carefully
- Teacher guide students through group discussion to identify the number of unknowns (variables) in the question.
- Team members were asked to write down their equation from the problem.
- Each group is led by the group leader to provide appropriate solution to the problem
- Teacher guide students to verify the answer
- After the process, each group was given ample time to provide their solutions on the white board for the whole class to see and equally explain their solutions to the class. After the cooperative learning by the treatment group, the entire class (treatment group) was then tasked to ask group members possible questions to which any group member is at liberty to answer.

The treatment group was guided and attention was paid to the following in each group:

i. Reading of word problems carefully two or three times and develop the skills to identify the number of unknowns in the question

ii. Representing the unknowns with variables starting from the least

iii. Carefully write the equation that represents the statement given. Attention was paid to mathematical operations to use in forming the equations and how to form them.

iv. Provide a step-by-step solution to the equation

v. Confirming if the solution provided is logical relative to the question given

3.6.3 Pilot Study

The researcher piloted the instruments and entire proposed lesson strategy at Peki Senior High School, a school, equally in the South Dayi District. The sample chosen for the pilot study was 38 students, thus General Arts 2A students. The group was divided into two with 19 students each to form the treatment and control group for the pilot study. The pilot study was done to unearth pertinent issues that the researcher will encounter in the main study so as to provide timely solutions prior to the main study.

3.6.4 Trying, revising and refining the Strategy

The researcher contacted the head of department for mathematics in Peki Senior High School (the school selected for pilot study) who personally helped supervised the pilot study and equally provided comments and recommendations to aid the researcher in refining the strategy for the main study. The researcher incorporated all the post-pilot study comments and recommendations which helped to ensure smooth instructional delivery during the main study. The researcher believed that the external supervisor (Head of Department for Mathematics at Peki Senior High School) served as an expert in providing the needed guide for refining the strategy to be used by the researcher to minimize challenges in the main study and ensure its fruition.

3.6.5 Validity and Reliability

Reliability in research refers to consistency whiles validity is a measure of stated research objectives only without deviation. The study employed construct and face validity to ensure only stated objectives were measured and nothing else. Specifically, the researcher submitted the test items, questionnaires and lesson delivery notes to the assigned research supervisor for comments and recommendations prior to actual field work. The researcher's conviction is that, the level of experience of the supervisor will help ensure all strategies, test items and questionnaire designed.

Internal consistency reliability was employed. The study used the Cronbach's Alpha to test the reliability of items. Cronbach's alpha (or reliability coefficient) is a measure of dependability or internal reliability established by Lee Cronbach in 1951. The formula for the Cronbach's Alpha is as shown below: $\alpha = \frac{N\bar{c}}{\bar{v}+(N-1)\bar{c}}$

Where α = Alpha Value, N = Overall number of Items

$\bar{c}$ = Average of Mean Covariance that exist between the various items pairs

$\bar{v}$= Average variance of items. For multiple choice questions, thus Likert scale questions, the general rule of thumb for the interpretation of Cronbach's alpha is shown below.

Table 3.4: Cronbach's Alpha Interpretations

Alpha Value (α)	Interpretation
$\alpha \geq 0.9$	Excellent
$0.8 \geq \alpha \geq 0.9$	Good
$0.7 \geq \alpha \geq 0.8$	Acceptable
$0.6 \geq \alpha \geq 0.7$	Questionable
$0.5 \geq \alpha \geq 0.6$	Poor
$\alpha < 0.5$	Unacceptable

The results of the Cronbach's Alpha of the various pairs of questions are as shown below:

Table 3.5 Reliability test for items used (difficulties students face in solving algebraic word problems)

Items	Cronbach's Alpha Value	Alpha Value based on Standardized test
5	0.957	0.957

Source: Field Study Area, September, 2022

Table 3.5 indicates an Alpha value (α) of 0.957 showing an excellent reliability value. Thus there is an excellent internal consistency between the 5 items in measuring the difficulties students face in solving algebraic word problems.

Table 3.6 Reliability test for items used (Attitudes of students towards cooperative learning in algebraic word problems)

Construct	Items	Cronbach's Alpha Value	Alpha Value based on Standardized test
Confidence	3	0.720	0.719
Nervous/Anxiety	3	0.756	0.757
Enjoyment	3	0.726	0.729
Persistence/Willingness	3	0.736	0.744
Total	**12**	**0.845**	**0.844**

Source: Field Study Area, September, 2022

Table 3.7 indicates that the 3 items used to measure confidence level of students towards cooperative learning in algebraic word problems recorded an Alpha value (α)

of 0.720 indicating an acceptable internal consistency. The three sub-categories of Nervousness or anxiety during cooperative learning in algebraic word problems recorded an Alpha value (α) of 0.756 equally indicating an acceptable internal consistency. The 3 sub-categories used to measure enjoyment of students towards cooperative learning in algebraic word problems recorded an Alpha value (α) of 0.726 indicating acceptable internal consistency values. Equally, persistence or willingness recorded Alpha value (α) of 0.736 indicating acceptable internal consistency. Overall, all the 12 items used to measure attitudes of students during cooperative learning in algebraic word problems recorded an Alpha value (α) of 0.845 indicating a good internal consistency. This implies that all the items together remains consistent in attempting to measure attitudes of students towards cooperative learning in algebraic word problems.

3.7 Data Collection Procedure

The researcher initially applied for introductory letter from the Mathematics Department of University of Education Winneba. Attached to the introductory letter was a copy of application letter to use students of the selected schools for data gathering which were submitted to the headmasters of the two schools. Copies were equally given to the Parent Teachers Association Chairpersons of both schools. The aim of the letter is to get the go ahead from the management of the two schools to use their students for academic data gathering. The researcher met the headmasters of the two schools on separate days to arrange for appropriate time for the entire process to ensure lessons were not distracted. The researcher visited the two schools and appealed to the mathematics teachers as well as the heads of department of mathematics in both schools for their assistance during the entire process. Specifically, their help was solicited for

grouping the treatment group students into sub-divisions for cooperative learning as well as supervision of the entire process. Though classes hours were used for the entire process, the days scheduled were days devoted for projects (clean-up) by the two schools and hence no official classes were destructed.

3.8 Data Analysis Plan

3.8.1 Data Computerization: Data gathered was computerized into Statistical Package for Social Science version 23 for statistical analysis.

3.8.2 Bio-Data:

Bio-data was gathered on three main constructs; Gender or sex, age range, religion and ethnicity. The results were presented using descriptive statistics showing frequency tables with frequencies and corresponding percentages. The category, in each case, with the highest frequency and percentage was interpreted as having the highest number of participants.

3.8.3 Objective 1: To identify the difficulties students face in solving algebraic word problems.

Five main items were used in the questionnaire to help solicit data to address this objective. Result was presented using descriptive statistical table showing mean, standard deviation, maximum and minimum values. Interpretation was done using the mean values and standard deviations. In each case, the mean values reflected the level of severity of the challenge faced by the participants in their attempt to solve algebraic word problems. Thus, 1= profound, 2= severe, 3= moderate, 4 = mild and 5 = less. Attempt was made to augment the findings from the questionnaire with errors committed by students after the test items were marked. In such cases, the researcher after marking pointed out the major challenges the students' encountered and discusses

same under the major constructs provided in the questionnaire distributed. The researcher discussed the findings with reference to empirical studies reviewed in chapter two of the study.

3.8.4 Objective two: To assess the attitudes of students towards cooperative learning in algebraic word problems.

Twelve (12) main items were used to assess this objective. The items were divided into four parts or under four main constructs; confidence, persistent, enjoyment and anxiety. The Results were then presented using descriptive statistical tables showing mean, standard deviation, maximum and minimum values. Interpretation was done using the mean values and standard deviations. In each case, the mean values reflected the participants' level of agreement or disagreement on each statement. Thus, 1= strongly disagree, 2= disagree, 3= neutral, 4 = agree and 5 = strongly agree.

Overall mean was compiled in each of the two tables to see whether the positive affirmative attitudes dominate the negative affirmative attitudes about attitudes of students towards cooperative learning in algebraic word problems. The researcher discussed the findings with reference to empirical studies reviewed in chapter two of the study.

3.8.5 Objective three: To evaluate students' conceptual understanding and performance in algebraic word problems using cooperative learning.

Achievement Test was used to measure this objective. The test was divided given to the students in the two groups (treatment and control group). 10 test items were provided to all the participants to answer. The marks of each group were solicited and computerized. Descriptive statistical results were provided on the test outcomes reflecting the level of performance in each of the two groups where mean, standard deviation, sum, variance, minimum and maximum values were provided. Inferential

statistics was then provided using independent sample t test where the F-test value was interpreted with degree of freedom for the control and treatment groups. A post hoc statistics (LSD) was then done to determine the effect size of the intervention. The researcher discussed the findings with reference to empirical studies reviewed in chapter two of the study.

3.9 Ethical Considerations

Informed consents: The researcher submitted introductory letter with letter of application to the two headmasters or the selected schools (School A and School B). Copies were also submitted to the Parent Teachers Association chairpersons of the two schools. This was done to seek their consent as well as green-light to undertake the study using their students. The entire students sampled for the study were equally briefed prior to the data gathering.

Respect for privacy: The school authorities in collaboration with the researcher selected days and periods that did not obstruct normal classes. Specifically, periods that were devoted for grounds work (clean-up) were used for the entire activity.

Respect for intellectual property: The study referenced all materials or empirical studies used at the appendix column.

Respect for anonymity and confidentiality: Though participants were required to provide their names on the test-items solutions, the researcher ensured that the data gathered was solely used for the study and nothing else. In the analysis, participants names were not provided to ensure neutrality of result discussions. For the questionnaire, participants were not required to provide their names on them.

3.10 Chapter Summary

The chapter provided the methodology, materials and methods of the study. The chapter justified the usage of positivist philosophy, quantitative research approach and experimental design used in the study. It provided brief description of the two selected populations of the study (second year students of School A and School B). It provided the mathematical approach used to determine the sample size for the study. Descriptions of the questionnaire and achievement test used for data gathering were discussed. The Bloom's Taxonomy was explained as the instructional design adopted in the study. How piloting was done and test items as well as questionnaire were refined were equally discussed in the chapter. Face and Construct validity adopted in the study was described whiles the statistical measure of reliability used was also discussed. How data was collection, editing, computerization and presentation were discussed.

CHAPTER 4

RESULTS AND ANALYSIS

4.0 Chapter Overview

The Chapter provided results from the field study. The results were presented pictorially as well as using Tables. Initial presentation was done on the results on the demographic characteristics of participants, which were presented using graphs or charts. This was followed by presentation of results based on the study objectives. The results were presented and analysed chronologically in line with the objectives as presented in chapter one. Reliability test was provided prior to the presentation of outcome on the three specific objectives of the study.

4.1 Demographic Characteristics/ Bio-data of participants

The results on the bio-data are as displayed below:

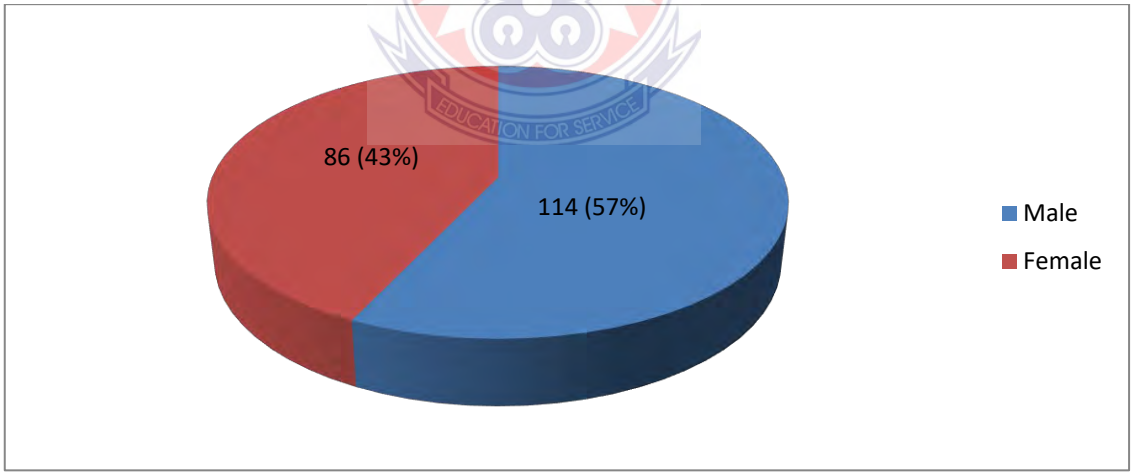

Figure 4.1: Gender of Participants

Source: Field Study Area, September, 2022

Results from Figure 4.1 indicate that majority of the participant students were males (thus, n=114, representing 57%). Females constitute the minority (thus, n= 86, representing 43%).

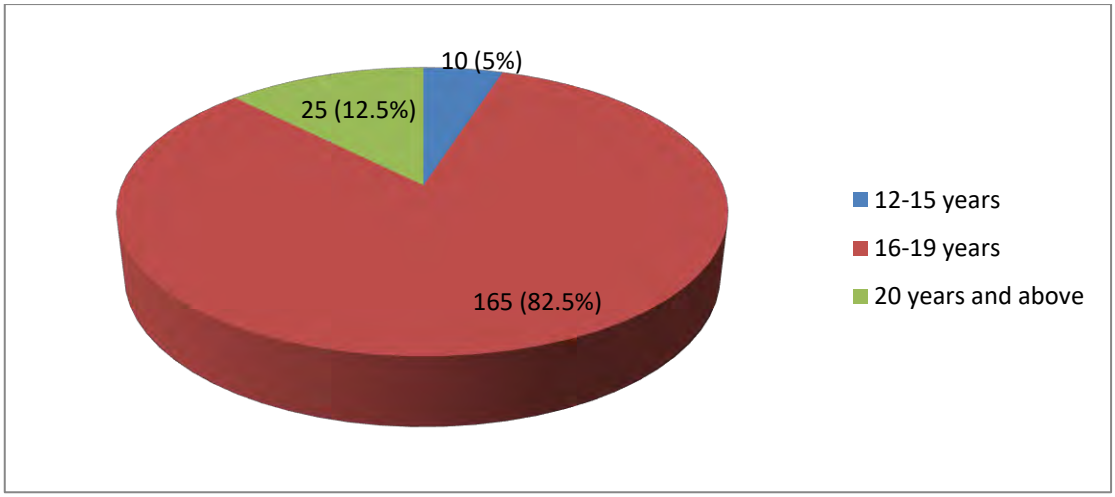

Figure 4.2: Age range of Participants

Source: Field Study Area, September, 2022

Result from Figure 4.2 indicates that majority of the participants (thus, n= 165, representing 82.5%) were within the age range of 16 years to 19 years. This was followed by 25 participants (representing 12.5%) that were at least 20 years of age; whiles only 10 participants (representing 5%) were at most 15 years of age during the time of the study. The result is not surprising as considering the education system in Ghana where an individual needs to progress from Kindergarten, to 6 years in primary and 3 years in Junior High school before going to senior high school, they might have been at least 15 years the time they get to senior high school.

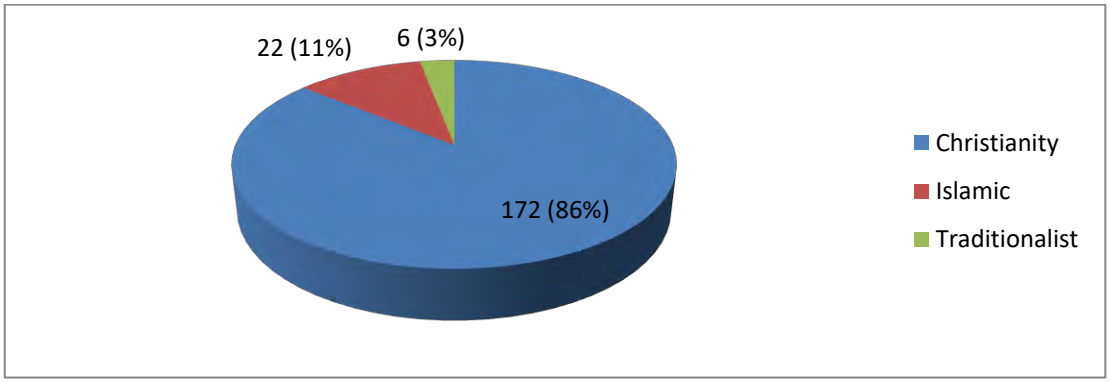

Figure 4.3 Participants' Religious believe

Source: Field Study Area, September, 2022

Figure 4.3 indicates that majority of the participants (thus, n=172, representing 86%) were Christians. This was followed by 22 participants (representing 11%) that were Moslems whiles only 6 agreed that they were traditionalist (representing 3%). The outcome confirmed the findings from Ghana's 2021 Population and Housing Census where Christianity was ranked as the religion with the largest members in Ghana.

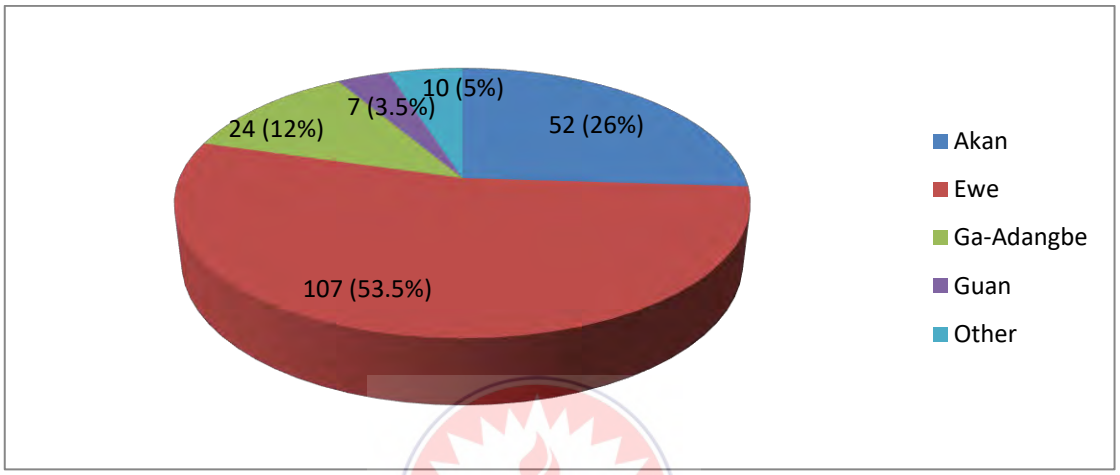

Figure 4.4 Participants' Ethnicity

Source: Field Study Area, September, 2022

Figure 4.4 indicates that majority of the participants (thus, n= 107, representing 53.5%) were Ewes. This was followed by 52 participants (representing 26%) that were Akans. 24 participants (representing 12%) were Ga-Adangbe, 10 selected other (representing 5%) whiles 7 participants (representing 3.5%) were Guans. The large number of participants that were Ewes does not come as a surprise as the schools used in the study were in the Volta Region. However, trend of outcome where many major ethnic groups in Ghana is represented can be associated with the computerized school placement.

4.2 Difficulties Students Face in Solving Algebraic Word Problems

The first objective is to identify the difficulties students face in solving algebraic word problems. Five main items were used in the questionnaire to help address this objective.

Results were presented using frequency distribution table and descriptive statistics. Frequency distribution tables for the result are as shown below:

Table 4.1 Frequency distribution on Difficulties Students Face in Solving Algebraic Word Problems

Difficulties encountered	*1*	*2*	*3*	*4*	*5*
Difficulties understanding the words or phrases used.	78 (39%)	74 (37%)	29 (14.5%)	15 (7.5%)	4 (2%)
Difficulties transforming algebraic word problems into equations.	74 (37%)	69 (34.5%)	35 (17.5%)	18 (9%)	4 (2%)
Challenges applying the mathematical priority rules to solve the equation.	56 (28%)	76 (38%)	40 (20%)	21 (10.5%)	7 (3.5%)
Calculation or simplification challenges.	55 (27.5%)	68 (34%)	47 (23.5%)	23 (11.5%)	7 (3.5%)
Difficulties verifying correctness of results obtained.	67 (33.5%)	63 (31.5%)	35 (17.5%)	25 (12.5%)	10 (5%)

Source: Field Study Area, September, 2022

From Table 4.1 indicate that majority of the participants (n=78, 39%) rated difficulties understanding the words or phrases used as profound. This was followed by 74(37%) participants that rated it as severe whiles the least number of participants (n=4, 2%) rated it as not a challenge. Most of the participants rated (n=74, 37%) rated difficulties understanding the words or phrases used as profound. This was followed by 69(34.5%) participants that rated it as severe whiles the least number of participants (n=4, 2%) rated it as not a challenge. Challenges applying the mathematical priority rules to solve the equation was rated by most of the participants (n=76, 38%) as severe challenge followed by 56 participants (28%) that rated it as profound whiles the least number of participants (n=7, 3.5%) rated it as not a challenge. Equally, most of the participants

(n=68, 34%) rated Calculation or simplification challenges as a severe challenge, 55 participants (27.5%) rated it as profound whiles the least number of participants (n=7, 3.5%) rated it as not a challenge. Difficulties verifying correctness of results obtained was rated by most of the participants (n=67, 33.5%) as a profound challenge. This was followed by 63 participants (63, 31.5%) that rated it as severe whiles the least number of the participants (n=10, 5%) rated it as not a challenge.

The descriptive statistics result indicating the mean and standard deviation as well as minimum and maximum values are as shown below. In terms of interpretation, the lower the mean value of a statement, the higher its severity as difficulty students faces in solving algebraic word problems.

Table 4.2 Descriptive Statistics on Difficulties Students Face in Solving Algebraic Word Problems

Possible Difficulties encountered	N	Min	Max	Mean	St. Dv
Difficulties understanding the words or phrases used.	200	1	5	1.96	1.009
Difficulties transforming algebraic word problems into equations.	200	1	5	2.04	1.043
Challenges applying the mathematical priority rules to solve the equation.	200	1	5	2.23	1.080
Calculation or simplification challenges.	200	1	5	2.30	1.097
Difficulties verifying correctness of results obtained.	200	1	5	2.16	1.108

Source: Field Study Area, September, 2022

From Table 4.2, difficulties understanding the words or phrases used recorded a minimum value of one (1) with a maximum value of five (5). This statement recorded the least mean value ($\bar{x}$) of 1.96 with standard deviation (σ) of 1.009. This value

implies that participants rated difficulties understanding the words or phrases used as the severest difficulty faced in solving algebraic word problems.

Difficulties transforming algebraic word problems into equations recorded a minimum value of one (1) with a maximum value of five (5). The statement recorded the second lowest mean value ($\bar{x}$) of 2.04 with standard deviation (σ) of 1.043. This value implies participants rated difficulties transforming algebraic word problems into equations as a moderately severe difficulty faced in solving algebraic word problems.

Table 4.2 shows that difficulties verifying correctness of result(s) obtained recorded a minimum value of one (1) with a maximum value of five (5). The statement recorded a moderately low mean value ($\bar{x}$) of 2.16 with standard deviation (σ) of 1.108. This value implies participants rated difficulties verifying correctness of results obtained as a moderately severe difficulty faced in solving algebraic word problems. This result does not come as a surprise as poor understanding of word problems, difficulties translating and solving will automatically lead to wrong final result which the student will find it difficult to verify.

Table 4.2 results, indicate that, challenges applying the mathematical priority rules to solve the equation, recorded a minimum value of one (1) with a maximum value of five (5). The statement recorded the fourth lowest mean value ($\bar{x}$) of 2.23 with standard deviation (σ) of 1.080. This value implies participants rated challenges applying the mathematical priority rules to solve the equation as a moderately severe in solving algebraic word problems. This result indicates that the challenge is the least severe one among the five challenges.

The results in Table 4.2 indicate that, calculation or simplification challenges recorded a minimum value of one (1) with a maximum value of five (5). The statement recorded a moderately low mean value ($\bar{x}$) of 2.30 with standard deviation (σ) of 1.097. This value implies participants rated calculation or simplification challenges as a moderately severe difficulty, faced in solving algebraic word problems.

The researcher equally verified the above results after administering the achievement test items to the students. It was indicated that some students could not attempt solving most of the questions given. In some cases, wrong translation was done leading to wrong equation formation. Another form of error identified relating to translation was "literal interpretations or translations". Thus, some participants gave literal or direct translation of the word problem as they understood them in English without applying mathematical semantics to them. For instance, for the question "if $\frac{(5x-3)}{7}$ is greater than $\frac{(2x+3)}{5}$ by 10, find x". Some candidates literally translated the equation as $\frac{(5x-3)}{7} > \frac{(2x+3)}{5}+10$ and ended up solving to get $x > 35.09$ instead of $x = 35.09$. Pictorial representations of some selected solution to attest for the error of translation during the pre-test stage is shown in appendix K of the study.

Equally, some, translated the questions well but could not solve them properly. For instance, for the question "if $\frac{(5x-3)}{7}$ is greater than $\frac{(2x+3)}{5}$ by 10, find x". Some candidates translated the problem as requested as $\frac{5x-3}{7} = \frac{(2x+3)}{5}+10$. However, some ended up adding 10 to the 3 to give $\frac{5x-3}{7} = \frac{2x+13}{5}$ and had wrong answers after calculation. Some also multiplied through by LCM of 7 and 5 which is 35 but did not

include the 10 in the multiplication. Thus $\frac{35\,(5x-3)}{7} = \frac{35(2x+3)}{5}$+10 which yielded a wrong answer. Some pictorial representations of the above are shown in appendix K of the study. Summary of test achievement is indicated in pre-intervention test report in Table 4.12.

The researcher also provided correlation output of the 5 construct terms to determine the extent of linear association between each pair. The statements were represented by the following words respectively, Understand, Translate, apply-operations, calculate, verify.

Table 4.3 Correlation Coefficient on the Difficulties Students Face in Solving Algebraic Word Problems

	Understand word problems	Translate to equations	Applying maths operations	Simplify Results	Verify Result
Understanding	1				
Translation to equation.	0.927***	1			
Apply maths operations.	0.727***	0.771***	1		
Simplify Result.	0.704***	0.748***	0.955***	1	
Verify Results.	0.850***	0.885***	0.810***	0.781***	1

*** =*correlation is significant at the 0.01 level (2-tailed).*
Source: Field Study Area, September, 2022

Results from Table 4.3 indicate that difficulties applying mathematical operations and calculating challenges recorded the highest correlation coefficient (ρ) of 0.955. This result was significant at one-percent significant level. This outcome could be interpreted

as existence of very strong linear association between the two difficulties students faced in solving algebraic word problems.

Table 4.3 indicates that, difficulties understanding word problems and challenges translating them to equations recorded a very high correlation coefficient (ρ) of 0.927. This result was significant at one-percent significant level. This outcome could be interpreted as existence of very strong linear association between the two difficulties students face in solving algebraic word problems.

The outcome in Table 4.3 also shows that challenges translating word problems into equations and difficulties verifying results recorded a high correlation coefficient (ρ) of 0.885. This result was significant at one-percent significant level. This outcome could be interpreted as existence of very strong linear association between the two difficulties students face in solving algebraic word problems. A likely justification for the result is that ability to get correct solution which can be verified is dependent on accurate translation of word problems into mathematical equations.

4.3 Attitudes of Students towards Cooperative Learning in Algebraic Word Problems.

The second specific objective of the study is to determine the attitudes of students towards cooperative learning in algebraic word problems. Here, only the treatment group members were allowed to answer questions aimed to address this objective since they were the group exposed to the intervention where cooperative learning strategy was used. Four major constructs (confidence, nervousness, enjoyment and persistence) were used to measure this objective with each having 3 main statements or sub-

categories. Participants were asked to rate their responses using the Likert scale; where 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree and 5= Strongly Agree. Initial parts of the results were presented using frequency distribution followed by descriptive statistics (mean) where the higher the mean value, the more likelihood the students agreed with the statement to represent their attitudes towards cooperative learning in algebraic word problems.

Table 4.4 Frequency distribution on Confidence Level of Students during Cooperative Learning in Algebraic Word Problems

Level of Confidence	S.D.A	D.A	N	A	S.A
Having confidence in asking questions when solving word problems in groups.	1 (1.0%)	7 (7.0%)	14 (14.0%)	38 (38.0%)	40 (40.0%)
Not feeling scared for mathematics word problems as far as it is given in groups.	1 (1.0%)	5 (5.0%)	14 (14.0%)	30 (30.0%)	50 (50.0)
Can solve mathematical word problems with friends at any time.	0 (0.0%)	6 (6.0%)	15 (15.0%)	32 (32.0%)	47 (47.0%)

Source: Field Study Area, September, 2022

From Table 4.4, the results indicate that most of the participants (n=40, 40%) strongly agreed that they have confidence in asking questions when solving word problems in groups. This was followed by 38 participants (38%) that agreed to the statement whiles only a participant (1%), the least, strongly disagree with the statement. The same trend was recorded for the statement that they are not feeling scared for mathematics word problems as far as it is given in groups as majority (n=50, 50%) strongly agreed to it. 30 participants (30%) agreed to the same statement whiles only a participant (1%), the least, strongly disagree with the statement. Most of the participants (n=47, 47%)

strongly agreed that they can solve mathematical word problems with friends at any time. This was followed by 32(32%) participants that agreed to the statement whiles 6 participants (6%) disagreed with no participant selecting strongly disagree. The descriptive statistics outcome for the above is as shown below:

Table 4.5 Descriptive Statistics on Confidence Level of Students during Cooperative Learning in Algebraic Word Problems

Level of Confidence	N	Min	Max	Mean	St. Dv
Having confidence in asking questions when solving word problems in groups.	100	1	5	4.12	0.925
Not feeling scared for mathematics word problems as far as it is given in groups.	100	1	5	4.26	0.898
Can solve mathematical word problems with friends at any time.	100	1	5	4.21	0.898

Source: Field Study Area, September, 2022

Table 4.5, indicates that having confidence in asking questions when solving word problems in groups recorded a minimum value of one (1) with a maximum value of five (5). The statement recorded a high mean value ($\bar{x}$) of 4.12 with standard deviation (σ) of 0.925. Not feeling scared for mathematics word problems as far as it is given in groups recorded a minimum value of one (1) with a maximum value of five (5). The statement recorded a mean value ($\bar{x}$) of 4.26 with standard deviation (σ) of 0.898. Ability to solve mathematical word problems with friends at any time, as a statement, recorded a minimum value of one (1) with a maximum value of five (5). The statement recorded a mean value ($\bar{x}$) of 4.21 with standard deviation (σ) of 0.898. The three sub-categories used to measure level of confidence during mathematical word problems, all together, recorded a mean value ($\bar{x}$) of 4.20 with standard deviation (σ) of 0.907.

Table 4.6 Frequency distribution on Level of Nervousness of Students during Cooperative Learning in Algebraic Word Problems

Level of Nervousness	S.D.A	D.A	N	A	S.A
Help reduces nervousness when solving algebraic word problems.	1 (1.0%)	6 (6.0%)	13 (13.0%)	32 (32.0%)	48 (48.0%)
All sinking feelings associated with solving algebraic word problems individually reduces when given group work.	0 (0.0%)	7 (7.0%)	18 (18.0%)	35 (35.0%)	40 (40.0%)
Tenseness and uneasiness reduce when solving algebraic word problems cooperatively.	0 (0.0%)	6 (6.0%)	18 (18.0%)	33 (33.0%)	43 (43.0%)

Source: Field Study Area, September, 2022

Table 4.6 results indicate that most of the participants (n=48, 48%) strongly agreed that cooperative learning in algebraic word problems help reduces their nervousness when solving algebraic word problems. This was followed by 32 (32%) participants that agreed to the statement whiles the least number of participants (n=1, 1%) disagreed with the statement. Majority of the participants (n=40, 40%) strongly agreed to the statement that all sinking feelings associated with solving algebraic word problems individually reduces when given group work. This was followed by 35 (35%) participants that agreed to the statement whiles 7(7%) disagreed with no participant selecting strongly disagreed. From the table above, most of the participants (n=43, 43%) strongly agreed that their tenseness and uneasiness reduces when solving algebraic word problems cooperatively. This was followed by 33 (33%) participants that agreed to the statement whiles 6(6%) disagreed with no participant selecting strongly disagreed. The descriptive statistics outcome for the above is as shown below:

Table 4.7 Descriptive Statistics on Level of Nervousness among Students during Cooperative Learning in Algebraic Word Problems

Level of Nervousness/Anxiety	N	Min	Max	Mean	St. Dv
Help reduces nervousness when solving algebraic word problems.	100	1	5	4.21	0.938
All sinking feelings associated with solving algebraic word problems individually reduces when given group work.	100	2	5	4.09	0.928
Tenseness and uneasiness reduce when solving algebraic word problems cooperatively.	100	2	5	4.12	0.927

Source: Field Study Area, September, 2022

Table 4.7 indicates that the statement "cooperative learning reduces nervousness when solving algebraic word problems", recorded a minimum value of one (1) with a maximum value of five (5). The statement recorded the highest mean value ($\bar{x}$) of 4.21 with standard deviation (σ) of 0.938. This was followed by the statement that "tenseness and uneasiness reduce when solving algebraic word problems cooperatively", which recorded a minimum value of two (2) with a maximum value of five (5). This statement recorded a high mean value ($\bar{x}$) of 4.12 with standard deviation (σ) of 0.927. All sinking feelings associated with solving algebraic word problems individually reduce when given group work, as a statement, recorded a minimum value of two (2) with a maximum value of five (5). This statement equally recorded a high mean value ($\bar{x}$) of 4.09 with standard deviation (σ) of 0.928. The overall mean for the statements used to measure level of nervousness of students during cooperative learning in algebraic word problems recorded a mean value ($\bar{x}$) of 4.14 with standard deviation (σ) of 0.931.

Table 4.8 Frequency distribution on Level of Enjoyment of Students during Cooperative Learning in Algebraic Word Problems

Level of Enjoyment	S.D.A	D.A	N	A	S.A
Enjoying learning algebraic word problems in groups.	0 (0.0%)	3 (3.0%)	15 (15.0%)	30 (30.0%)	52 (52.0%)
Feeling comfortable in solving algebraic word problems in groups.	0 (0.0%)	2 (2.0%)	15 (15.0%)	37 (37.0%)	46 (46.0%)
Cooperative learning in solving algebraic word problems is interesting.	0 (0.0%)	4 (4.0%)	20 (20.0%)	29 (29.0%)	47 (47.0%)

Source: Field Study Area, September, 2022

Table 4.8 indicates that most of the participants (n=52, 52%) strongly agreed that they enjoy learning algebraic word problems in groups. This was followed by 30 (30%) participants that agreed to the same statement whiles only 3 participants disagreed with no participant selecting strongly disagree. Table 4.8 indicates that most of the participants (n=46, 46%) strongly agreed that they feel comfortable in solving algebraic word problems in groups. This was followed by 37 (37%) participants that agreed to the same statement whiles only 2 (2%) participants disagreed with no participant selecting strongly disagree. The outcome in the table above indicate that most of the participants (n=47, 47%) strongly agreed that cooperative learning in solving algebraic word problems is interesting. This was followed by 29 (29%) participants that agreed to the same statement whiles only 4 (4%) participants disagreed with no participant selecting strongly disagree. The descriptive statistics outcome for the above is as shown below:

Table 4.9 Descriptive Statistics on Level of Enjoyment of Students during Cooperative Learning in Algebraic Word Problems

Level of enjoyment/comfortability	N	Min	Max	Mean	St. Dv
Enjoying learning algebraic word problems in groups.	100	2	5	4.31	0.836
Feeling comfortable in solving algebraic word problems in groups.	100	2	5	4.25	0.802
Cooperative learning in solving algebraic word problems is interesting.	100	2	5	4.17	0.914

Source: Field Study Area, September, 2022

Table 4.9 indicates that enjoying learning algebraic word problems in groups recorded a minimum value of two (2) with a maximum value of five (5). The statement recorded the highest mean value ($\bar{x}$) of 4.31 with standard deviation (σ) of 0.836. This was followed by feeling comfortable in solving algebraic word problems in groups, as a statement, that equally recorded a minimum value of two (2) with a maximum value of five (5). This statement recorded a high mean value ($\bar{x}$) of 4.25 with standard deviation (σ) of 0.802. The statement that cooperative learning in solving algebraic word problems is interesting, equally recorded a minimum value of two (2) with a maximum value of five (5). This statement recorded a high mean value ($\bar{x}$) of 4.17 with standard (σ) of 0.914. The grand mean for the 3 items recorded a high mean value ($\bar{x}$) of 4.18 with standard deviation (ó) of 0.851. This implies that the cooperative learning employed helped to improve the students' level of enjoyment, their comfortability rate, and interest with the learning of word problems in mathematics.

Table 4.10 Frequency distribution on Level of Persistence/Willingness of Students during Cooperative Learning in Algebraic Word Problems

Level of Persistence	S.D.A	D.A	N	A	S.A
I help group members to understand concepts when they encounter any difficulties during cooperative learning.	0 (0.0%)	3 (3.0%)	15 (15.0%)	31 (31.0%)	51 (51.0%)
Practice algebraic word problems with friends at home/ during leisure times.	1 (1.0%)	2 (2.0%)	14 (14.0%)	34 (34.0%)	49 (49.0%)
I ask group members for clarity when in doubt during cooperative learning.	1 (1.0%)	8 (8.0%)	13 (13.0%)	34 (34.0%)	44 (44.0%)

Source: Field Study Area, September, 2022

Table 4.10 indicates that majority of the participants (n=51, 51%) strongly agreed that they help group members to understand concepts when they encounter any difficulties during cooperative learning. This was followed by 31(31%) participants that agreed to the statement whiles only 3 (3%) participants strongly agreed to the statement with no participant selecting strongly disagree. From the table above, most of the participants (n=49, 49%) strongly agreed that they practice algebraic word problems with friends at home/ during leisure times. This was followed by 34(34%) participants that agreed to the statement whiles only a participant (1%) selected strongly disagree. Most of the participants (n=44, 44%) strongly agreed that they ask group members for clarity when in doubt during cooperative learning. This was followed by 34(34%) participants that agreed to the statement whiles only a participant selected strongly disagree. The descriptive statistics outcome for the above is as shown below:

Table 4.11 Descriptive Statistics on Level of Persistence/Willingness among Students during Cooperative Learning in Algebraic Word Problems

Level of persistence/willingness	N	Min	Max	Mean	St. Dv
I help group members to understand concepts when they encounter any difficulties during cooperative learning.	100	2	5	4.30	0.833
Practice algebraic word problems with friends at home/ during leisure times.	100	1	5	4.29	0.832
I ask group members for clarity when in doubt during cooperative learning.	100	1	5	4.13	0.963

Source: Field Study Area, September, 2022

Table 4.11 indicates that helping group members to understand concepts when they encounter any difficulties during cooperative learning, as a statement, recorded a minimum value of two (2) with a maximum value of five (5). The statement recorded the highest mean value ($\bar{x}$) of 4.30 with standard deviation (σ) of 0.833. Practicing algebraic word problems with friends at home/ during leisure times, as a statement, followed with a high mean value ($\bar{x}$) of 4.29 and standard deviation (σ) of 0.832. This statement recorded a minimum value of one (1) with a maximum value of five (5). Asking group members for clarity when in doubt during cooperative learning recorded a high mean value ($\bar{x}$) of 4.13 with standard deviation (σ) of 0.963. This statement equally recorded a minimum value of one (1) with a maximum value of five (5).The grand mean for the statements used to measure level of persistence/willingness among students during cooperative learning in algebraic word problems was 4.24 with standard deviation (σ) of 0.876. This implies that cooperative learning help arouse students' level of persistency in attempting to understand and solve word problems.

4.4 Evaluating Students' Conceptual Understanding and Performance in Algebraic Word Problems using Cooperative Learning

The third specific objective was to improve students' conceptual understanding and performance in algebraic word problems using cooperative learning. In all, the students were divided into two groups in each school. Preliminary test (independent t-test) was run to check the level of already existing performance between the groups prior to the intervention. The test-item used can be seen in the appendix F of the study.

4.4.1 Preliminary Result (Pre-intervention Results) to Check the Level of Performance of Students in Algebraic Word Problems between the Two Groups

Figure 4.5 indicates that 38 participants in the control group had marks in the range of 16 to 20 marks whiles 36 participants in the experimental group had marks in that same range. Twenty participants in the control group had marks in the range of 21 to 25 marks whiles only 14 participants in the experimental group had marks in that same range.

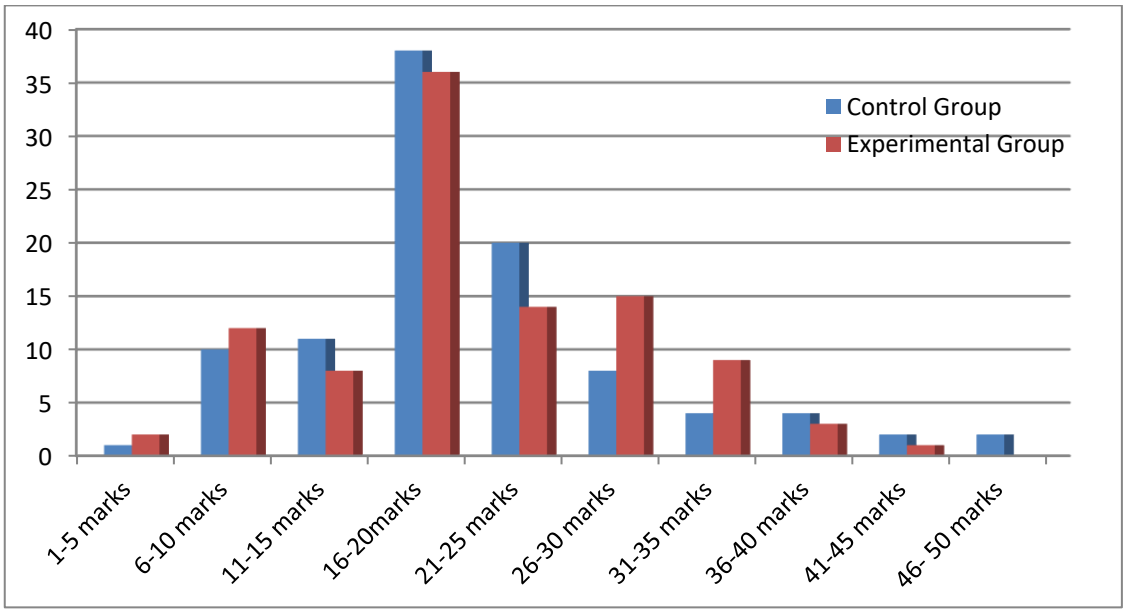

Figure 4.5 Bar chart on pre-intervention test outcomes for both groups

Source: Field Study Area, September, 2022

From Figure 4.5, 15 participants in the experimental group had marks in the range of 26 to 30 marks whiles only 8 participants in the control group had marks in that same range. Two participants in the control group had marks in the range of 41 to 45 marks whiles only a participant in the experimental group had marks in that same range. Two participants in the control group had marks in the range of 46 to 50 marks whiles no participants in the experimental group had marks in that same range. The descriptive statistics of the results are as displayed below:

Table 4.12 Descriptive Statistics of Pre-intervention Result

Group	N	Min.	Max.	Mean	St. Dv
Control Group	100	5	48	21.28	9.023
Treatment Group	100	3	42	20.41	8.250

Source: Field Study Area, September, 2022

Table 4.12 shows that the descriptive statistics result for the control group during the pre-intervention test recorded a minimum mark of 5 whiles the treatment group recorded a minimum mark of 3. The maximum mark recorded for the control group is 48 whiles that of the treatment group is 42. The control group recorded a mean mark ($\bar{x}$) of 21.28 marks out of 50 with standard deviation (σ) of 9.023. The treatment group, on the other hand, recorded a mean mark ($\bar{x}$) of 20.41 with standard deviation (σ) of 8.250. In all, the mean marks recorded indicate below average performance since the overall mark assigned to the test items was 50 marks. The normality test was done to determine the suitability of an independent t-test since all the other assumptions (scale measurement and adequacy of sample size) were satisfied. The outcome is as shown below:

Table 4.13 Test for Normality of Pre-Intervention Result

Group	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	***Df***	***Sig.***	***Statistic***	***Df***	***Sig.***
Control Group	0.156	100	0.200	0.935	100	0.324
Treatment Group	0.100	100	0.156	0.982	100	0.180

Source: Field Study Area, September, 2022

Table 4.13 results indicate a Kolmogorov-Smirnov statistical value for the control group as 0.156 which is insignificant at five percent significant level. The treatment group recorded a Kolmogorov-Smirnov statistic of 0.100 which is insignificance at 5 percent significance level. Shapiro-Wilk statistical result for the control group was 0.935 and it was insignificant at five percent significance level whiles that of the treatment group was 0.982 and is insignificance at 5 percent significance level. The null hypothesis for both, Kolmogorov-Smirnov test and Shapiro-Wilk normality test is (Ho): *there is a presence of normality*. As such, we accept the null hypothesis based on the results above and conclude that normality exist in the data set. The independent sample t-test was then used to check if there is variation in mean result recorded between the two groups during the pre-intervention stage.

Table 4.14 Independent t-Test for Equality of Pre-Intervention Means

					95% Confidence Interval of the difference	
	T	Df	Sig.	Mean Difference	*Lower*	*Upper*
Equal variances.	0.71	198	0.478	0.870	-1.541	3.281
No-equal variances.	0.71	196.4	0.478	0.870	-1.541	3.281

Source: Field Study Area, September, 2022

Result from Table 4.14 indicates that the t-statistics for both equal variance and no equal variance is 0.71 and the value is not significant at the three conventional significant levels (1%, 5% and 10% significance levels). The finding indicates that indeed there is no statistical difference between mean marks scored by the treatment group and that of the control group at the pre-intervention stage. This is a good ground to compare intervention outcomes and hence variations in the means after the intervention could be attributed to the intervention method used. The result equally indicates that the two groups are all of the same level in terms of performance in algebraic word problems prior to intervention and can be compared should there be any intervention.

4.4.1 Intervention Strategies

The researcher then intervenes and used the cooperative group method to teach the topic "algebraic word problems" to the selected treatment group members. This was done in the two schools used in the study. Pictorial evidence of students gathered in group and solving the questions during this stage can be seen at the appendix L.

The researcher adopted the Students Teams Achievement Division (STAD) Strategy for cooperative learning proposed by Slavin in 1995. The approach or strategy was employed since it was empirically used by some researchers in their attempt to measure effectiveness of cooperative learning (Assan-Donkoh et al., 2022). Hermawan et al., (2020) provided five main phases of Students Teams Achievement Division (STAD) and this was followed during the intervention stage by the researcher.

- ***Phase 1: Organizing students into groups (Day 1)***

The researcher organized the participants in the experimental group into groups. Minimum number of participants per group was 5. Each group had a leader whose role was to coordinate the affairs of the group. The researcher solicited the help of the subject teachers at the two schools to help categorize the participants into the various groups. This was done since they are familiar with the strength of the participants regarding solving mathematics. This procedure was employed to ensure the group is heterogeneous and has both weak and strong students, male and female students. The researcher explained the purpose of the group and role each member needed to perform to participants. Thus, participants were made aware of the need to assist each other, the need to ask pertinent questions for clarity, the need to juxtapose ideas to help provide a solid and correct solution together. Equally, they were encouraged to participate in every activity to curb free rider situations. The phase lasted a day each in both schools and included only experimental group members.

Phase two (2): Class Presentations (Day 2)

The researcher organized and provided detailed lesson on the topic "algebraic word problems" with emphasis on solving the pre-intervention test items with the students. During this stage, step by step approach in solving word problems were explained in details with specific examples solved with the participants. Key objectives were to be able to identify key variables in word problems, understand key phrases used in word problems, how to link variables in word problems, translating word problems to mathematical equations, simplifying equations and result verification. The phase lasted a day each in both schools and included only experimental group members.

Phase three: Provision of test item (Day 3)

The researcher provided each group with 10 questions printed on an A 4 sheet with marks allocated for each question. The number of copies of the questions presented to a group depended on the number of participants in the group. The time allocated for the test was 60 minutes. Each group was asked to provide one group solution which must be detailed (step by step solution). The phase lasted a day each in both schools and included only experimental group members.

Phase four (4): Assessment (Day 3 continued)

The researcher with the assistance of a subject teacher in each of the schools assessed the students by going round monitoring and observing their approach to provide solution to the questions. At this stage, informal assessment was done. Equally, the researcher and the subject teacher, selected provided immediate feedback to each group provided they were finding difficulties at any stage of their attempt to provide correct solution to the questions. They equally praised teams or groups that were very active and assisting members to understand each step in solving the questions.

Formal assessment was also provided where participant group leaders were asked to present their solutions on the white board and explain to the whole class. At this stage, each group was tasked to present solutions on only two questions. Equally, any group member was allowed to step up and provide further detailed explanation to a step written by the group or assist the group leader in doing same. This was done to check if members participate fully in the activity.

Individual assessment was also given to ascertain the level of understanding of approach used in solving the group task. Here the researcher gave similar test item to the participants to attempt individually. Samples of the questions used are shown at the appendix column (evaluation column of the lesson note). Participants were monitored

and they provided individual answers. However, the marks obtained by members were cumulated to the group they belong to for overall group mark.

Phase five (5): Awarding Teams or Recognition (Day 4)

After stage 3, the researcher with the help of the assisted subject teachers (in each school) awarded the groups using pen and pencils for each member as a form of motivation. The groups were awarded based on the following criteria: most disciplined group and the most cooperative group (group with several active members contributing to discussions). Pictorial evidence of the intervention stage can be seen in the appendix L.

4.4.2 Post Intervention Results

After the intervention, test items were given to the two groups (treatment and control group) as a post intervention assessment method. Copy of the test-item can be seen at the appendix column. The results are as shown below:

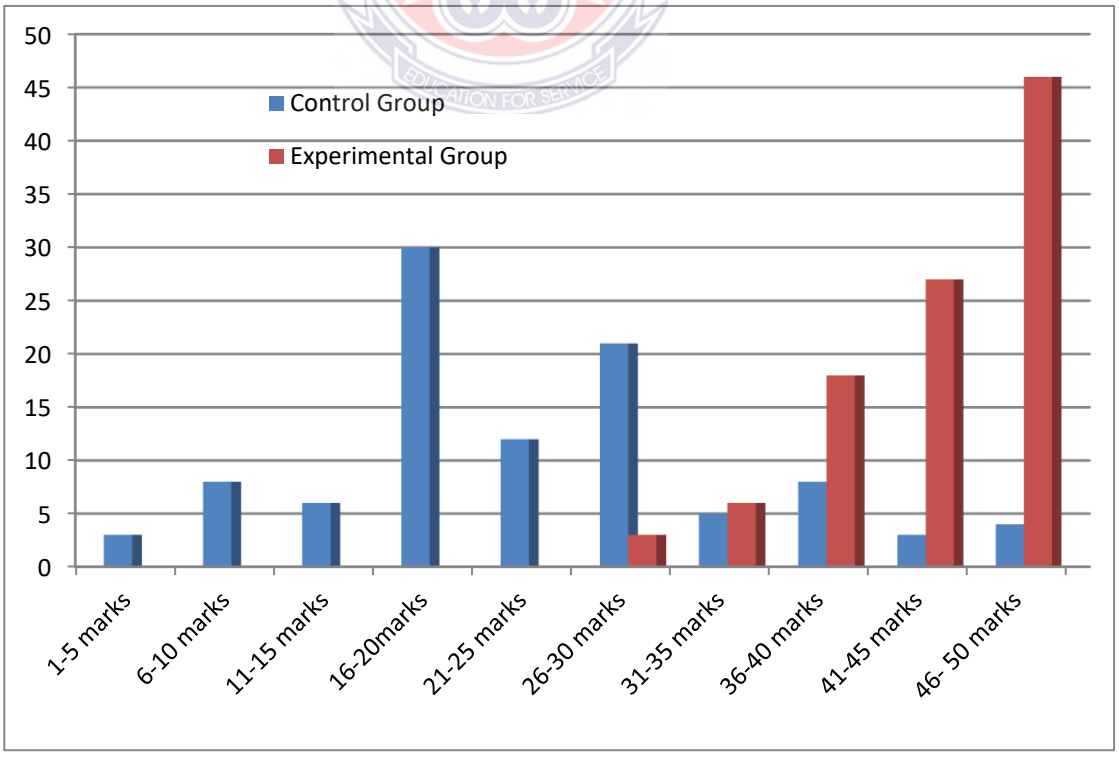

Figure 4.6 Bar chart on post-intervention test outcomes for both groups
Source: Field Study Area, September, 2022

Figure 4.6 indicates that 46 participants in the experimental group had marks in the range of 46 to 50 whiles only four participants in the control group had marks in the same range. Twenty-seven participants in the experimental group had marks ranging from 41 to 45 whiles 3 had marks in the same range in the control groups. Eighteen of the participants in the experimental group had marks within the range 36 to 40 whiles 8 participants had marks in the range of 36 to 40 marks. Six participants in the experimental group had marks ranging from 31 to 35 whiles 5 participants in the control group had marks ranging the same range. Whiles only 3 participants in the experimental group had marks ranging from 26 to 30 whiles 21 participants in the control group that had marks in the same range. Majority of the participants in the control group had marks in the range of 16 to 20 marks whiles no participant in the experimental group had marks below 26 marks. The descriptive statistics of the results are as displayed in Table 4.15.

Table 4.15 Descriptive Statistics of Post-intervention Results

Group	N	Min.	Max.	Mean	Std. Dev.
Control Group 1	50	9	50	25.86	10.418
Treatment Group 1	50	30	50	44.34	5.197
Control Group 2	50	4	45	21.26	9.655
Treatment Group 2	50	28	50	43.70	5.342

Source: Field Study Area, September, 2022.

Table 4.15 indicates that the treatment group in the first study area recorded the highest mean mark ($\bar{x}$) of 44.34 out of 50 marks, with standard deviation (σ) of 5.197. This was followed by the treatment group from the second study area that recorded a mean mark

($\bar{x}$) of 43.70 out of 50marks, with standard deviation (σ) of 5.342. The mean mark recorded by the control group from the first study area was 25.86 with standard deviation of 10.418 whiles that of the control group from the second study area was 21.26 with standard deviation of 9.655. The results indicate that control group participants recorded very low mean marks relative to that of the treatment group that recorded very high mean marks. The researcher then conducted normality test to confirm the suitability of independent t-test for use to check the statistical significance difference in mean marks recorded. The result is as shown below:

Table 4.16 Test for Normality of Post-Intervention Results

Group	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	***Df***	***Sig.***	***Statistic***	***df***	***Sig.***
Control Group	0.105	100	0.800	0.968	100	0.610
Treatment Group	0.138	100	0.572	0.903	100	0.343

Source: Field Study Area, September, 2022.

Table 4.16 results indicate a Kolmogorov-Smirnov statistical value for the control group as 0.105 which is insignificant at five percent significance level. The treatment group recorded a Kolmogorov-Smirnov statistic of 0.138 which is insignificant at five percent significance level. A Shapiro-Wilk statistical result for the control group was 0.968 and it was insignificant at five percent significance level whiles that of the treatment group was 0.903 and is insignificant at five percent significance level. The null hypothesis for both, Kolmogorov-Smirnov test and Shapiro-Wilk normality test is "there is a presence of normality". As such, we can accept the null hypothesis based on the results above and conclude that normality exist in the data set. The independent

sample t-test was then used to check if there is variation in mean results recorded between the two groups during the post-intervention stage.

Results from Table 4.17 indicate that the t-statistics for both equal variance and no equal variance is -17.8 with degree of freedom at 198 and 147.6 respectively. The values are significant at five percent significance level. The mean difference recorded indicates -22.732 for assuming of equal variance whiles -22.737 was recorded for no-equal variance. The table is as shown in Table 4.17.

Table 4.17 Test for Equality of Post-Intervention Means

	t-value	Df	Sig.	Mean Difference	95% Confidence Interval of the difference	
					Lower	*Upper*
Equal-variances	-17.8**	198	0.000	-20.5	-22.732	-18.188
No-equal variances	-17.8**	147.6	0.000	-20.5	-22.737	-18.183

*where *, ** and *** represents levels of significant at 10%, 5% and 1% respectively*

Source: Field Study Area, September, 2022.

From Table 4.17, the null hypothesis for independent sample t-test is "the two means for the two groups (control and treatment) are equal". As such, since the values recorded remain significant, we can reject the null hypothesis that the sample provided strong evidence that the two means are not different. Since the two groups were almost at equal levels in terms of performance prior to the intervention (as indicated in Table 4.14), the researcher can associate the improvement in performance of the students in the treatment group to the intervention method used. Marked scripts of the control group members indicate step by step solution provision and are a clear indication that the participants understand the topic. Cohen's test was used to calculate the effect size. The outcome is as shown below:

Table 4.18 Effect Size using Cohen's D Test

Groups	N	Mean	Std. Deviation	Cohen's D
Control Group	100	23.56	10.257	
Treatment Group	100	44.02	5.253	
Pooled	200	33.79	8.15	-2.51

Source: Field Study Area, September, 2022.

From Table 4.18, the calculated Cohen's d value is approximately -2.51. This indicates a large effect size, suggesting a substantial difference between the means of the two groups. The negative sign indicates that Group 2 (with a mean of 44.02) has a higher mean than Group 1 (with a mean of 23.56).

CHAPTER 5

DISCUSION OF RESULTS

5.1 Overview

This chapter provides discussion of results presented in the previous chapter. Discussion was done in accordance to the specific objectives. This was done chronologically. Findings were discussed with reference to past empirical studies to see if outcome conforms to already existing findings or otherwise

5.2 Research Objective 1: To Identify the Difficulties Students Face in Solving Algebraic Word Problems.

The findings were that participants rated difficulties understanding the words or phrases used as the severest difficulty faced in solving algebraic word problems. The probable reason for the above finding could be associated with the descriptive nature of word problems (where words are combined with numbers in a statement) which often makes them challenging. Simply put, the challenge could arise from inability to clearly understand what exactly the question relates to due to linguistic and numerical complexities of word problems. The finding is in harmony with the assertions of Jupri and Drijvers (2016) that understanding the notion of variables as well as algebraic expressions and understanding the different meanings of the equation are among the challenges in initial algebra. The outcome also conforms the findings of Chan et al., (2020) that students only have a little understanding of formulating and solving algebraic problems. In Ghana, the result conforms to the assertions of Nashiru et al., (2018) that mathematics word problems can be difficult because they demand students to read and grasp the problem's content as well as recognize the main variable(s) from the question that demands answers prior to formulating the appropriate equation. Bottom line is students

struggling to understand the word problems. In view of this, Gabina et al., (2020) in their study using pre-Service Teachers' in Colleges of Education in Ghana argues that the challenge of understanding word problems could arise from difficulties interpreting the meaning of the questions, confusion of everyday language with mathematical words and lack of vocabulary. Asase et al., (2022) in their study of primary schools in Greater Accra also provided similar conclusions as they argued that the major challenge of word problem is reading and comprehension error.

It was further revealed that participants rated difficulties transforming algebraic word problems into equations as a moderately severe difficulty faced in solving algebraic word problems. A plausible reason for the above finding could be the difficulties students faced in identifying and showing the relationship between key words or variables in word problems, difficulties identifying the type of mathematical symbol to use to link the variables and how to use them. This result is in line with the findings of Chan, Ying et al., (2020) that in mathematics word problems, major difficulty of students remains mathematizing the problem, thus converting the word problem to mathematics to enable easy solution. They continued to add that mathematization captures proper understanding of the problem to be able to frame the word problem in equation form bringing to light all the needed mathematical signs and symbols in the equation (Chan, Ying et al., 2020). To, Chan, Ying et al., (2020), the problem or difficulty emanates from poor content knowledge and remains a preliminary difficulty as solving to get a correct answer depends on getting the equations right. In Ghana, similar findings exist in empirical studies conducted over the years though such studies were conducted at different academic levels. For instance, the finding conforms to the conclusions of Nashiru et al., (2018) that found that translation errors remain a major challenge faced by college of education students in their attempt to solve word

problems. Intsiful and Davis (2019) in their study using Junior High school students in Cape Coast Metropolis provided similar conclusion as they argued that "the wrong interpretation of the questions, often informed by certain phrases within the questions, resulted in transformational errors and meaningless manipulation of numbers". Asase et al., (2022) in their study using primary school pupils in Ghana equally concluded that "translating word problems into solvable equations and relations is one area of mathematics that pupils have a great deal of difficulty with (evident)".

The study results also indicated that participants rated challenges applying the mathematical priority rules to solve the equation as a moderately severe difficulty faced in solving algebraic word problems. This result indicates the challenge is the least severe challenge among the five challenges. The result shows that the challenge of applying the mathematical priority rules to solve the equation is a difficulty faced in solving algebraic word problems. This could arise from poor mathematical background of students or lack of detailed lessons on how and when to apply a specific mathematical rule. This result conforms to the findings of Jupri and Drijvers (2016) that a major difficulty students face in solving algebraic word problems is application of the various mathematical operations such as addition and or subtraction or multiplication of terms. They further argued that this also includes usage of the various mathematical properties such as commutative, associative and distributive (CAD) properties, application of priority rules (example the BODMAS rule; bracket of division, multiplication, addition and subtraction rule) (Jupri & Drijvers, 2016). Similar findings was also reported by Chan, Ying et al., (2020) that major and preliminary difficulties faced include poor knowledge of students in application of various mathematical principles.

This value implies participants rated calculation or simplification challenges as a moderately severe difficulty faced in solving algebraic word problems. The finding does not come as a surprise as inability to correctly use mathematical priority rules will necessitate wrong calculations or simplification of equations. The result does not deviate from the findings of Sikukumwa (2017) that noted that difficulties such as inability to properly utilize or deal with (solve) the equations obtained mathematically as among several challenges faced by students in their attempt to solve word problems in mathematics.

It was further revealed that participants rated calculation or simplification challenges as a moderately severe difficulty faced in solving algebraic word problems. The finding does not come as a surprise as inability to correctly use mathematical priority rules will necessitate wrong calculations or simplification of equations. According to Sikukumwa (2017) such difficulties result into wrong application of mathematics rules and also difficulties dealing with fractions. Similar empirical report was also provided by Jupri and Drijvers, (2016), that many students find it difficult to proceed to solve word problems even after transforming the word structured question into equation. In Ghana, the finding is in line with the conclusion of Gabina et al., (2020) as they found out during their pre-intervention test that among the major challenges college of education students faced in solving word problems in mathematics is the calculation error. Similarly, Asase et al., (2022) captioned it as a processing error to involve difficulties calculating or simplifying transformed equations.

The study further revealed that there exist very strong linear association between challenges applying mathematical operations and calculating challenges in solving algebraic word problems. A plausible justification for the result is that the student needs to know how to properly apply basic mathematical operations such as BODMAS

(bracket of division, multiplication, addition and subtracting) before a successful solution of word problems can be achieved. This outcome conforms to the empirical results of Asase et al., (2022) that captioned both error in applying mathematical operations and error in calculating as processing error. The result is also in line with the findings of Gabina et al., (2020) that argued that most students committed calculation and inverses errors.

The study revealed that there existed a strong linear association between difficulties understanding of word problems and challenges translating them to equations A plausible justification for the result is that understanding of word problem leads to correct translating of the problem into equations. This finding is in line with the views of Nashiru et al., (2018) in their study in Ghana as they argued that appropriate problem representation indicates that the problem solver has perceived the problem and serves to guide the student toward the solution plan.

In conclusion, the outcomes indicate high correlation coefficient for each two pairs of challenges students face in solving algebraic word problems indicating that there is a strong linear association between them. This observation indicates that the problems are related. This conforms to Newman's Chronological approach of solving mathematical task as cited by Intsiful and Davis, (2019). It equally conforms to the views of Gabina et al., (2020) in their study in Ghana as they argued that the challenges of word problems ranges from difficulties understanding, translating and providing a suitable solution to given problems. Asase et al., (2022) in their study also provided a related assertion that solving mathematics word problems encompasses careful understanding which leads to translation of the problem to equations and this then result to effective calculations.

5.3 Research Objective 2: To Assess the Attitudes of Students towards Cooperative Learning in Algebraic Word Problems

The outcome from the results presented in the previous chapter indicated a high level of confidence of students during cooperative learning in algebraic word problems. The above finding conforms to assertions of Naseer, (2016) that argued that cooperative learning strategy breeds positive interdependency which promotes learning together, exchange of ideas and it help arouse students' learning interest, enhances creative thinking and ultimately improve students' attitude towards learning. He further argued that the strategy gives the students intrinsic motivation to work harder. The study finding is also in consonance with empirical results in Ghana. For instance, it conforms with the findings of Edekor and Agbornu, (2020) using Junior High school students in Ghana and concluded that cooperative learning enhances interdependency, teamwork and peer teaching which help to build the level of confidence of students towards solving mathematics problems. Equally, Assan-Donkoh et al., (2022) in their study using SHS in Ghana also provided related conclusion that cooperative learning enhances students confidence through building on their creative thinking abilities as they work in groups.

The outcome indicated a reduced level of nervousness among students during cooperative learning in algebraic word problems. The result is in harmony with past empirical studies. For instance in the works of Julius et al., (2018), they argued that students enjoy learning in groups which help reduces tension associated with individualized learning hence improve students attitude towards learning. The study result is also in conformity with some empirical studies in Ghana. For instance, Edekor amd Agbornu, (2020) concluded in their study that cooperative learning reduces fear

associated with working mathematical assignments or exercises individually. Assan-Donkoh et al., (2022) also supported the above and argued that cooperative learning provides opportunity for building social communication skills of students as they give weak students the ability to learn from peers and hence help reduces mathematical anxiety.

The study revealed that the use of cooperative learning helped to improve the students' level of enjoyment, their comfortability rate, and interest with the learning of word problems in mathematics. This findings is in line with the assertions of Julius et al., (2018) that argued that mathematical problems can be satisfactorily solved by students who have both interest and ability as those with the latter, are usually those that remain eager to learn. Team work guarantees activeness and positive attitude of students towards learning help achieve learning goals. Cooperative learning boost attitude of students which in-turn help improve students' understanding as well as their performance (Julius et al., 2018). The study result is also in conformity with some empirical studies in Ghana. For instance, Edekor and Agbornu, (2020) in their study found that that cooperative learning creates some sense of belongingness among group members in their attempt to work together as they enjoy the feeling of helping each other as well as assess the ideas of each other for the common group goal. Assan-Donkoh et al., (2022) in their study provided similar assertion as they argued that the cooperative learning strategy gives group members the opportunity to provide prompts, cues, reminders and encouragement to members who request for help and equally facilitates each other by identifying their strength and weaknesses. They further argued that, the strategy provides some level of enjoyments and makes working peers (group members) feel comfortable with the approach as it remain interesting to them.

The study results further revealed that cooperative learning help arouse students' level of persistency in attempting to understand and solve word problems. This result is in line with the empirical findings of James and Adewale, (2015) found that there is a link between cooperative learning and positive attitudes toward mathematics as the strategy allows students the opportunity to discuss and listen critically to the views and opinions of others (James & Adewale, 2015). Similar findings was also reported in the work of Naseer (2016) that stated that attitude of students towards mathematical has a positive impact on mathematics performance due to the fact that, positive attitude towards learning exerts impacts on students' motivation towards learning the topic and hence it seems to reflect in their performance. The result is in consonance with empirical works of Edekor and Agbornu, (2020) that asserted that cooperative learning help arouse students learning interest and cultivates their exploring ability.

5.4 Research Objective 3: To Evaluate Students' Conceptual Understanding and Performance in Algebraic Word Problems using Cooperative Learning.

The finding indicates that the use of the cooperative learning strategy help improves the academic performance of the students in solving algebraic word problems. This finding from the study is in line with several empirical reports. For instance, Naseer (2016) concluded in his study that cooperative learning impact positively on mathematics performance. Similar outcome was also provided by Julius et al., (2018). Evidence also support the fact that cooperative learning remain an effective instructional strategy for improving students' academic achievement in academic research (Ahmed et al., 2020; Assan-Donkoh et al., 2019; Edekor & Agbornu, 2020). In Ghana, for instance, Assan-Donkoh et al., (2022) in their study concluded that "cooperative learning strategy had a positive effect on academic achievement and interest of students in Core Mathematics

at the Senior High School level irrespective of students' achievement level". Similar conclusion was also provided by Edekor & Agbornu, (2020) that "students performed better using cooperative learning strategy irrespective of their ability level than those students who were taught using the traditional method".

CHAPTER 6

SUMMARY OF FINDINGS, CONCLUSION AND RECOMENDATIONS

6.0 Overview of the Study

The Chapter was discussed under the heading 'summary of findings, conclusions and recommendations. The chapter provides summary of the major findings of the study. It also discusses the conclusion of the entire study as well as recommendations. The chapter provides the limitations of the study which pave way for suggestions for future researchers.

6.1 Summary of the Study and Findings

The purpose of the study is to assess the effects of cooperative learning on students' conceptual understanding in solving algebraic word problems in selected Senior High Schools in South Dayi District. The study is theoretically rooted in the social interdependence and the constructivist learning theories.

The study is grounded on the positivist philosophy, whiles the research approach adopted is the quantitative in nature. Experimental design was employed in this study. The study population was limited to 2 selected Senior High School in the South Dayi-District of the Volta Region (thus, School A Senior High Technical School and School B Senior High Technical School). The Target population of the study is senior high two students of the two schools, thus 730. The study used the Cochran's formula to determine the appropriate sample size of 200 and employed the stratified random sampling to sample participants where the existing classes/ courses in the two schools were used as the strata groupings. The study adopted questionnaire and achievement tests (pre-test and post-test) as data gathering instruments for three weeks. Results were

presented both descriptively and inferentially. Descriptive statistics used were both figurative (bar chart and pie chart) and in tabular formats (thus mean, standard deviation, minimum and maximum values). Inferentially, Pearson's correlation coefficient was used to determine the linear association between identified challenges faced by students in their attempt to solve algebraic word problems. Kolmogorov-Smirnov and Shapiro-Wild tests were used to test for normality whiles independent t-test was employed to compare the mean mathematics achievement score between the control and experimental groups.

The first specific objective of the study was to identify the difficulties students face in solving algebraic word problems. Five main items were used in the questionnaire to help solicit data to address this objective. The study revealed that difficulties understanding the terminologies used in framing word problems was rated as the severest difficulty faced in solving algebraic word problems. Furthermore, the study found that difficulties transforming algebraic word problems into equations, difficulties applying the mathematical priority rules to solve the equation and difficulties faced in calculation or simplification equations were moderately severe difficulties faced by students in solving algebraic word problems. Equally identified moderately severe challenge faced in solving algebraic word problems is the difficulties verifying correctness of results.

The study revealed that there exists significantly positive and high linear association between each pair of challenges (challenges faced in solving algebraic word problems) identified indicating a linkage between them. Thus, the inability to clearly understand what exactly the question relates to due to linguistic and numerical complexities of

word problems could be linked with wrong interpretation of word problem, calculation or simplification challenges.

The second specific objective of the study was to assess the attitudes of students towards cooperative learning in algebraic word problems. Four major constructs (confidence, nervousness, enjoyment and persistence) were used to measure this objective:

- The study results indicate a high level of confidence of students using the cooperative learning strategy in learning or solving algebraic word problems as it helps improve student's confidence in asking questions and increases their zeal to solve mathematical word problems with friends at any time.
- The outcome indicates a reduced level of nervousness among students during cooperative learning of algebraic word problems as it helps to reduce tenseness, uneasiness as well as reducing all sinking feelings associated with solving algebraic word problems individually.
- The result further revealed that the cooperative learning helped to improve students' level of enjoyment, their comfortability rate, and interest towards the learning of word problems in mathematics. Equally, the study findings indicate that cooperative learning help arouse students' level of persistency in attempting to understand and solve word problems as average performing students assist low performing students in the process which boost the level of understanding of the latter.

The third specific objective was to evaluate the conceptual understanding and performance of students' in algebraic word problems using cooperative learning. In all,

the students were divided into two groups in each school (control and experimental group). Preliminary independent t-test result, prior to intervention, indicates t-statistics for both equal variance and no equal variance is 0.71 (with p-value of 0.478) which is not significant. The finding indicates that indeed there is no statistical significance difference between mean marks scored by the treatment group and that of the control group at the pre-intervention stage. This is a good ground to compare intervention outcomes and hence variations in the means after the intervention could be attributed to the intervention method used.

Intervention stage was characterized by the use of cooperative learning strategy. Post-estimation outcome indicated that the t-statistics for both equal variance and no equal variance is -17.8 with degree of freedoms at 198 and 147.6 respectively. The values are significant at one percent significant level (recording p-values at 0.00 each). Since the two groups were almost at equal levels in terms of performance prior to the intervention, the study can conclude that the improvement in performance of the students in the treatment group could be associated or attributed to the intervention method (cooperative group method) used. The result of the intervention implies that when the cooperative group strategy is employed to augment traditional teaching of algebraic word problem, it enhances students' attitude, understanding, performance in solving mathematics word problems.

6.2 Conclusion

The study discusses the effects of cooperative learning on students' conceptual understanding in solving algebraic word problem in selected Senior High Schools in the South Dayi District. Two sampled schools were used with total sampled students of 100

per school. Participants were sampled using the stratified sampling technique and data was analysed using descriptive and inferential statistics.

The first specific objective of the study was to identify the difficulties students face in solving algebraic word problems. The study concludes that challenges facing students in their attempt to solve mathematics word problems include difficulties understanding the words and phrases used in the word problems, difficulties in transforming words problems into equations, difficulties applying priority rules as well as challenges calculating and simplifying equations.

The second specific objective of the study was to assess the attitudes of students towards cooperative learning in algebraic word problems. Furthermore, the study concludes that the use of cooperative learning strategy help improves students' attitude and conceptual understanding of word problems through boosting their confidence in solving algebraic word problems, reducing their anxiety and nervousness associated with solving word problems and increasing their intrinsic motivation to solve word problems. The study can be concluded that given students the opportunity to solve word problems using cooperative learning strategy breeds positive interdependency between them which promotes learning together, exchange of ideas, help arouse students' learning interest, enhances creative thinking and ultimately improve students' attitude towards learning.

The third specific objective was to evaluate the conceptual understanding and performance of students' in algebraic word problems using cooperative learning. Ultimately, the study concluded that cooperative learning exerts positive rippling

effects on the students' performance in solving mathematics word problems. The study's success using the cooperative learning strategy indicates that attempt to improve students' performance in solving word problems can be achieved using this strategy as it gives weak students the opportunity to learn and achieve the maximum outcome. The study tends to favour the goal of the current curriculum review specified in the National Pre-tertiary Education Curriculum Framework that places emphasis on activity-based teaching and learning approach which involves inquiry, creativity, manipulation, collaboration and social interaction among students during learning. It should however be noted that the positive rippling effects of the use of the cooperative learning strategy depends on effective class control and supervision strategy used by the teacher(s). Thus, if cooperative learning strategy is not carefully managed and controlled it could result to the "free rider" situation where some students will not participate in the assignment or could lead to a situation where average students could hijack the group hindering participation and understanding of low performing students.

6.3 Recommendation

The study recommends that:

- Senior High School students should remember that improving their algebra skills takes time and consistent effort. However, with practice by starting with simpler problems and gradually move to more complex ones they can overcome these difficulties and become more proficient in solving algebraic problems. It is recommended that SHS students should ensure they have a solid grasp of basic arithmetic operations, including addition, subtraction, multiplication, and division as algebraic word problems builds upon these fundamental concepts. They should also familiarize themselves with common algebraic terms and

symbols, such as variables (letters used to represent unknown values), coefficients (numbers multiplied by variables), and constants (fixed numbers).

- It is recommended that mathematics teachers in the study area should endeavor to create diverse groups with a mix of abilities and personalities in assigning task relating to algebraic word problems to their students. Equally, they should ensure they clearly explain the purpose of the group activity, the roles of each member, and the expected outcomes. In such a way, they should structure tasks so that each group member's success depends on the success of the whole group. This encourages collaboration and ensures that everyone is actively engaged in problem-solving as it will increase students' confidence, reduces their nervousness and anxiety associated with solving algebraic word problems, and increases their enjoyment.

- Mathematics teachers in the study area should use cooperative group learning strategy to augment traditional teaching strategy in teaching and learning of word problems. This is because the approach or strategy enhances students' conceptual understanding and boost their achievement in solving word problems. It is equally recommended that in employing the cooperative group learning strategy in teaching word problems, mathematics teachers should take into consideration effective class control measures and ensure maximum participation of all group members to warrant higher achievement of all participants irrespective of their abilities.

6.4 Suggestion for Further Studies

Conceptually, the study is limited to algebraic word problems and hence further studies should be directed towards replicating the same study using different topic(s) in mathematics. In effect, topics captured by WAEC chief Examiner's report as topics where majority of WASSCE candidates finds difficult should be considered. Findings in such studies could be compared to this recent study results.

Geographically the study is limited to public senior high schools in the South Dayi District of the Volta region of Ghana. New studies should replicate the same study using different geographical settings in Ghana. Preferably, new studies should use different schools (either private or public) in the same region or different region(s) in Ghana. Findings in such studies could be compared to this recent study results.

Methodologically the study is limited by the use of the cooperative learning strategy. As such, new studies should be directed towards using other teaching or learning strategies such as the use of Cuisenaire rods, schemas or problem-solving approach. Findings in such studies could be compared to this recent study results.

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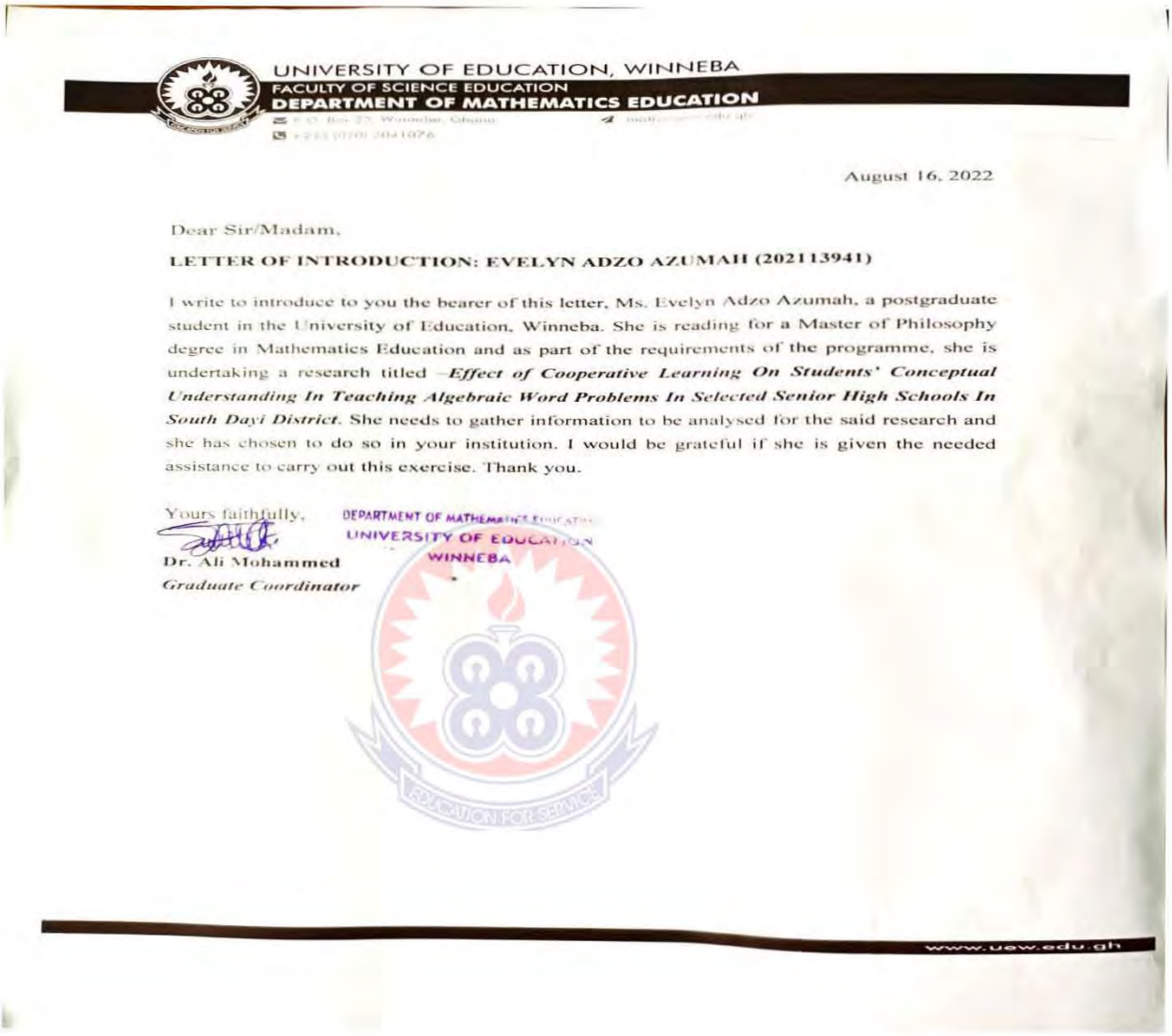
APPENDICES

APPENDIX A

INTRODUCTORY LETTER: PERMISSION FOR CONSENT



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

August 16, 2022

Dear Sir/Madam,

LETTER OF INTRODUCTION: EVELYN ADZO AZUMAH (202113941)

I write to introduce to you the bearer of this letter, Ms. Evelyn Adzo Azumah, a postgraduate student in the University of Education, Winneba. She is reading for a Master of Philosophy degree in Mathematics Education and as part of the requirements of the programme, she is undertaking a research titled –***Effect of Cooperative Learning On Students' Conceptual Understanding In Teaching Algebraic Word Problems In Selected Senior High Schools In South Dayi District***. She needs to gather information to be analysed for the said research and she has chosen to do so in your institution. I would be grateful if she is given the needed assistance to carry out this exercise. Thank you.

Yours faithfully,

DEPARTMENT OF MATHEMATICS EDUCATION
UNIVERSITY OF EDUCATION
WINNEBA

Dr. Ali Mohammed
Graduate Coordinator

www.uew.edu.gh

APPENDIX B:

SIGNED CONSENT FORM

PEKI SENIOR HIGH TECHNICAL SCHOOL
GHANA EDUCATION SERVICE

In case of reply, the number and date of this letter should be quoted

PESTECH

P.O. Box 97
Peki V/R

My Ref. No. GES/VR/PSST/TP/194/2

Your Ref. No.....

..... 7TH SEPT, ..20 22

TO WHOM IT MAY CONCERN

LETTER OF CONSENT
NAME: MISS AZUMAH EVELYN ADZO
INSTITUTION: UEW
INDEX: 202113941

I refer to your letter dated 16th August, 2022 regarding a research undertaking by Miss Evelyn Adzo Azumah, a student of the above mentioned institution to inform you that approval has been given to carry out the research in our school.

The entire school community shall accord you the needed assistance and co-operation to fulfil this exercise.

Thanks you.

VINOLIA AFI GAKPETOR
(ASSIST. HEADMISTRESS) (ACAD.)
ASSIT. HEAD (ACAD)
PEKI SNR. HIGH TECH. SCHL.

APPENDIX C:

QUESTIONNAIRE FOR SENIOR HIGH SCHOOL TWO (SHS-2) STUDENTS IN THE SOUTH DAYI DISTRICT

Preamble: The purpose of this questionnaire is to collect data on the study "effects of cooperative learning on students' conceptual understanding in teaching algebraic word problems in selected Senior High School in South Dayi District".

The researcher is an Mphil Student of University of Education Winneba.

Be sure to provide accurate responses as possible. Do not provide your name on the questionnaire. Answer all questions by ticking [√] the appropriate box

Section A: Bio-Data

1. Gender
   A. Male [ ] B. Female [ ]
2. Age Range
   A. 12-15 years [ ] B. 16-19 years [ ] C. 20 years and above [ ]
3. Religion
   A. Christianity [ ] B. Islamic [ ] C. Traditionalist [ ]
4. Ethnicity
   A. Akan [ ] B. Ewe [ ] C. Ga-Adangbe [ ] D. Guan [ ]
   E. Other? [ ], Specify ……

Section B: The difficulties Students Face in Solving Algebraic Word Problems

The questions in this section aimed to identify difficulties students faced in solving word problems. Rate your responses using the levels of severity of the challenges relating to you as a student.

Use the Likert Scale: 1= profound, 2= severe, 3= moderate, 4= mild and 5= less.

S/N	**Possible challenges faced in solving algebraic word problems**	**Level of Challenge**				
		1	2	3	4	5
5	Difficulties understanding the words or phrases used in the algebraic word problems					
6	Difficulties mathematizing or transforming algebraic word problems into equations or notation errors					
7	Challenges applying the mathematical operations (priority rules) needed to solve the equation					
8	Calculation or simplification challenges					

9	Difficulties verifying correctness or results obtained					

Section C: The Attitudes of students towards Cooperative Learning in Solving Algebraic Word Problems

Questions in this section aimed to extract information on the attitudes of students towards cooperative learning in algebraic word problems.

Rate your responses using the Likert scale where 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree and 5= Strongly Agree

S/N	Confidence	Rating of attitude				
		1	2	3	4	5
10	I have confidence in asking daring questions when solving word problems in groups					
11	Mathematical word problems do not scare me as far as it is given in groups (group work)					
12	I can solve mathematical word problems with friends at any time					
	Nervousness/ Anxiety					
13	Cooperative learning reduces my nervousness when solving algebraic word problems					
14	All sinking feelings associated with solving algebraic word problems individually reduces when given group work					
15	I feel secured during cooperative learning in solving algebraic word problems					
	Enjoyment					
16	I enjoy learning algebraic word problems in groups					
17	I feel comfortable in solving algebraic word problems in groups					
18	Cooperative learning in solving algebraic word problems is interesting					
	Persistence or Willingness					
19	I am willing to contribute my quota in cooperative learning to ensure my group become the best					
20	I practice algebraic word problems with friends at home/ during leisure times					
21	I take active part in reading word problems as well as mathematizing it in cooperative learning					

APPENDIX D: LESSON NOTE 1

LESSON PRIOR TO THE USE OF THE COOPERATIVE GROUP LEARNING STRATEGY

NAME OF SCHOOL: PEKI SHTS & KPEVE SHTS **SUBJECT:** CORE MATHEMATICS

REFERENCE: CORE MATHEMATICS FOR SHS; AKI-OLA SERIES REVISED EDITION BY PETER ASIEDU

STRAND/ Sub-strand	CONTENT INDICATORS	EXAMPLERS	CORE-POINTS	EVALUATION
Strand: ALGEBRAIC EXPRESSION **Sub-Strand:** WORD PROBLEMS	**CONTENT INDICATORS** The student will be able to: **i.** Mathematize Algebraic word problems. **ii.** Solve algebraic word problems. **iii.** Check to confirm if final solution from algebraic word problem solved is logical relative to the question given	**TLRs:** Blackboard Illustrations **STARTER** Teacher introduces the lesson by asking students to define what algebraic word problems are by given examples. **EXAMPLERS** Teacher then gives a problem and guide students to solve it. *Question: Kofi and Yaw's age is 27. If Kofi is 9 years older than Yaw, find their ages.* Teacher guide students through a whole class discussion to identify the number of unknowns (variables) in the question . From the question above, there are 2 unknowns (Kofi's age and Yaw's age). Teacher guide students through demonstration to represent the unknowns by starting from the least:	Word problems are to be read carefully two or three times to help identify the number of unknowns in the question. It is important to then represent the number of unknowns in the question by starting from the least. Write the equation that model the problem given. Carefully check if indeed the model /equation represent the problem given Solve the equation to get the results of the unknowns. Verify the results to see	**1.** Kofi and Yaw are two brothers, the sum of their ages is 30 years If Kofi is 5 years older than Yaw, find their ages. **2.** A number is subtracted from 10 and the result is multiplied by 2 to give a final answer of 90, find the number. **3.**The sum of the ages of two brothers (Kofi and Yaw) is 36. If Kofi is 10 years older than his brother, how old is Kofi?

	ENTRY BEHAVIOUR Students are already familiar with algebraic expressions.	From the above, Yaw is the least and can be represented by "x". Whiles Kofi can be represented by "x+9". Teacher demonstrate to students how to state mathematize the word problems: From the question, the equation is: x + x+9 = 27 Teacher guide students through demonstration to solve the problem. From the above, 2x +9 =27 2x = 27-9 2x =18 x=9, hence Yaw is 9 years whiles Kofi is 9+9 =27 years. Teacher guide students to verify results. From the above question, Yaw's age is 9 years and Kofi is 9 years older than Yaw implying Kofi us 9+9 =18. Hence their total age = 18 +9 =27. **CONCLUSION** Teacher summarizes the lesson by stating the main steps of approach needed to solve algebraic word problems and give assignment to end the lesson	if they are logical	

APPENDIX E: LESSON NOTE 2:

LESSON USING THE COOPERATIVE GROUP LEARNING

NAME OF SCHOOL: PEKI SHTS & KPEVE SHTS **SUBJECT:** CORE MATHEMATICS

REFERENCE: CORE MATHEMATICS FOR SHS; AKI-OLA SERIES REVISED EDITION BY PETER ASIEDU

STRAND/ Sub-strand	CONTENT INDICATORS	EXAMPLERS	CORE-POINTS	EVALUATION
STRANDS: ALGEBRAIC EXPRESSION **SUB-STRANDS:** WORD PROBLEMS	**CONTENT INDICATORS** The student will be able to: **i.** Translate word problems into mathematics equations **ii.** Solve mathematics word problems step by step **ENTRY BEHAVIOUR** Students are already familiar with algebraic expressions.	**Teaching Strategy:** Cooperative group learning **STARTER** Teacher divide the students into groups and explain the task to the group members. Teacher assign group leaders for each group. **EXAMPLERS** Teacher then gives the test to each group. And directs the groups to start work. Teacher then moves round the class to supervise and monitor activities of each group. At this stage, immediate response is provided if a group is having difficulties at any stage or step. Teacher directs the groups to stop work when it is time. Each group leader is asked to present answers to two questions on the board and	Word problems are to be read carefully two or three times to help identify the number of unknowns in the question. It is important to then represent the number of unknowns in the question by starting from the least. Write the equation that model the problem given. Carefully check if indeed the model /equation represent the problem given Solve the equation to get the results of the unknowns. Verify the results to see	**1.** A number is chosen and is subtracted by 8. The result is then divided by 3. If the final answer is 12, find the number. **2.**The sum of the ages of two brothers (Kofi and Yaw) is 36. If Kofi is 10 years older than his brother, how old is Kofi? **3.** Ama's age is 3 years more than twice her sister's age (Jane). If the sum of their ages is 39, find their ages. **REMARKS:**

		explain them to the class. Teacher then give another task where she directs group members to provide individual answers. Teacher then direct a member to solve the questions on the board and explain to the class. **CONCLUSION** Teacher summarizes the lesson by stating the main steps of approach needed to solve algebraic word problems and give assignment to end the lesson	if they are logical	

APPENDIX F: PRE-INTERVENTION TEST

EXERCISE ON ALGEBRAIC WORD PROBLEMS FOR SENIOR HIGH SCHOOL TWO (SHS-2) STUDENTS IN THE SOUTH DAYI DISTRICT

TIME: 30 MINUTES

Answer all questions. In each case, show working.

1. a. If $\frac{5x-3}{7}$ is greater than $\frac{2x+3}{5}$ by 10, find the value of x ***5 marks***

   b. The sum of a fraction and 10 times its reciprocal is 37/4. What is the fraction? ***5marks***

2. a. Kofi is 6 years older than Kwame currently. Six years ago, Kofi was twice as old as Kwame. Find their ages currently. ***5 marks***

   b. The sum of the ages of Yaw and Kofi is 30 years. If Kofi is 5 years older than Yaw, how old is Kofi? ***5 marks***

3. a. The sum of 2 numbers is 72. One of the numbers is twice as the other. Find the two numbers ***6 marks***

   b. The sum of two consecutive numbers is 41. What are the numbers? ***6 marks***

4. a. There are 47 boys in the class. This is three more than four times the number of girls. How many girls are there in the class? ***6 marks***

   b. In a class, 1/3 of the total number of students are girls. If there are 15 girls in the class, what is the number of boys? ***6 marks***

5. A salesman sold twice as much mangoes in the afternoon than in the morning. If he sold 360 mangoes in all that day, how many mangoes did he sell in the morning and how many in the afternoon if she did not sell in the evening? ***6 marks***

APPENDIX G:

MARKING SCHEME FOR PRE-TEST

Question Number	Step by Step Answers	Mark
Q.1 a.	$\frac{5x-3}{7} = 10 + \frac{2x+3}{5}$	01
	LCM of 5 and 7 = 35, multiply through by 35 to give	01
	$35[\frac{(5x-3)}{7}] = 35(10) + 35[\frac{2x+3}{5}]$	01
	$5[5x - 3] = 350 + 7[2x + 3]$	01
	$25x - 3 = 350 + 14x + 21$	01
	$25x - 14x = 350 + 15 + 21$	
	$11x = 386$, Hence $x = \frac{386}{11}$ or 35.0909	
Q.1b.	Let the fraction = x , Hence its reciprocal = $\frac{1}{x}$	
	From the statement, hence $x + \frac{10}{x} = \frac{37}{4}$	01
	LCM = 4 x	01
	$x(4x) + 4x(\frac{10}{x}) = (\frac{37}{4})\,4x$	
	$4x^2 + 40 = 37\,x$	01
	$4x^2 - 37\,x - 40 = 0$	
	Solving quadratically: use 5 and 32	
	$(4x^2 - 5) - (32\,x + 40) = 0$	01
	$x(4x - 5) - 8(4x - 5) = 0$	
	$(x - 8)(4x - 5) = 0$	
	$x = 8$ $or = \frac{5}{4}$	01
Q.2a.	Let Kwame's current age = x, Hence Kofi's current age = $(x + 6)$	01
	6 years ago, Kwame = $x - 6$ and Kofi's age = $(x + 6 - 6)$	01
	From the statement : $2(x - 6) = (x + 6 - 6)$	01
	$2x - 12 = x$	
	$2x - x = 12$, Hence $x = 12$	01
	So, Kwame is currently 12 years old whiles Kofi is currently 12+6 = 18 years old	01
	Let Yaw's age = x and Hence Kofi's age = $x + 5$	01
Q.2b.	Sum of their ages implies, $x + x + 5 = 30$	01

	$2x = 30 - 5$	01
	$x = \frac{25}{2} = 12.5$ which represents Yaw's age	01
	Kofi's age = 12.5+5 = 17.5 years olds	01
Q. 3a	Let the numbers = x *and* y	01
	Let x = twice as y to give: $x = 2y$	01
	Hence, $y + 2y = 72$	01
	3y = 72, Hence, y = $\frac{72}{3} = 24$	01
	x= 2(24) = 48	02
Q.3b	Let the numbers = x *and* $x + 1$	01
	Sum: $x + x + 1 = 41$	01
	$2x$= 41-1	01
	$2x$= 40, Hence, $x = \frac{40}{2} = 20$ as the first number	01
	The second number = 20+1 = 21	02
Q. 4a	Let b= boys = 47 and let g = girls in the class	01
	47 = 3+4g	01
	47-3 = 4g	01
	44= 4g	01
	Hence, g = $\frac{44}{4}$ = 11 girls	02
Q. 4b	Let g = number of girls Let T = total number of students in the class	
	Let b = number of boys in the class	01
	$\frac{1}{3}$(T) = 15	01
	T = 3(15) = 45	01
	Hence b+g = 45, where g = 15 and hence	01
	15 + b = 45	01
	To give, b = 45-15 = 30 boys	01
Q. 5	Let sales in the morning = x	01
	Hence sales in the afternoon = 2x	01
	x + 2x = 360	01
	3x=360	01
	x = $\frac{360}{3}$ = 120	01

Morning sales = 120 mangoes Afternoon sales = 360 -120 = 240 mangoes	01

APPENDIX H: POST-INTERVENTION TEST

EXERCISE ON ALGEBRAIC WORD PROBLEMS FOR SENIOR HIGH SCHOOL TWO (SHS-2) STUDENTS IN THE SOUTH DAYI DISTRICT

TIME: 60 MINUTES

Answer all questions. In each case, show working. All questions carry equal marks

1. A number is chosen and is subtracted from 8. The result is then divided by 3. If the final answer is 12, find the number. ***5 marks***
2. Twice a number is subtracted from 6. The result is then divided by 8 which is then added to 5 to produce a final result of 12. Find the number ***5 marks***
3. The sum of the ages of Kofi and Yaw is 36. If Kofi is 10 years older than his brother, how old is Kofi? ***5 marks***
4. Ama's age is 3 years more than twice her sister's age. If the sum of their ages is 39, find their ages. ***5 marks***
5. Adzo is 6 years older than Esi. Six years ago, Adzo's age was twice as that of her sister. How old are they now? ***5 marks***
6. There are three programs of study (General Arts, Home Economics and Visual Arts) in a particular secondary school. If there are two more Home Economics students than General Art students and four times as many Visual Arts as Home Economics students exist in the school. Find the number of students offering the three subjects separately if the total number of students in the school is 520. ***5 marks***
7. Kwame is twice as old as Yaa his younger sister. In 20 years, Yaa will be two-thirds as old as Kwame. How old is each now? ***5 marks***
8. A supermarket pays its sales personnel on a weekly basis. At the end of each week, each sales person receives a basic weekly wage of 500 cedis, less 150

cedis everyday he or she absent and plus a bonus of 120 cedis for everyday he or she worked. If Kofi worked for the entire 7 days, how much we will he receive?

5 marks

9. If 4 times a number is subtracted from 3 and the result is multiplied by 7 and the final result is 609, find the number. ***5 marks***
10. Kwame's height is divided by 3 and the result is added to Yaw's height of 130cm to give 180cm. Find Kwame's age. ***5 marks***

End of Test

APPENDIX I:

MARKING SCHEME FOR POST-TEST

Question Number	Step by Step Answers	Mark
Q.1	Let the number = x	
	Result subtracted from 8 to give: 8-x	
	Result divided by 3 to give: $\frac{8-x}{3}$	01
	Final answer = 12, Hence	
	$\frac{8-x}{3} = 12$	01
	LCM = 3	
	$3[\frac{8-x}{3}] = 3(12)$	01
	$8 - x = 36$	01
	$-x$= 36-8	
	$-x$= 28; Hence $x = -28$	01
Q. 2	Let the number = x	
	Twice the number subtracted from 6 to give: 6-2x	
	Result divided by 8 to give: $\frac{6-2x}{8}$	01
	Final answer added to 5 to give: : $\frac{6-2x}{8} + 5$	
	Final Result = 12 to give	
	$\frac{6-2x}{8} + 5 = 12$	01
	LCM = 8	
	$8[\frac{6-2x}{8}] + 5(8) = 12(8)$	01
	$6 - 2x + 40 = 96$	
	$-2x$= 96 -40 -6	01
	$-2x$= 50	
	$x = -\frac{50}{2}$ = - 25	01

Q.3	Let Yaw's age = x	
	Kofi's age = 10 + x	01
	x+ 10 + x= 36	01
	2x= 36-10	01
	2x= 26	01
	Hence, $x = 13$	
	Yaw's age = 13 years and Kofi's age = 10 +13 = 23 years	01
Q.4	Let Ama's sister's age = x	
	Twice the sister's age = 2x	01
	3 years more than twice = 3+ 2x	
	Hence Ama's age = 3+ 2x	
	3+ 2x + x = 39	01
	3x= 39-3	01
	3x= 36	
	Hence x= $\frac{36}{3}$=12 years (Ama's sister's age)	01
	Ama's age = 3+2(12) = 3+ 24 = 27 years	01
Q.5	Let Esi's age = x	01
	Adzo's age = 6 + x	01
	Hence six years ago, Esi = (x-6) years old and Adzo = (6+x-6) years old	01
	Adzo's age 6 years ago is twice Esi's age, hence	01
	6+ x -6 = 2 (x-6)	01
	x= 2x-12	
	-x = -12	01
	x = 12	

Q.6	Let number of Visual Art students = $\boldsymbol{x}$	
	Number of Home Economics students = $\boldsymbol{4x}$	
	Number of General Art students = $\boldsymbol{4x - 2}$	01
	Total = 520	
	Hence	
	$\boldsymbol{x}$+ $\boldsymbol{4x + 4x - 2}$ = 520	01
	$\boldsymbol{9x}$= 520+2	
	$\boldsymbol{9x}$= 522	01
	$\boldsymbol{x}$= $\frac{\boldsymbol{522}}{\boldsymbol{9}}$=58 = Number of Visual Art students	01
	Number of Home Economics students = $\boldsymbol{4}$ $\boldsymbol{(58)}$ = 232 students	0.5
	Number of General Art students = $\boldsymbol{4(58) - 2}$ = 232-2 = 230 students	0.5
Q.7	Let Yaw's age = x	
	Kwame's age = $2x$	
	In 20 years' time, each will be:	
	Yaw = $x + 20$ and Kwame = $2x + 20$	01
	Hence, we have:	
	$x + 20 = \frac{2}{3}(2x + 20)$	01
	LCM = 3	
	$3(x + 20) = 2(2x + 20)$	
	$3x + 60 = 4x + 40$	01
	$3x - 4x = 40 - 60$	01
	$-x = -20$; Hence $x = 20$	0.5
	Yaw's age = 20 years and Kwame's age = 20(2) = 40 years	0.5
Q.8	Basic wage = 500 cedis for a week	0.5
	Absent penalty = -150 cedis a day	0.5
	Bonus per day = 120 cedis a day	01
	Working for 7 days demands = basic wage + 7 days bonus	01
	Bonus for 7 days = 7(120) = 840 cedis	01
	Hence Total amount for 7 days = 500+840 = 1340 cedis	01

Q.9	Let the number = x	
	Four times the number = $4x$	0.5
	Result is then subtracted from 3 to give = $3-4x$	0.5
	Result multiplied by 7 to give = $7(3-4x)= 609$	
	Hence; $7(3-4x)= 609$	01
	$21-28x= 609$	01
	$-28x= 609 -21$	01
	$-28x= 588$	
	$x = \frac{588}{28} = -21$	01
Q.10	Let Kwame's height = x	
	Let Yaw's height = y = 130 cm	
	Kwame's height divided by 3 = $\frac{x}{3}$	01
	$\frac{x}{3} + y = 180cm$	0.5
	$\frac{x}{3} + 130cm = 180cm$	0.5
	$\frac{x}{3} = 180cm -130cm$	01
	$\frac{x}{3} = 50cm$	
	LCM = 3	01
	$3(\frac{x}{3}) = 3(50cm)$	01
	$x = 150cm$	

APPENDIX J: NORMALITY PLOTS

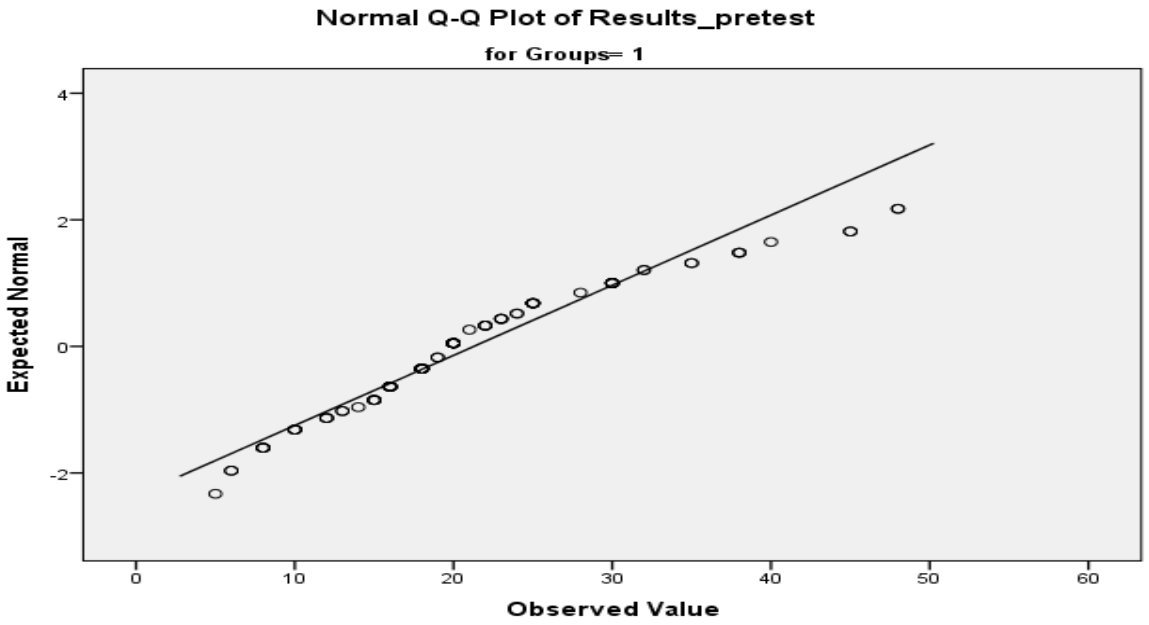


Figure 1: Normality Plot for Control Group during Pre-intervention stage

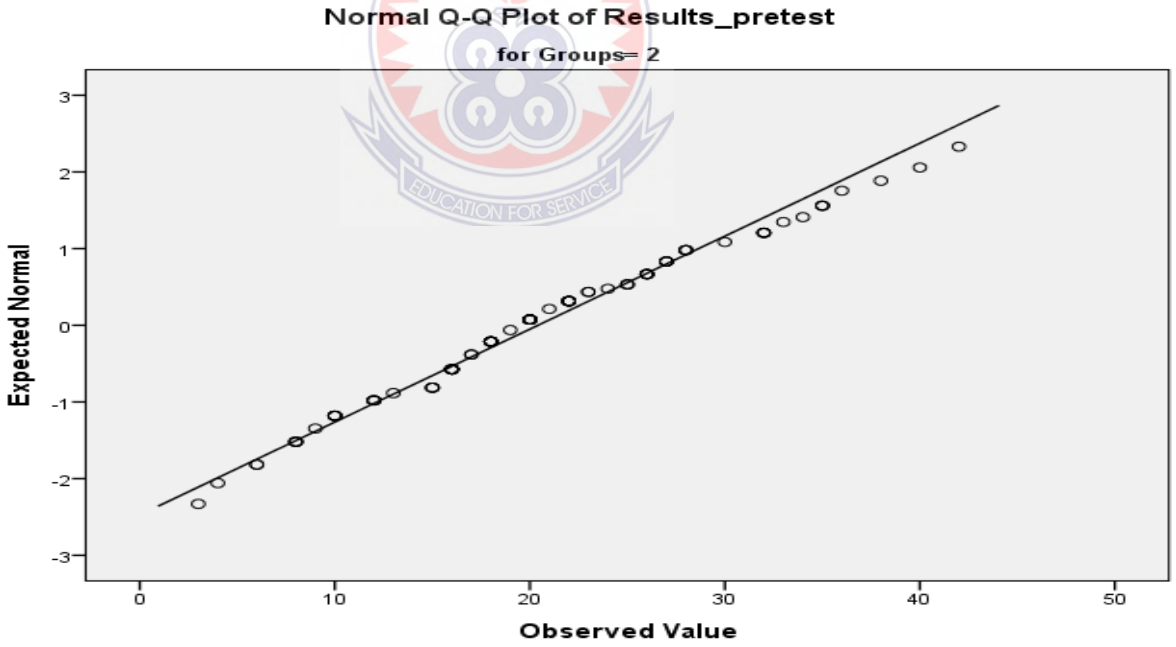


Figure 2: Normality Plot for Treatment group members during the Pre-intervention stage.

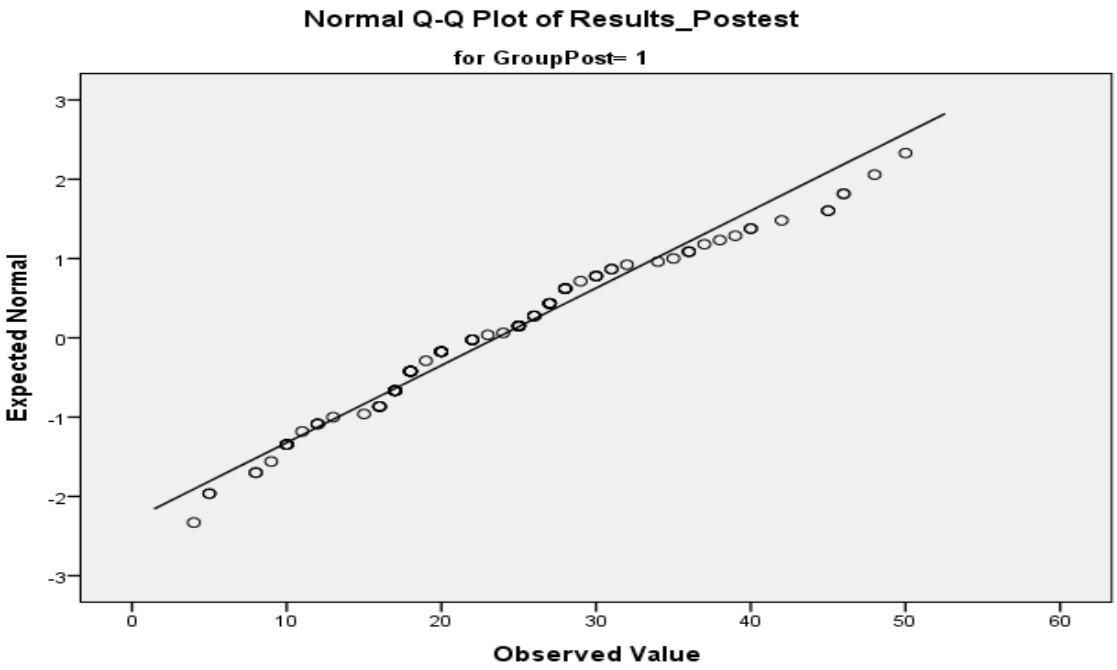


Figure 3: Normality Plot for Control group members during the Post-intervention stage.

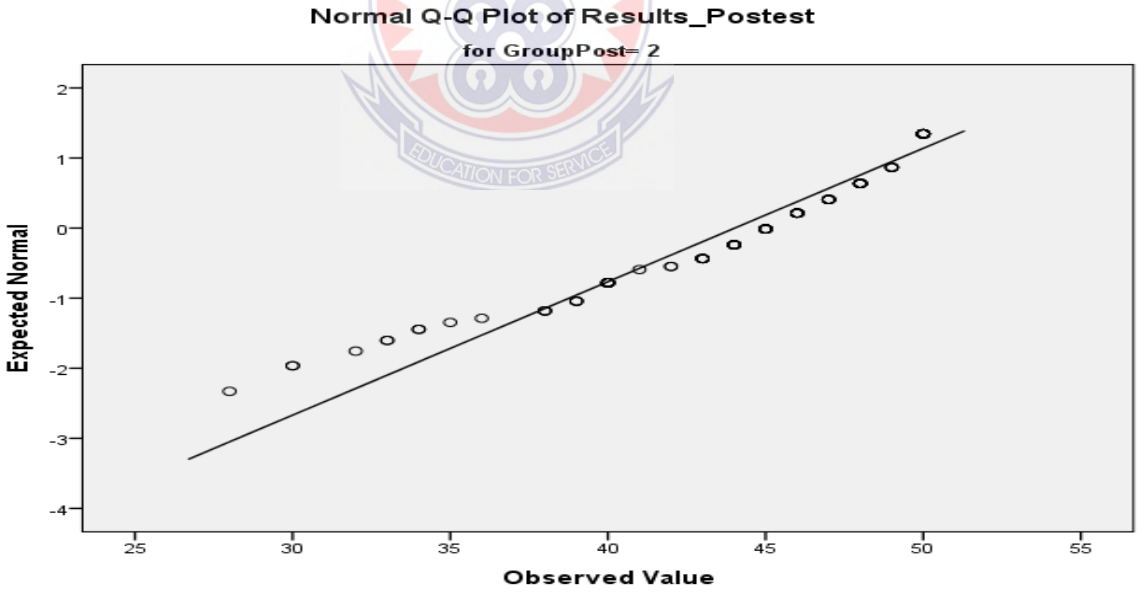
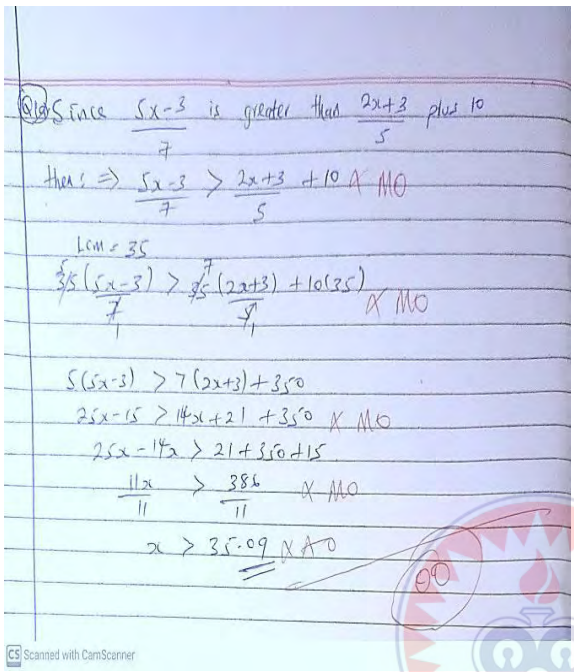
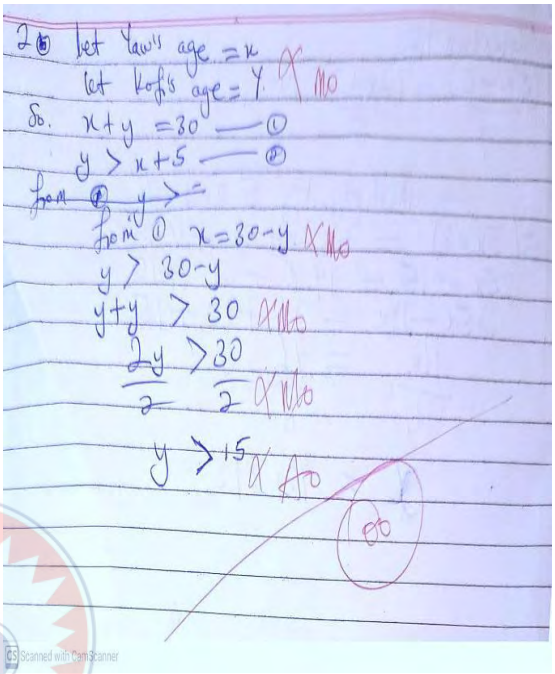


Figure 4: Normality Plot for Treatment group members during the Post-intervention stage

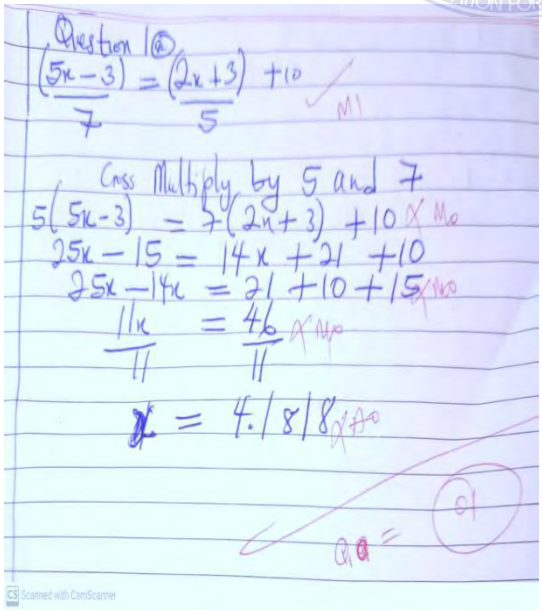
APPENDIX K:

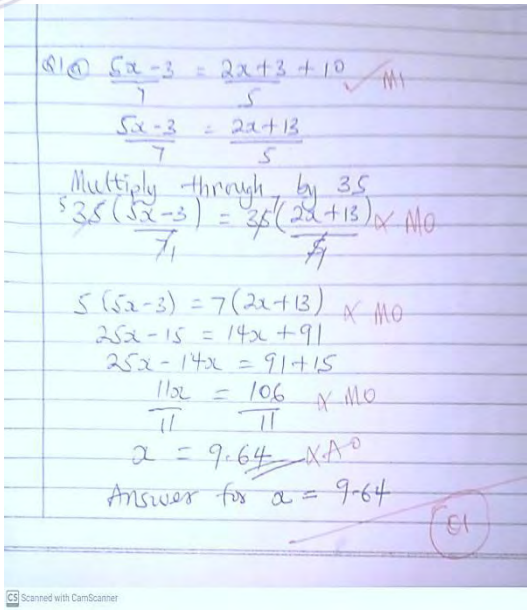
SAMPLED ERRORS COMMITTED BY PARTICIPANTS DURING THE PRE-INTERVENTION TEST





Picture 1 and 2: Sampled evidences of wrong translation of questions into mathematical equations





Picture 3 and 4: Sampled evidences of correct translation of questions into mathematical equations with wrong calculation or processing error

APPENDIX L:

PICTORIAL VIEW OF COOPERATIVE GROUP STUDIES CARRIED OUT AT THE STUDY AREA- DURING THE INTERVENTION STAGE

Pictorial view of experimental group participants from Peki SHTS during intervention stage (Cooperative group learning)

Pictorial view of experimental group participants from Kpeve SHS during intervention stage (Cooperative group learning)