

Chapter One

Introduction

1.1 Background to the Study

Mathematics has permeated nearly every domain of knowledge due to its significance in various professional paths. A number of scholars have investigated how Mathematics can influence the interest of learners or students in the teaching and learning of the subject. Mathematics is a fundamental discipline; understanding it is crucial not only for academic achievement but also for navigating the complexities of daily life². Mathematics proves to be invaluable across nearly every discipline. The farmers, carpenters, hunters, housewives, and others utilise it, even if they are not consciously aware of its presence. The importance of Mathematics in its various applications cannot be overstated in today's scientific and technological era³.

Mathematics extends beyond its impact on the sciences, engineering, and technology; it also significantly shapes our everyday activities. Mathematical techniques find application in various fields such as painting, music, management information systems, traffic control, accounting, and many others. The Federal Government of Nigeria, acknowledging its significance, has designated Mathematics as a core subject within the National Policy on Education, to be taught at both the basic and post-basic levels of education.

The significance of Mathematics in areas such as commerce, record management, comprehension of the natural world, critical analysis, and logical deduction can effectively maintain students' engagement within the formal education framework. Similarly, Mathematics remains the central element upon which no science can succeed without undergoing mathematical demonstration⁴. The applicability of Mathematics is evident across various domains of study and human endeavours, including the arts, social sciences, religions,

mysticism, commerce, warfare, and personal life. It has been discovered that decorative arts have significantly influenced the preference for geometry, religion, and commerce, which in turn has driven the evolution of numbers, while conflict has sparked interest in Mathematics programming and beyond⁴.

The rapidly evolving educational landscape prioritises the development of effective learning strategies and the promotion of equitable academic achievement. Mathematics, as a central component of educational curricula, plays a vital role in shaping critical thinking skills and preparing students for a broad range of professional fields. Algebraic expressions, a fundamental component of Mathematics, often prove to be a challenging hurdle for many students including college students hereby impacting their overall academic success¹. To address this issue, educators and researchers have explored various pedagogical approaches.

The inadequate achievement of students in Mathematics, particularly in Algebraic expressions at various Colleges of Education in Nigeria, can undoubtedly be linked to the teaching methods employed by lecturers in these institutions indicate that the learning and comprehension of school subjects have been hindered by ineffective methods, teaching techniques, and instructional materials. The National Mathematical Centre, Abuja (NMC) has conducted a thorough investigation into the factors contributing to widespread failure in Mathematics at the secondary school level. This research has highlighted several issues, including the methods employed by teachers and their interpretation of word problems³.

Students should be capable of sharing their thought processes, demonstrating the adaptability to explore new domains of Mathematics, and showing a readiness to engage in mathematical work. The negative attitudes of students towards Mathematics, their beliefs about the subject, the lack of competent lecturers, and the insufficiency of pedagogical resources have contributed significantly to the persistent issues of low achievement in Mathematics²⁹. Creating

a positive atmosphere, fostering enthusiasm, and providing adequate guidance in Mathematics, along with the need for relevant instructional materials, can lead to students achieving success in Mathematics with respect²⁹.

Nigerian teaching curriculum, Mathematics is a core subject that everyone is searching for at both basic and post-basic education³⁰. The approved institution for the preparing of elementary school teachers in Nigeria is the Colleges of Education. The National Policy on Education indicates that the minimal qualification for the teaching profession in Nigeria is the Nigerian Certificate in Education (NCE)³¹. By implication, NCE holder is to teach in primary schools or Junior Secondary Schools (JSS). The Federal Ministry of Education established the National Commission for Colleges of Education (NCCE) in 1989 through an act, serving as a crucial component in the oversight of tertiary institutions in Nigeria³². The Commission was assigned the task of establishing standards for all Teacher Education programmes, overseeing and regulating quality within Colleges of Education, accredited certificates, and academic awards, and approving guidelines for accreditation. The NCCE has produced a document that outlines the curriculum for the NCE programme in accordance with the established mandate. The title of the document is “Minimum Standards for NCE Teachers”.

The NCCE report, responding to the mandate from the Federal Ministry of Education, indicates that a curriculum review was conducted in 2020, which is the document currently utilised in the Colleges of Education. This curriculum is referred to as the minimum standard of 2020. This also fulfilled the requirements of Universal Basic Education (UBE). The review mandates that all NCE students must take essential subjects, including Mathematics, English Language, and Computer Education. The introduction of students to these subjects is intended to equip them with the necessary skills to effectively teach at the primary school and junior secondary level. The subjects are structured within the NCE curriculum as General Studies

Education (GSE). GSE are essential courses that every prospective NCE holder must successfully complete.

Five courses are offered in General Studies Education (GSE) Mathematics for the NCE programmes: GSE 113 (Basic General Mathematics I) and GSE 122 (Basic General Mathematics II). The courses outlined are designated for first and second semesters of 100 level students. The GSE 212 (Basic General Mathematics III) and GSE 222 (Basic General Mathematics IV) are designed for first and second semester at the 200 level, taking place prior to their teaching practice programme. Students engage with the curriculum of these courses to ensure they can competently fulfil their responsibilities in Mathematics during their teaching practice, and upon completing their NCE programme while GSE 322 (Basic General Mathematics V) will be taught at 300 level in the second semester.

This involves the capacity to apply knowledge acquired in Basic General Mathematics courses to address challenges related to NCE Mathematics. In other terms, there are components that indicate the transfer of learning, serving as a measure of proficiency. The transfer of learning refers to how the knowledge or skills acquired from one task influence the achievement of another task. Schools are created to promote a constructive transfer; otherwise, the founding of educational institutions turns into projects with negative implications³³.

Moreover, as gender disparities in Science, Technology and Mathematics-related fields continue to gather attention, understanding the potential influence of gender differences in the context of algebraic expression learning becomes crucial⁵. A significant number of studies have concentrated on the disparities between genders in the achievement of Algebraic expressions. The achievement in algebraic expressions among college students showed no significant difference between female and male students; however, there was a decline observed in the 200 Level cohorts. Research indicated that students' proficiency in Algebraic expressions matched

that of their male counterparts in the first year; however, this achievement declined in the second year⁶. The findings from TIMSS indicated that there was no disparity in the average mathematical achievement between male and female students at the NCE 300 Level across the countries examined⁸.

Studies conducted in Africa revealed a significant gender difference in Algebraic expression achievement, favouring male students compared to their female counterparts. Research findings indicated that the academic achievement of female students in Algebraic expressions was notably inferior compared to that of male students. The disparity in achievement between female and male can be attributed to differences in mathematical interest. While significant attention has been directed towards the accomplishments of female in Algebraic expression, studies have also highlighted the underachievement of male in comparison to their female counterparts⁸. Furthermore, the possible impact of gender differences on the effectiveness of these strategies in College-level Algebra education should not be ignored, given that gender disparities in Mathematics achievement have been a topic of continuous investigation⁹.

The concept of attitude stands as a fundamental pillar in modern social psychology and scientific inquiry. This pertains to the emotional and cognitive factors that motivate a person to engage in a specific activity. Attitude is “a learned disposition or tendency on the part of an individual to respond positively or negatively to some object, situation, concept or another person, define attitude towards Mathematics as positive, negative, or neutral feelings and dispositions¹⁰. Attitude can be bi-dimensional, (a person’s emotions and beliefs) or multidimensional (affect, behaviour, and cognition). Over the last decades, an extensive body of research from different settings and contexts has investigated variables that influence

students' attitude towards Science, Technology, Engineering and, Mathematics (STEM). This means that attitude determines and may be used as a predictor for academic achievement¹¹.

Numerous studies on students' attitude towards Mathematics which always translated as liking and disliking of the subject have been published. To some secondary school students, Mathematics appears abstract, difficult to comprehend, boring and viewed with limited relationship or relevance to everyday life experiences. Students start learning the subject well but gradually start disliking some topics or the entire subject¹². They feel uncomfortable and nervous during learning and examinations. This is partly attributed to students' lack of self-confidence, and motivation during problem-solving. To some students, persevering and studying algebraic has become a nightmare. Indeed, some students do not seem to know the significance of learning Mathematics beyond the compulsory level. Students may (may not) relate mathematical concepts beyond the classroom environment if they have a negative attitude towards the subject¹³.

This may lead to their failure to positively transfer mathematical knowledge and skills in solving societal problems. Findings from other studies revealed a significant and positive relationship between attitudes towards Algebraic expression and Mathematics achievement¹⁴. Achievement in Mathematics is inextricably linked to future career opportunities, plays an important role in the level of the student's general learning acquisitions, and a reliable criterion to divide students into scientific or literary streams. Also, achievement in Algebraic expression can be a gateway to well-rewarded and high-status positions. Lecturers, parents, and researchers noticed that students are suffering from difficulties in Algebraic expression at all levels in Colleges of Education¹⁵.

Researchers have identified important factors that contribute to students' attitudes towards learning Algebraic expression. These include the students themselves, the school, the

teachers' beliefs, and their teaching methods¹². The teachers' teaching strategies have a major influence on students' attitudes. Teachers can do many things to facilitate classroom learning to alleviate students' engagement level and confidence in teaching Algebraic expression. Teachers can find ways to encourage student engagement and confidence in learning Algebraic expression¹³. This can be achieved by implementing meaningful activities embedded in real-life contexts.

The impact of using mathematical games on college students' attitudes towards learning Algebraic expression was also reported. A pre-post design method was used to assess students' perception of the learning environment and their attitude towards learning Algebraic expression. Eight classes out of 33 used a game's context. The students from the classes that used games found their lessons more interactive, got involved, and enjoyed learning Algebraic expression¹⁵.

Class size is a prominent factor in scholastic exploration which was interpreted as the fair quantity of students per lesson, evaluated by dividing the number of students enrolled by the number of classes¹⁶. The number of students per teacher in a lesson is an academic method that can be used to illustrate the fair number of students per lesson in a College. It is often simply considered as the respective population of students in each class. Various researchers have established a strong relationship with class size and students' academic achievement¹⁷.

In Nigeria, class size in post-basic schools exists far above the approved number of students 30 or 40 students per classroom. The normal class size in biggest post-basic schools exceeds 50¹⁸. In Nigeria schools that retain as numerous as 80, 100, or above 100 students per class have also been reported¹². These class sizes are supposed to be too numerous for the optimum academic feat of students. This among other factors might give birth to provoke the verdict that nothing is wrong with the education policy in Nigeria¹⁹.

In the pursuit of optimising students' academic achievement in Algebraic expressions, educators and researchers have explored a plethora of strategies and interventions. Among these, class-wide peer tutoring and problem-solving strategies have emerged as a promising approach to enhance learning outcomes. This pedagogical method harnesses the power of peer interactions and solving of Mathematics problems step-by-step, where students collaborate with one another to deepen their understanding of Algebraic concepts²⁰.

One method of teaching that engages students in active learning is the class-wide peer tutoring method (CWPT). Others include group, discussion method and mentoring. In using the class-wide peer tutoring strategy, students are allowed to teach themselves in an organised setting where one student acts as the tutor and others as the tutees. The more intelligent students are asked to act as the tutors, while the less intelligent ones learn as the tutees. Through interactions among themselves, both sets of students can learn from each other by playing, talking and sharing ideas and sometimes even through quarreling²¹.

Class-wide peer tutoring (CWPT) is a collaborative and instructional approach used in educational settings to enhance students' learning and academic achievement. This teaching strategy involves students working together in pairs or small groups, with one student serving as the tutor and the other(s) as the tutee(s). The primary goal of CWPT is to facilitate peer-to-peer learning, where students help one another grasp and reinforce key concepts, develop problem-solving skills, and improve their overall understanding of the subject matter¹⁶. Studies have increasingly highlighted the effectiveness of CWPT as an inclusive teaching strategy in improving students' academic achievement in Mathematics. It also involves students working collaboratively to help one another in the understanding of complex concepts, promoting peer interaction and collective learning²².

Furthermore, in a class-wide peer tutoring classroom each student gets more attention from the tutor and more often time to speak, while others listen¹⁴. This allows the students take active part in constructing their knowledge. Also this approach focuses on peers to solve a problem, and is most effective in fostering creativity, experimentation, problem-solving skills and the learning of difficult concepts in Science, Mathematics and Technology. The teacher serves as a facilitator in using class-wide peer tutoring instructional strategy²³.

On the other hand, problem-solving strategy is the process of solving questions that deal with understanding the problem by splitting it into parts, identifying the knows and unknowns, proffering a solution method and solving it²⁴. It is defined as a cognitive process directed at transforming a problem from the given state to the goal state when the problem solver is not immediately aware of the solution method. Problem-solving strategy refers to a set of strategy employed to find solutions to complex or challenging issues or questions. Effective problem-solving is a valuable skill in various aspects of life, including education works, and personal decision-making. Problem-solving strategy, stands have gained recognition as a pedagogical method that fosters critical thinking and the strategy enhances Mathematical comprehension²⁶.

Problem-solving strategy is essential in mastering Algebraic expressions. Problem-solving strategy can empower students to depict complex Mathematical problems and enhance their Algebraic competency. Educational research has focused on various problem-solving strategy, including the use of real-life scenarios, visualization tools, and step-by-step approaches^{2, 16}. Understanding how these strategies affect students' academic achievement in Algebraic expressions is crucial for tailoring teaching methods to the specific needs of this demographic²⁷.

In a study, the researchers were particularly interested in determining how idea class-wide peer tutoring and problem-solving teaching strategy affect the overall achievement of

Colleges of Education students in Mathematics especially algebraic expressions^{22, 25}. Researchers observed that students' grasp of Mathematics concepts and their ability to remember such concepts increased when class-wide peer tutoring strategy was employed in conjunction with idea of problem-solving strategy. Besides, to a more in-depth comprehension of the subject matter, the students had shown considerable gains in their ability to think critically about the material.

Furthermore, a research used an idea of class-wide peer tutoring and problem-solving teaching strategy to encourage conceptual shifts in Algebraic expression concept among future educators^{21, 27}. Researchers showed that when two strategies were used together with students' conceptual knowledge increased significantly and their misunderstandings about Mathematics topics were reduced. Improved conversation and teamwork were other benefits of the class-wide peer tutoring and problem solving²⁷.

The combination of these instructional strategy appears to enhance students' conceptual understanding, critical thinking skills, motivation, and attitudes toward the subject. As these studies have demonstrated positive outcomes, it is reasonable to consider implementing such strategy in College of Education programmes to better prepare future educators in the field of Mathematics. This study therefore determined the effects of class-wide peer tutoring and problem-solving on students' achievement in Algebraic expression in colleges of education southwest, Nigeria.

1.2 Statement of the Problem

Students' academic achievement in Algebraic expression is a challenge in Federal Colleges of Education. This has been a subject of concern due to various challenges faced by Students in Federal Colleges of Education. The current methods of teaching students general

Mathematics in Federal Colleges of Education Southwest, Nigeria seem not effectively engage students or adequately address their teaching needs. Traditional didactic approaches often focus on rote memorisation and fail to promote deep understanding and critical thinking skills among students in Federal Colleges of Education. Also, several issues have been identified as the underlying causes of the academic underachievement of students in Federal Colleges of Education in the general studies involving Mathematics. Many students in Federal Colleges of Education Southwest, Nigeria found it difficult to understand and apply Algebraic expression, the continuous use of teacher centred approaches contribute to students low achievement hence, there is a need to investigate alternative teaching strategy that promote active learning and students involvement. Factors such as gender difference, large class sizes, and students' attitude could potentially contribute to poor academic achievement in Algebraic expressions. Interactive and students centred strategy such as class-wide peer tutoring (CWPT) and problem-solving strategy may enhance students' academic achievement. To address these concerns, this research explored two innovative teaching strategies such as class-wide peer tutoring and problem-solving strategies as potential solutions to enhance the achievement levels of students in Federal Colleges of Education. Problem solving strategy, which involves step-by-step approach, has shown promise in promoting meaningful teaching and knowledge acquisition. Similarly, class-wide peer tutoring, which encourages collaborative teaching experiences among students, has the potential to foster a deeper understanding of Mathematics concepts especially algebraic expressions and enhance communication and teamwork skills. Therefore, this research aims to fill this gap by determining the effects of class-wide peer tutoring and problem-solving strategy on students' academic achievement in Algebraic expressions in Federal Colleges of Education Southwest, Nigeria.

1.3 Aim and Objectives of the Study

The study aimed to investigate the effect of class-wide peer tutoring and problem-solving strategy on students' academic achievement in Algebraic expressions in Federal Colleges of Education Southwest Nigeria. The objectives of the study were to:

- i. determine the main effect of class-wide peer tutoring and problem-solving strategy on students' academic achievement in Algebraic expression in Federal Colleges of Education;
- ii. examine the main effect of gender on students' academic achievement in Algebraic expressions in Federal Colleges of Education;
- iii. examine the main effect of class-size on students' academic achievement in Algebraic expressions in Federal Colleges of Education;
- iv. examine the two-way interaction effect of class-wide peer tutoring and problem-solving strategies, and gender on students' academic achievement in Algebraic expressions in Federal Colleges of Education;
- v. examine the two-way interaction effect of class-wide peer tutoring and problem-solving strategies, and attitude on students' academic achievement in Algebraic expressions in Federal Colleges of Education;
- vi. examine two-way interaction effect of gender and attitude on students' academic achievement in Algebraic expressions in Federal Colleges of Education;
- vii. examine three-way interaction effect of treatment class-wide peer tutoring, problem-solving and conventional teaching strategy, gender and attitude on students' academic achievement in Algebraic expressions in Federal Colleges of Education.

1.4 Hypotheses

Based on the above stated objectives, the following null hypotheses at 0.05 level of significance were tested

H₀₁: There will be no significant main effect of class-wide peer tutoring and problem-solving and conventional strategies on students' academic achievement in Algebraic expressions.

H₀₂: There will be no significant main effect of gender on students' academic achievement in Algebraic expressions.

H₀₃: There will be no significant main effect of class-size on students' academic achievement in Algebraic expressions.

H₀₄: There will be no significant interaction effect of class-wide peer tutoring and problem-solving and conventional strategies and gender on students' academic achievement in Algebraic expressions.

H₀₅: There will be no significant interaction effect of class-wide peer tutoring and problem-solving and conventional strategies and attitude on students' academic achievement in Algebraic expressions.

H₀₆: There will be no significant interaction effect of gender and attitude on students' academic achievement in Algebraic expressions.

H₀₇: There will be no significant interaction effect of treatment (class-wide peer tutoring, problem-solving and conventional teaching strategies), gender and attitude on students' academic achievement in Algebraic expressions.

1.5 Significance of the Study

The findings of this study would be of important value to all stakeholders in Education. It is hope that the finding from the study would be significant for the educational landscape in

Nigeria, particularly in the Southwest region, where it sought to investigate strategies that can enhance students' academic achievement in Algebraic expressions. Improving students Mathematics education is critical for producing well-rounded teachers and enhancing the overall quality of education in the country. Findings from this study will provide valuable insights into innovative teaching strategies that teachers in Nigeria and elsewhere can adopt to make Mathematics more accessible and engaging for students.

It would be useful to the students because the knowledge derived from this study would equip them on how their achievement in Algebraic expressions can be enhanced. The findings from this study would equally help the lecturers in the teaching of the subject to identify how they are performing in the teaching of Algebraic expressions and if there are any gaps or shortcomings the result of this study would enable them to discover it and take necessary steps to bridge the gaps.

It would provide information that is relevant to the curriculum planners and policy makers in National Commission on Colleges Education to decide in areas of future curriculum development whether there would be a change in the Mathematical contents of Mathematics in all Colleges of Education in Nigeria. Policy makers and educational administrators can use the results of this study to make informed decisions about curriculum development, teacher programme, and resource allocation. Evidence-based insights into effective teaching strategies could guide educational reforms aimed at improving Mathematics education in Colleges of Education.

Besides, it would also provide insight for tutors the necessity of using different strategies in the teaching and learning of Algebraic expressions to their students in order to achieve maximum success. This study would provide insight for the writers and publishers in organisation of the content, arrangement of topics from simple to complex hence, help to

maintain principles of curriculum balance which would enhance meaningful teaching and learning of Mathematics.

It also believed that findings from this study would improve students' academic achievement in Algebraic expression could have a long-lasting effect on students' academic and career prospects. Also, the findings of this study would have broader applicability beyond Southwest, Nigeria. Effective teaching strategies and interventions could be adapted and implemented in other educational settings, both within Nigeria and in other countries facing similar challenges in Mathematics education.

Lastly, this study would contribute to the existing body of knowledge by providing empirical data on the effect of Class-wide Peer tutoring and problem-solving strategies in the context of Algebraic expressions. It would add to the academic discourse on Mathematics education and could serve as a reference for future research. Lecturers and educators could be of benefit from the study's findings by incorporating successful teaching strategies into their classrooms. This could lead to the professional growth of educators and the improvement of the learning experience for students.

1.6 Scope of the Study

The study covered all Federal Colleges of Education Southwest, Nigeria. It is also limited to Algebraic expression of Mathematics concepts, class-wide peer tutoring, problem-solving strategies and 100 level students. The research was conducted at three different Federal Colleges of Education: Federal Colleges of Education (Special), Oyo, Oyo State; Federal College of Education Osiele, Ogun State and Federal College of Education, Iwo, Osun State.

1.7 Operational Definition of Terms

Algebraic Expressions: These are the mathematical phrases that combines, variables, constants, and mathematical operations (+, -, x, ÷, /,) to represent a value or relationship.

Students' Academic Achievement: This is the students learning outcome obtained from the scores of Algebraic Expressions Test for 100 level students from each of the Federal Colleges of Education selected in the study.

Class-wide Peer tutoring: This is an instructional strategy in which the class will be divided into small groups.

Problem-solving Strategies: These are the plans used to find solutions to overcome Mathematical challenges in Algebraic expressions.

Gender is the male and female sex of the students that would partake in the study.

Class-size: This is the total number of students in Algebraic expressions classes. It ranges on the carrying capacity of each of the Federal Colleges of Education Southwest, Nigeria

Attitude to Mathematics: This is the students' disposition towards learning of Algebraic expressions.

Federal Colleges of Education: These are institutions owned by Federal Republic of Nigeria that prepare NCE teachers in the country.

NCE 1 Students: These are the set of students in the study sample, selected for the study.

Endnotes

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Chapter Two

Literature Review

This chapter deals with a review related to the topic under discussion; this is with a view to creating links in research and bridge the academic gap. The chapter was presented under the following subtopics:

2.1 Conceptual Review

- 2.1.1 Importance of Mathematics
- 2.1.2 Student Achievement in Algebraic Expressions
- 2.1.3 Concept of Algebraic Expressions
- 2.2.4 Class-wide Peer tutoring in Algebraic Expressions
- 2.1.5 Problem-solving strategies in Algebraic Expressions
- 2.1.6 Gender
- 2.1.7 Class-size
- 2.1.8 Attitude

2.2 Theoretical Framework

- 2.2.1 Social Learning Theory
- 2.2.2 Constructivist Theory
- 2.2.3 Lev Vygotsky's Theory
- 2.2.4 Cognitive Learning Theory

2.3 Review of Empirical Studies

2.3.1 Class-wide Peer tutoring and Achievement in Algebraic Expressions

2.3.2 Problem-solving and Achievement in Algebraic Expressions

2.3.3 Gender and Achievement in Algebraic Expressions

2.3.4 Class-size and Achievement in Algebraic Expressions

2.3.5 Attitude and Achievement in Algebraic Expressions

2.4 Conceptual Model

2.5 Summary of the Gap in Literature Reviewed

Endnotes

2.1 Conceptual Review

2.1.1 Importance of Mathematics

Mathematics serves as a crucial foundation for the effective operation of all areas of human activity, and no nation can attain significant scientific and technological progress without a solid grounding in this discipline¹. The significance of Mathematics is evident in its role in admissions to higher institutions in Nigeria; the Joint Admission Matriculation Board (JAMB) brochure specifies that a credit pass in Mathematics is necessary for entry into both science and non-science programs. A credit in Mathematics is essential for admission into various disciplines in numerous higher education institutions globally. Despite the significant role Mathematics plays, it continues to be one of the subjects in which students consistently struggle to achieve satisfactory achievement. The concerning rate of inadequate achievement in Mathematics has raised significant issues for all stakeholders, particularly regarding the factors that contribute to this challenge².

Mathematics is all about devising solutions to problems. Problem-solving is an important cognitive activity applied in a real-life context that requires training, effort, styles,

mathematical and arithmetic skills, meta-cognitive skills, and determination with aspiration. Its main function is to make decisions on what and how a problem may be answered³.

Most students may have mastered the Mathematics concepts but struggle when they are applied in real life and when stated in a form of word problems. Since the real importance of learning Mathematics is not memorizing its concepts but the understanding of bit by students to solve many problems in Mathematics which need thorough analysis and critical thinking and result to helping students improve their problem-solving achievement, it is important to know what would affect their achievement. The significance of Mathematics across various domains of human activity is profound and should not be overlooked. The significance of this subject spans various domains, including scientific and technological endeavours, commerce, economics, education, the arts, and the humanities, highlighting its crucial role in the broader educational landscape. Mathematics stands as a fundamental subject across basic classes, senior secondary schools, and tertiary institutions in Nigeria. The instruction of Mathematics holds significant value across all human pursuits⁴.

Solving problems is the essence of Mathematics. The best way to address the problems of what, how, and where to calculate is to first transform every statement into a mathematical statement. An individual's ability to make an accurate decision was directly related to his or her mathematical understanding. In this age of rapid technological development, it is even more crucial for individuals to possess a solid grasp of Mathematics in order to thrive in society. Advancements in technology necessitate a high level of mathematical sophistication. The core intellectual discipline of technological cultures is Mathematics⁵.

For scientists, Mathematics is the universal language. In addition to being the universal language of science, Mathematics is a vital component of any healthy diet that includes thinking, reasoning, and development. In addition to emancipating the mind, Mathematics

provides an evaluation of one's intellectual capacities and a roadmap for personal growth. In conclusion, it was stated that Mathematics forms the bedrock of all technological fields and, by extension, all human endeavours. The influence of Mathematics extends to every facet of human knowledge. Despite Mathematics' pervasive relevance and significance, many students continue to flounder in the subject due to their repeated failures. Quantum mechanics (number theory), algebraic structures (space and geometry), and mathematical analysis of change are all parts of Mathematics⁶.

Throughout the history of humankind, and continuing to the present day, Mathematics has proven to be immensely valuable in various facets of human endeavours. The instruction and acquisition of Mathematics globally, particularly in developing nations such as Nigeria, has raised significant concern among various stakeholders. It is evident that numerous events within educational environments have highlighted the crucial importance of Mathematics knowledge in the lives of individuals globally today⁷.

Mathematics is essential as it serves as the foundation for nearly all other disciplines, particularly in the fields of science and technology. Furthermore, the extent of one's mathematical understanding in post-secondary education significantly influences the career paths available to them. This determines the status of the subject as essential and mandatory for students in basic classes, senior secondary, and General Studies Education in Colleges of Education in Nigeria. Mathematics serves as an essential instrument for navigating the complexities of our current technological era.

The instruction of Mathematics holds significant value in human existence as it revolves around the pursuit of solutions to various problems⁸. The exploration of Mathematics holds significance in nearly every facet of human endeavours. Numerous human endeavours are inherently linked to a propensity for Mathematics. In the realm of Science Education,

Mathematics is recognised as a crucial subject essential for the scientific and technological advancement of any nation. Numerous studies have highlighted this importance, and ongoing efforts are being made to enhance its teaching and learning, particularly at the basic and post-basic levels, to establish a solid foundation for future studies⁹.

Over the years, educators in Mathematics and those engaged in scholarly inquiry have conducted studies on the factors contributing to inadequate achievement in Mathematics at the basic, post-basic, and college levels. The factors include a shortage of qualified Mathematics teachers, inadequate facilities and equipment, insufficient instructional aides for effective teaching and learning, reliance on traditional chalk-and-talk methods, a large student-to-teacher ratio, and various forms of Mathematics anxiety, among others. Numerous elements have typically been recognised as indicators of underachievement in Mathematics¹⁰. The educator lacking both academic and professional teaching qualifications could adversely affect the instruction and comprehension of the subject matter. In addition to qualifications, there are various other factors that can influence students' academic success in Mathematics, either in a positive or negative manner¹¹.

The National Policy on Education of Nigeria outlines essential subjects alongside elective courses that students are required to undertake. All students are required to study the core subjects, regardless of their aptitude for them. Mathematics stands as a fundamental discipline. To advance their education in higher learning institutions, particularly in Colleges of Education and Universities, students are required to achieve a credit pass in Mathematics. This is especially crucial for those pursuing science, management, and many social science courses. This positions Mathematics as a crucial subject for the progression of students. The significance of Mathematics is two-fold. The advancement of science is crucial; it enhances our

comprehension of the universe's mechanisms in today's world and is significant for personal growth, both intellectually and professionally¹².

Mathematics is recognised globally as a fundamental instrument across various domains, such as natural science, engineering, medicine, and the social sciences. Applied Mathematics encompasses the area of Mathematics that focuses on utilising mathematical principles in various domains. This field not only draws inspiration from new mathematical findings but also can result in the creation of entirely new mathematical areas, including statistics and game theory. Every branch of science, including physics, chemistry, biology, astronomy, engineering, aeronautics, transportation, and communication, necessitates that the individual studying it gain a comprehensive understanding of Mathematics to grasp the theories of the subject effectively. A significant number of scientific theories are grounded in mathematical concepts¹³

2.1.2 Student Achievement in Algebraic Expressions

Algebra has consistently been a fundamental area of study within Mathematics globally. A total of 65 countries worldwide, including Malaysia, have agreed on this fact through their participation in the Programme for International Student Assessment (PISA). This is likely because algebra serves as a gateway to the expansion of intricate arithmetic expressions, facilitating a significant transition from tangible to abstract ideas in the study of Mathematics. The positioning of algebra as a subject within the Mathematics curriculum in schools can vary significantly. Some countries may present it as part of an integrated syllabus, whereas others might treat it as a distinct strand alongside other areas such as arithmetic and geometry⁵. Algebraic expressions form a core part of Mathematics curriculum at all educational levels. Despite its importance, students in Nigeria particularly in Federal Colleges of Education, often

exhibit poor achievement in the area. Traditional methods of instruction appear inadequate in facilitating meaningful understanding and engagement.

Algebra is incorporated into the Mathematics curriculum through various chapters. Students are initially introduced to the subject at the primary school level, with the syllabus evolving into more comprehensive and advanced stages at the secondary school level. To achieve a high level of proficiency in Mathematics, students typically need to attend Mathematics classes for a minimum of four to five periods each week. Despite the generally respected syllabus, the average Mathematics achievement in Malaysia, as indicated by the Trends in International Mathematics and Science Study (TIMSS), continues to fall significantly short compared to other Asian countries like Japan, Hong Kong, Korea, and Singapore⁸.

Additionally, Malaysia has consistently struggled in Mathematics in PISA assessments, notably ranking among the lowest performers in 2012, falling below the 50th position alongside countries like Colombia, Peru, and Albania. Furthermore, the examination of TIMSS-2007 revealed that Malaysia achieved the lowest score, recording only 24% and 2.1 points. This position is significantly beneath the International Average Score of 34% and 0.3 points, resulting in a last-place finish, trailing even behind Thailand and Indonesia. In Malaysia, the situation deteriorates due to insufficient data, hindering the ability to explore the factors influencing Mathematics achievement, particularly at the secondary school level⁹. This has resulted in increased interest among various stakeholders to explore students' academic achievement in Mathematics, given that the subject has consistently been linked to enhanced employment opportunities, improved wages, and greater productivity in the workplace. For this reason, it is crucial to identify the factors that influence students' Mathematics achievement, to facilitate effective progression and forecasting for the future concerning mathematical decisions.

This paper concentrated exclusively on equity, examining two specific dimensions: gender and types of schools¹³. Every student possesses distinct characteristics when it comes to the process of knowledge acquisition in learning. Regarding outcomes, student achievement might be lacking, not solely due to a deficiency in skills, but rather because they have not effectively maximised their abilities⁹³. It has been suggested that measuring student achievement in Mathematics is crucial, as achievement in high school can significantly impact their Mathematics success at the tertiary level¹⁴. Additionally, the Centre for the Study of Testing, Evaluation, and Educational Policy (SCTEEP) at Boston College indicates that a Mathematics test is utilised to represent students' overall achievement in a non-hierarchical manner. Therefore, compiling a student's comprehensive results could serve as an effective initial step to evaluate and draw out a broader spectrum of skills in algebra. As noted earlier, it has been observed that the academic achievement of Malaysian students, especially in Mathematics, is experiencing a significant decline. The analysis indicated that Malaysia ranked 10th among 38 participating countries, achieving an average score of 519 points¹⁸.

Malaysia achieved its highest ranking, initially placing 16th out of 46 countries with an average score of 508 points. However, it subsequently dropped to 20th place out of 50 participating countries, with a score of 474 points. The situation deteriorated further as Malaysia fell to 26th place with 440 points, and its achievement in PISA worsened, ranking 57th in Mathematics among 74 participating countries. It is a well-established fact that Malaysian students are encountering challenges in Mathematics proficiency, and there is much to discuss regarding their achievement in Mathematics, both in comparison to their peers globally and within neighbouring countries²⁰.

The difference was clear when a comparison is drawn with Singapore, our nearest neighbour. Research indicated that over 50 percent of students in Singapore achieved scores

exceeding the average of 603, whereas only 10 percent of students in Malaysia reached that benchmark in the same examination. Through a comparative analysis of the subjects assessed in TIMSS, including geometry, measurement, fractions, and algebra, it was observed that students from Singapore consistently achieved significantly higher scores than their Malaysian counterparts, irrespective of gender.

The findings indicated that girls consistently surpass boys across all tested areas, with girls achieving an average score of 53.0, whereas boys typically maintain an average of 47.0 in Mathematics, which is experiencing a significant decline. Additionally, as noted by the Centre for the Study of Testing, Evaluation, and Educational Policy (SCTEEP) at Boston College, a Mathematics test can serve as a valuable tool in compiling a student's overall achievement, potentially providing the necessary impetus to evaluate and draw out a broader spectrum of skills in algebra¹⁵.

Through a comparative analysis of the subjects assessed in TIMSS, including geometry, measurement, fractions, and algebra, it was observed that students from Singapore consistently achieved significantly higher scores than their Malaysian counterparts, irrespective of gender. Results indicated that girls consistently outperformed boys across all tested areas, with girls achieving an average mean of 53.0, while boys typically remain around¹⁶. Every student possesses distinct characteristics when it comes to the process of knowledge acquisition in learning. Regarding outcomes, student achievement might be lacking, not solely due to a deficiency in skills, but rather because they have not effectively harnessed their abilities. It has been suggested that measuring student achievement in Mathematics is crucial, as achievement in high school can significantly impact their Mathematics success at the tertiary level¹⁷.

The difference was evident when a comparison is drawn with Singapore, our nearest neighbour. Research indicated that over 50 percent of students in Singapore achieved scores

exceeding the average of 603, whereas only 10 percent of students in Malaysia were able to do the same in the same examination²³. Through a comparative analysis of the subjects assessed in TIMSS, including geometry, measurement, fractions, and algebra, it was determined that Singaporean students consistently achieved significantly higher scores than their Malaysian counterparts, irrespective of gender. Results indicated that girls consistently outperformed boys across all tested areas, with girls achieving an average mean of 53.0, while boys typically scored around a lower average²⁵.

Achieving proficiency in algebraic expressions is fundamental for students as it forms the cornerstone of their mathematical journey. In this comprehensive exploration, we delve deeply into the concept of students' academic achievements in algebraic expressions, elucidating its intricacies, significance, and practical applications. Algebraic expressions represent mathematical relationships using variables, constants, and operations such as addition, subtraction, multiplication, division, and exponentiation. At its core, mastering algebraic expressions empowers students to solve problems, analyse patterns, and make predictions across various disciplines²⁶.

Foundational Understanding

To excel in algebraic expressions, students must grasp foundational concepts. Variables symbolize unknown quantities, constants remain fixed, coefficients scale variables, and exponents denote repeated multiplication. Understanding these elements facilitates the manipulation and interpretation of algebraic expressions²³.

Simplification and Evaluation

Simplifying algebraic expressions involves combining like terms, distributing operations, and adhering to the order of operations (PEMDAS/BODMAS). Proficient students streamline expressions to their simplest form, facilitating easier analysis and calculation.

Additionally, they evaluate expressions for specific values, aiding in problem-solving and real-world applications²⁶.

Translating Word Problems

Proficiency in algebraic expressions extends to translating word problems into mathematical expressions and equations. Students adeptly extract relevant information, assign variables to unknowns, and construct equations that accurately model the problem's constraints and objectives. This skill is crucial for tackling real-world scenarios across diverse domains.

Equation Solving and Inequalities:

Mastery in algebraic expressions empowers students to solve equations and inequalities efficiently. Whether linear, quadratic, or rational, proficient students employ systematic approaches to isolate variables, apply inverse operations, and derive solutions. Solving equations is not merely computational but fosters logical reasoning and problem-solving prowess.

Graphing and Visual Representation:

Understanding how algebraic expressions translate into graphical representations is pivotal. Proficient students analyse the behaviour of functions, discerning how changes in coefficients and constants affect graph characteristics such as slope, intercepts, and curvature. Graphical comprehension enhances intuition and aids in interpreting mathematical relationships visually.

Applications in Real-World Context

Algebraic expressions find myriad applications in real-world contexts, from physics to finance. Proficient students adeptly model and solve practical problems, leveraging algebraic techniques to analyse data, optimize processes, and make informed decisions. The ability to

bridge abstract concepts with concrete scenarios underscores the relevance and utility of algebraic proficiency.

Critical Thinking and Problem-Solving

Mastery in algebraic expressions cultivates critical thinking and problem-solving skills. Proficient students dissect complex problems, identify relevant information, and devise strategic approaches for resolution. This entails logical reasoning, pattern recognition, and adaptability an essential toolkit for navigating mathematical challenges and beyond.

Effective Communication of Mathematical Reasoning

Articulating mathematical reasoning is paramount for proficient students. Clear and coherent communication elucidates problem-solving strategies, justifies mathematical decisions, and fosters collaboration and understanding. Proficiency in algebraic expressions entails articulating ideas concisely, employing precise notation, and engaging in constructive discourse.

Achieving proficiency in algebraic expressions is a multifaceted endeavour that transcends computational prowess. It encompasses conceptual understanding, problem-solving acumen, and real-world application. By nurturing these skills, educators empower students to navigate mathematical landscapes with confidence, unlocking a world of analytical possibilities and intellectual growth.

2.1.3 Concept of Algebraic Expressions

Algebra represents a fascinating and engaging area of Mathematics where numbers, shapes, and letters come together to articulate problems. In the process of studying algebra or analysing a specific test, one will observe that nearly all mathematical problems are articulated

in verbal form. Consequently, translating written word problems into algebraic expressions becomes essential when we seek to solve them. Many algebraic word problems are based on real-life scenarios or narratives. Some are straightforward expressions like the explanation of a mathematical issue. This article will explore the process of constructing algebraic expressions from straightforward word problems and subsequently progress to moderately complex word problems²⁹.

Algebraic expressions represent the concept of conveying numerical values through the use of letters or symbols, without indicating their precise quantities. The fundamentals of algebra introduce the concept of representing an unknown quantity with variables like x , y , z , and so forth. These letters are referred to as variables. An algebraic expression consists of a combination of variables and constants. A value that precedes and is multiplied by a variable is known as a coefficient³⁰.

An algebraic expression in Mathematics consists of variables and constants combined through algebraic operations such as addition and subtraction. Expressions consist of various terms. Additionally, engage with the questions presented in the Algebraic Expressions Worksheets available at BYJU'S. Algebraic expressions represent mathematical statements formed by applying operations like addition, subtraction, multiplication, and division to variables and constants. For instance, consider a scenario where James and Natalie engaged in an activity with matchsticks, aiming to create number patterns through their arrangement. James utilised four matchsticks to create the numeral 4. Natalie incorporated three additional matchsticks to create a configuration featuring two 4's.

They discovered that by adding 3 matchsticks in each round, they could create an additional "four". Based on their analysis, they determined that a total of $4 + 3(n-1)$ sticks is required, in general, to create a pattern consisting of n instances of 4's. In this context, $4 + 3(n -$

1) is referred to as an algebraic expression³¹. An algebraic expression, also known as a variable expression, consists of a combination of terms linked by operations such as addition, subtraction, multiplication, and division. Consider the expression $5x + 7$ as a case study. Therefore, it can be concluded that $5x + 7$ serves as an illustration of an algebraic expression. Below are additional instances:

- $5x + 4y + 10$
- $2x^2y - 3xy^2$
- $(-a + 4b)^2 + 6ab$

How to Solve Algebraic Expression?

The objective of resolving an algebraic expression within an equation is to identify the unknown variable. Equating two expressions results in an equation, which facilitates the process of solving for unknown terms? To address an equation, arrange the variables on one side while positioning the constants on the opposite side. Isolating the variables can be achieved through the application of various arithmetic operations such as addition, subtraction, multiplication, division, square root, and cube root, among others. An algebraic expression is consistently interchangeable. This indicates that the equation can be rewritten by swapping the left-hand side and the right-hand side³².

Example 1

Calculate the value of x in the following equation.

$$5x + 10 = 50$$

Solution

This given equation is $5x + 10 = 50$.

- Isolate the variables and the constants;
- You can keep the variable on the LHS and the constants on the RHS.

$$5x = 50 - 10$$

Subtract the constants;

$$5x = 40$$

Divide both sides by the coefficient of the variable;

$$x = 40/5 = 8$$

Therefore, the value of x is 8.

Example 2

Find the value of the y when $5y + 45 = 100$.

Solution

Isolate the variables from the constants;

$$5y = 100 - 45$$

$$5y = 55$$

Divide both sides by the coefficient;

$$y = 55/5$$

$$y = 11$$

Example 3

Determine the value of the variable in the following equation:

$$2x + 40 = 30$$

Solution

Separate the variables from the constants;

$$2x = 30 - 40$$

$$2x = -10$$

Divide both sides by 2;

$$x = -5$$

Example 4

Find t when $6t + 5 = 3$.

Solution

Separate the constants from the variable,

$$6t = 5 - 3$$

$$6t = -2$$

Divide both sides by the coefficient,

$$t = -2/6$$

Simplify the fraction,

$$t = -1/3$$

Variables, Coefficient & Constant in Algebraic Expressions

In Algebra we work with Variable, Symbols or Letters whose value is unknown to us.

In the above expression (i.e. $5x - 3$),

x is a variable, whose value is unknown to us which can take any value.

5 is known as the coefficient of x , as it is a constant value used with the variable term and is well defined.

3 is the constant value term that has a definite value.

The whole expression is known to be the Binomial term, as it has two unlikely terms.

Types of Algebraic expression

There are 3 main types of algebraic expressions which include:

Monomial Expression

Binomial Expression

Polynomial Expression

Monomial Expression

An algebraic expression which is having only one term is known as a monomial.

Examples of monomial expressions include $3x^4$, $3xy$, $3x$, $8y$, etc.

Binomial Expression

A binomial expression is an algebraic expression which is having two terms, which are unlike. Examples of binomial include $5xy + 8$, $xyz + x^3$, etc.

Polynomial Expression

In general, an expression with more than one term with non-negative integral exponents of a variable is known as a polynomial. Examples of polynomial expression include $ax + by + ca$, $x^3 + 2x + 3$, etc.

Other Types of Expression

Apart from monomial, binomial and polynomial types of expressions, an algebraic expression can also be classified into two additional types which are:

Numeric Expression

Variable Expression

Numeric Expression

A numeric expression consists of numbers and operations, but never includes any variable. Some of the examples of numeric expressions are $10 + 5$, $15 \div 2$, etc.

Variable Expression

A variable expression is an expression that contains variables along with numbers and operation to define an expression. A few examples of a variable expression include $4x + y$, $5ab + 33$, etc.

Algebraic Expression for Class 7

In Class 7, students will come across the terms of algebraic equations such as: Coefficient of a term; Variables; Constant; Factors of a term; Terms of equations; like and unlike terms. Examples of using these terms are given below.

If $2x^2 + 3xy + 4x + 7$ is an algebraic expression

Then, $2x^2$, $3xy$, $4x$ and 7 are the terms

Coefficient of term $x^2 = 2$

Constant term = 7

Example of like and unlike terms:

Like terms: $2x$ and $3x$

Unlike terms: $2x$ and $3y$

Factors of a term:

If $3xy$ is a term, then its factors are 3 , x and y .

Monomial, Binomial & Trinomial

Also, in grade 7 we will learn about types of expressions, such as monomial, binomial and trinomial. Let us see examples of each.

Monomial: $2x$

Binomial: $2x+3y$

Trinomial: $2x+3y+9$

Addition and Subtraction of Algebraic Expressions

We can add and subtract like terms easily. Example: Add $3x + 5y - 6z$ and $x - 4y + 2z$.

By adding both the expressions we get; $(3x + 5y - 6z) + (x - 4y + 2z)$

Separating the like terms and adding them together: $(3x + x) + (5y - 4y) + (-6z + 2z)$

$$4x + y - 4z$$

Formulas

The general algebraic formulas we use to solve the expressions or equations are:

- $(a + b)^2 = a^2 + 2ab + b^2$
- $(a - b)^2 = a^2 - 2ab + b^2$
- $a^2 - b^2 = (a - b)(a + b)$
- $(a + b)^3 = a^3 + b^3 + 3ab(a + b)$
- $(a - b)^3 = a^3 - b^3 - 3ab(a - b)$
- $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$
- $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$

Variables: Variables are symbols used to represent unknown or varying quantities. They are typically denoted by letters such as x , y , a , b , etc. Variables can represent a wide range of quantities, such as measurements, quantities of items, or values that can change over time or in different scenarios. For example, in the expression $3x + 2y$, x and y are variables.

Coefficients: Coefficients are the numerical constants that are multiplied by variables in an expression. They represent the scaling factor by which the variable is multiplied. For instance, in the expression $3x$, the coefficient is 3, which means x is multiplied by 3. Similarly, in $2y$, the coefficient is 2.

Constants: Constants are fixed numerical values that do not change within an expression. They can be whole numbers, fractions, decimals, or even irrational numbers. For example, in

the expression (5) , 5 is a constant. Constants can also appear alongside variables in expressions, such as in $(2x + 5)$, where 5 is a constant.

Operators or Mathematical Operations: These are symbols that indicate the mathematical operations to be performed on the variables, coefficients, and constants within an expression. The basic mathematical operations include:

- Addition (+): Combines two or more quantities.
- Subtraction (-): Finds the difference between two quantities.
- Multiplication ($\times$): Multiplies two or more quantities.
- Division ($\div$): Divides one quantity by another.
- Exponentiation ($^$): Raises a quantity to a power.

Exponents: Exponents are numbers that indicate how many times a variable or constant is multiplied by itself. They are written as superscripts. For instance, in the expression (x^2) , the exponent is 2, indicating that (x) is multiplied by itself two times. Exponents are used to represent repeated multiplication, and they play a crucial role in algebraic expressions, particularly when dealing with powers and polynomials.

Algebraic expressions can vary in complexity, ranging from simple linear expressions like $(3x + 2)$ to more intricate polynomial expressions or rational expressions involving fractions and exponents. They are used extensively in algebra to model real-world situations, solve equations, analyse mathematical relationships, and make predictions in various fields such as physics, engineering, economics, and computer science. Understanding algebraic expressions is essential for developing problem-solving skills and mathematical reasoning abilities⁴⁰.

2.1.4 Class-wide Peer tutoring

Lecturers of science subjects especially Mathematics at all educational levels can hardly say that it is well with teaching and learning of Mathematics. The teacher as the pivot of the teaching and learning process is expected to use measures that would be favourable for classroom activities, and create a conducive environment for meaningful interaction between teacher-students, students-students and learning contents in the classroom. This can only be achieved with innovative teaching methods. One of the innovative teaching methods that can be employed by Lecturers of Mathematics in this present 21st century is known as Class-wide Peer tutoring model. Scholars that researched on Class-wide Peer tutoring approach model said that an alternative method of teaching that support learners' Centre is Class-wide Peer tutoring strategies¹.

Across the entire class peer tutoring, also referred to as peer mentoring, is an instructional approach that involves pairing high-performing students with lower-performing students in a classroom setting or in a shared environment outside of school, all under the guidance of a lecturer. The terms “tutoring” and “mentoring” will be considered interchangeable, as the role of a tutor encompasses fostering a supportive and encouraging relationship with the tutee. There is ample evidence supporting the advantages of Class-wide Peer tutoring as an enhancement to conventional teaching methods².

Peer mentoring has been implemented in various higher education institutions and has demonstrated improvements in academic achievement for a diverse group of learners across a broad spectrum of content areas. The approach proves to be beneficial for understanding algebraic expressions, promoting an inclusive learning environment that avoids stigmatisation and alienation of students. When Class-wide Peer tutoring is effectively executed in a classroom environment, learners can engage with the curriculum at their unique learning levels, employing strategies customised for each mentee³.

Across the entire class Peer tutoring fosters advanced cognitive processes through detailed explanations of concepts, the implementation of high-level questioning, and the application of effective communication skills. Peer tutors can help tutees to grasp concepts that were previously covered in a conventional module environment and enhance their understanding by employing advanced cognitive skills.

The implementation of peer mentoring had a positive impact on social self-concepts and behavioural outcomes. Reduction in disruptive behaviour and enhancement of social interactions among peers from diverse cultural and developmental background across the entire class Peer tutoring enhances students' internal sense of responsibility for their achievements and improves their capacity to accept constructive feedback from their tutors. As a result, educating students in a comprehensive manner Peer tutoring strategies can help students take ownership of their learning and enhance their capacity to acknowledge and accept accountability for academic setbacks⁴.

Two primary forms of Class-wide Peer tutoring exist: Incidental Class-wide Peer tutoring (IPT) and Structured Peer Tutoring (SPT). Incidental class-wide peer tutoring occurs in both school and home settings during social interactions among peers. In instances where children engage with one another, whether through play or study, one often takes on the role of guiding the other. Class-wide Peer tutoring (CWPT) involves the implementation of peer tutoring in targeted instances and for designated subjects, adhering to a meticulously organised plan developed by the educator. Studies indicate that a range of structured peer tutoring programs are effective in the teaching and learning of Mathematics, including Class-wide Peer tutoring (CWPT),

Peer Assisted Learning Strategies (PALS), and reciprocal Same-age Peer tutoring (SAPT) ⁵. Effective peer tutoring strategies often incorporate various materials, reward systems,

and reinforcement techniques, yet fundamentally, they possess certain common characteristics. Nevertheless, across the entire class the approach implemented in this study involves organising the entire class into groups of two to six students, each with varying ability levels.

CWPT is an instructional strategy designed to help educators tailor their teaching while ensuring that students have plenty of chances to engage actively in classroom activities, where they can take on the roles of both tutors and tutees. CWPT encompasses meticulously organised procedures, direct rehearsal, and competitive teams. Effective communication and collaboration are integral elements of CWPT and are crucial for achieving success in learning. Through dialogue and the exploration of diverse perspectives, students develop knowledge, skills, strategic thinking, self-determination, and empathy⁶.

Collaborative learning provides learners with significant advantages that are not accessible through traditional methods. Collaborative learning groups facilitate significant understanding and effectively address challenges more efficiently than any single individual could achieve independently. Problem-solving is a process where the learner identifies a combination of previously acquired rules that can be utilised to find a solution for a new situation. Problem-solving is fundamental to physics and represents a sophisticated learning process that employs a hierarchical structure and previously acquired simplex methods to visualise, imagine, manipulate, analyse, and connect concepts. Problem-solving can be seen as an educational approach or a cohesive activity that starts with a challenging situation and concludes once the issue has been resolved and the circumstances evaluated⁷.

Mathematical problem-solving is a fundamental skill essential for learners and represents a higher-order cognitive process required to tackle Mathematics problems. When learners are actively engaged in the educational process and participate fully, they tend to achieve a deeper understanding and replicate the successes they have experienced when faced

with similar or related challenges. It involves the capacity to utilise mathematical skills and concepts across various scenarios. The skills acquired in Physics, particularly in mathematical problem-solving, engage students in addressing computational challenges with clear solutions while also offering them valuable experience in tackling open-ended problems⁸.

Furthermore, observed that females that want to study sciences and related courses often complain that traditional methods do not fit their learning styles. Perhaps, one possible way to improve students' academic achievement and encouraging female's participation and achievement in science is to address the issue of instructional practice in educational system especially at secondary school level. Several studies such as those of have shown differential achievement in science subjects in secondary schools as a result of gender, while some other studies found no gender influences on achievement at the secondary school level⁸.

As a result, this challenging situation necessitates the development of learners' problem-solving skills and the introduction of innovative teaching methods. The class-wide peer tutoring strategy warrants experimentation in classroom instruction to assess its effectiveness on students' mathematical problem-solving achievement in electrical concepts within Physics. Merely placing students with disabilities in an inclusion classroom does not guarantee they will overcome their learning challenges. The key factor is providing instruction that employs evidence-based practices, tailored to promote the success of each student as an individual⁷.

One strategy that could enhance opportunities and foster a more interactive learning experience for students in inclusive classrooms is Class-wide The study examined the effects of Collaborative Work Peer Tutoring (CWPT) on students with moderate and severe disabilities in various subjects within general junior high school classes. A multiple probe across subject design was employed to assess the effectiveness of CWPT for both students with and without

disabilities. After the baseline period, students engaged in CWPT during their pre-algebra, gym, and history classes^{5, 6}.

The findings indicate that CWPT has the potential to enhance academic engagement and could foster a more interactive learning environment for all learners. CWPT, created by two experts and an elementary school teacher, seeks to enhance teaching methods for urban minority students and individuals with disabilities. Much of the initial investigation concentrated on specific content domains, including spelling, reading, and fundamental math facts. CWPT has the potential to provide numerous instructional advantages for students, including enhanced engagement and opportunities for responses, individualised interaction, constructive social interactions with peers, and more chances for error correction.

During CWPT, students may collaborate with partners or in small groups, resulting in non-classified students gaining the additional advantage of learning to engage with a more diverse population. Utilising classroom peers can lead to positive outcomes in an inclusive educational setting. Engagement among students plays a vital role in the educational experience. The potential advantages of CWPT include enhanced opportunities for student response and engagement, leading to greater possibilities for academic success and growth³.

When implemented as a tailored lesson plan, CWPT showed great promise for boosting students' level of active participation. The fact that CWPT increases students' time on task and their level of active involvement implies it can be a highly beneficial tool for educators. The utilisation of CWPT has also been shown to improve students' achievement in the classroom. Several studies have shown that CWPT has the ability to help spell words correctly. It tested the impact of CWPT on the accuracy rate of word spelling using an ABAB design. It was concluded that CWPT may produce beneficial outcomes in the domain of spelling for children

with learning impairments because all three of the participating students demonstrated academic progress throughout the CWPT intervention¹.

In addition to its promise in Mathematics and literacy, CWPT has demonstrated promise in teaching reading strategies and raising literacy rates. The impact of PALS on special education courses in high school was investigated using a hybrid CWPT technique. Students' abilities to understand what they read were the primary focus of the study, which took place in ten high schools and eighteen special education classes. Results were inconsistent, although PALS did appear to have promise for improving students' reading comprehension. Indicate that, in comparison to conventional classroom teaching, PALS could provide better outcomes for secondary school students reading at a level between second and sixth grade^{10, 11}.

The implementation of CWPT in teaching algebra problem-solving skills produced varied outcomes. The findings indicate that CWPT demonstrates effectiveness comparable to that of independent practice. Additionally, it was observed that CWPT effectively facilitated the development of higher-order problem-solving skills. CWPT has been effectively utilised across diverse classroom environments, demonstrating its ease of implementation. It can seamlessly integrate with the current curriculum and available instructional materials. The fundamental procedures of CWPT consist of arranging the class into pairs of tutors and tutees, as well as splitting the class into two teams. Each team has the opportunity to accumulate points by accurately responding to questions or effectively executing the tutoring process⁷.

The CWPT process typically occurs in thirty-minute segments, allowing each student to engage in ten minutes of tutoring, followed by a review period of five to ten minutes dedicated to individual and team scoring assessments. The team aspect of CWPT facilitates both individual and collective responsibility, which is a crucial element of cooperative learning. The

presence of team goals is believed to enhance the cooperative learning experience by fostering interdependence among students for achieving success⁴.

Student pairings can be determined by first ranking the class based on the skill to be assessed. The list is then divided in half, pairing the highest performing student with the lowest performing student, the second highest with the second lowest, and continuing this pattern. Clearly establishing and modelling each step of the tutoring process is crucial for teachers. Both tutors and tutees must have well-defined roles and expectations, which encompass providing feedback, correcting answers, maintaining student focus, and offering praise⁸. Adhering to CWPT procedures can result in an environment where the activity's structure enhances student engagement, facilitates peer supervision, and empowers the teacher to adopt a more supportive and supervisory role. It is essential for each student to fulfil the roles of both tutor and tutee. CWPT has shown effectiveness in enhancing the positive social interactions among students with disabilities⁵.

Across the entire class Peer tutoring (CWPT) represents a distinct approach to peer-mediated instruction, implemented across elementary, middle, and high school educational settings. In CWPT, pairs of students alternate between the roles of tutor and student. Participants accumulate points for their respective teams through engagement in tutoring activities, with the victorious team receiving acknowledgement. Investigations have been conducted on the effectiveness of CWPT across various academic fields. Class-wide Peer tutoring (CWPT) is a method of peer-mediated instruction in which the educator organises pairs of students to take turns as tutor and learner. The instructor poses enquiries, notes key aspects, and offers evaluations on the alignment of the student's answers with the correct responses established by the educator. The student articulates responses both verbally and in

written form to the enquiries and engages in practicing the correct answer three times whenever mistakes occur⁸.

The instructor oversees the tutoring sessions and allocates points for effective tutoring achievement. Students in a classroom are organised into pairs that form two teams. They accumulate points for their teams by providing correct answers, rectifying any mistakes, and offering effective tutoring to one another. At the conclusion of the week, the team that accumulates the highest number of points is acknowledged as the victorious team. CWPT has been utilised to assist students in mastering spelling, fundamental principles of Mathematics, foundational word recognition, reading proficiency, vocabulary development, and information pertinent to a specific field of study. It seems that there are a greater number of published studies on CWPT demonstrating positive results specifically in the domain of spelling compared to other fields. The CWPT technique has been applied across various age groups, including pre-school, elementary, middle school, and high school students. CWPT was first developed and studied in the early 1980s at the Juniper Gardens Children's Project at the University of Kansas⁶.

CWPT has demonstrated effectiveness in teaching spelling to students in general education as well as those with attention deficit hyperactivity disorder (ADHD), mild intellectual disabilities, and learning disabilities. CWPT has contributed to enhancing sight word retention and reading fluency among students with varying levels of school achievement, including those with average achievement, low achievement, and learning disabilities. CWPT has demonstrated an enhancement in math fact fluency for both students with and without disabilities, and it has led to improved math achievement scores among middle school students diagnosed with ADHD.

Evidence suggests that CWPT aids learners across various age groups in acquiring knowledge, including health and safety information, historical content, and concepts in social studies. CWPT has been recorded to positively influence the social skills and frequency of social interactions among students with mild disabilities and high functioning autism. Research demonstrates the effectiveness of CWPT in teaching students across various ages and ability levels essential physical skills, including catching, striking a ball with a paddle, and cardio-pulmonary resuscitation skills³.

The United States Department of Education's What Works Clearinghouse has assessed the efficacy of CWPT in General Reading Achievement and English Language Learning (ELL). The reviews yielded a "potentially positive" effectiveness rating for General Reading Achievement among elementary school kids, while no rating was assigned for ELL, as no studies matched the What Works Clearinghouse evaluation requirements. The What Works Clearinghouse presently does not offer reports on the effectiveness of CWPT in any further domains. Promising Practices Network regards CWPT as a "Proven Program"⁶.

Class-wide peer tutoring in algebraic expressions is an instructional strategy that leverages the collective knowledge and skills of students within a classroom setting to enhance learning outcomes. This approach involves students working collaboratively in pairs or small groups, with one student assuming the role of tutor while the other serves as the tutee. Through this process, students engage in active learning, peer interaction, and reciprocal teaching, which can lead to deeper conceptual understanding and improved academic achievement in algebraic expressions. This paper provides a comprehensive exploration of the concept of Class-wide Peer tutoring in algebraic expressions, including its theoretical foundations, implementation strategies, benefits, challenges, and recommendations for effective implementation¹.

Algebraic reasoning serves as a cornerstone in the mathematical development of students, yet its abstract nature often presents challenges in comprehension and mastery. To address these challenges, educators have turned to innovative instructional strategies, including Class-wide Peer tutoring. This comprehensive exploration delves into the concept of Class-wide Peer tutoring in algebraic expressions, examining its theoretical foundations, practical implementation strategies, benefits, challenges, and implications for teaching and learning. Drawing upon research in education, psychology, and pedagogy, this paper aims to provide educators with a deep understanding of how Class-wide Peer tutoring can enhance algebraic learning experiences and empower students to become active participants in their mathematical journey⁸.

Class-wide Peer tutoring in algebraic expressions is a valuable instructional strategy that promotes collaborative learning and enhances students' understanding of mathematical concepts. By harnessing the power of peer interaction and support, CWPT creates opportunities for meaningful engagement and knowledge construction. While challenges may arise in implementation, thoughtful planning, teacher support, and a focus on fostering positive group dynamics can help overcome obstacles and maximize the benefits of CWPT for both tutors and tutees¹.

Algebraic expressions are fundamental to Mathematics education, serving as building blocks for more advanced mathematical concepts. However, many students struggle with understanding and manipulating algebraic expressions, leading to academic challenges and a lack of confidence in math. Class-wide Peer tutoring offers a promising approach to address these issues by fostering collaborative learning environments where students actively engage with the material and support one another's learning⁵.

Algebra, often considered the gateway to higher Mathematics, stands as a crucial pillar in the realm of mathematical education. Its concepts form the backbone of problem-solving strategies, critical thinking skills, and logical reasoning abilities. However, the abstract nature of algebraic expressions, equations, and functions can pose significant challenges for many students, leading to a sense of apprehension and disengagement in the learning process. In response to these challenges, educators have continuously sought innovative pedagogical approaches to make algebra more accessible, engaging, and comprehensible for learners of varying abilities and backgrounds⁸.

Class-wide Peer tutoring in algebraic expressions emerges as a promising instructional strategy rooted in the principles of social constructivism and collaborative learning. By harnessing the collective expertise and support of peers, this approach seeks to democratize the learning experience, empowering students to take an active role in their mathematical journey. Through structured pairings, guided interactions, and reflective practices, Class-wide Peer tutoring fosters a dynamic learning environment where students not only deepen their understanding of algebraic concepts but also cultivate essential communication, collaboration, and problem-solving skills².

In this comprehensive exploration, we delve into the concept of Class-wide Peer tutoring in algebraic expressions, examining its theoretical underpinnings, practical implementation strategies, and potential benefits and challenges. By elucidating the intricacies of this pedagogical approach, we aim to equip educators with the knowledge and tools necessary to harness the transformative power of peer learning in the realm of algebraic education. From the foundational principles of peer interaction to the nuanced dynamics of group collaboration, this investigation seeks to illuminate the path towards fostering a vibrant community of learners who thrive in their exploration and mastery of algebraic reasoning⁸.

CWPT draws on various theoretical frameworks, including social constructivism, cognitive apprenticeship, and Vygotsky's Zone of Proximal Development (ZPD). Social constructivism posits that learning is a social process facilitated by interaction with others and participation in meaningful activities. CWPT capitalizes on this principle by promoting peer interaction and collaborative problem-solving. Cognitive apprenticeship theory emphasizes the importance of modelling, coaching, and scaffolding in the learning process. In CWPT, more knowledgeable peers serve as tutors, guiding their classmates through algebraic problems and providing support as needed. Vygotsky's ZPD highlights the role of social interaction in advancing students' learning beyond their individual capabilities. Through CWPT, students operate within their ZPD, receiving assistance and guidance from peers to solve algebraic problems that may initially exceed their individual competence³.

Effective implementation of CWPT in algebraic expressions requires careful planning and consideration of various factors. Teachers typically begin by grouping students heterogeneously to ensure a balance of abilities within each tutoring pair or team. Clear expectations and guidelines for tutoring sessions are established to promote accountability and engagement. Teachers may provide initial instruction on algebraic concepts and problem-solving strategies before implementing CWPT to ensure that students have the necessary background knowledge. During tutoring sessions, students take turns serving as tutors and tutees, with tutors guiding their peers through problems, asking probing questions, and providing feedback. Teachers monitor and facilitate the tutoring process, offering support and guidance as needed. Regular reflection and feedback sessions allow students to assess their progress and identify areas for improvement⁸.

CWPT in algebraic expressions offers numerous benefits for both tutors and tutees. For tutors, the act of teaching reinforces their understanding of algebraic concepts and problem-

solving strategies. Explaining concepts to their peers helps tutors consolidate their knowledge and develop communication and leadership skills. Tutees benefit from personalized support and guidance tailored to their individual learning needs. Working with peers can reduce anxiety and increase confidence in tackling algebraic problems. Moreover, CWPT promotes a sense of camaraderie and cooperation among students, fostering a positive classroom climate conducive to learning¹.

Despite its many benefits, CWPT in algebraic expressions may pose challenges in implementation. Group dynamics can impact the effectiveness of tutoring sessions, with conflicts or disparities in skill levels hindering collaboration. Teachers must carefully monitor group interactions and intervene as needed to address issues and maintain a supportive learning environment. Additionally, some students may be reluctant to seek help from their peers due to concerns about judgment or embarrassment. Teachers can mitigate this challenge by fostering a culture of mutual respect and emphasizing the value of collaborative learning. Furthermore, time constraints and curriculum demands may limit the frequency and duration of CWPT sessions, requiring teachers to balance Class-wide Peer tutoring with other instructional activities⁶.

CWPT in algebraic expressions has significant implications for teaching and learning. By leveraging peer interaction and collaboration, this instructional approach promotes active engagement and deeper understanding of algebraic concepts. Students develop not only mathematical proficiency but also communication, teamwork, and problem-solving skills essential for success in academic and real-world contexts. Teachers play a critical role in facilitating CWPT and creating supportive learning environments where students feel empowered to learn from and teach their peers. As such, professional development

opportunities and resources should be provided to help teachers effectively implement CWPT and maximize its impact on student learning outcomes⁸.

In the realm of Class-wide Peer tutoring in algebraic expressions, the roles assumed by both tutors and tutees are pivotal in shaping the dynamics of the learning environment and influencing the outcomes of the instructional strategy. Each role is carefully crafted to foster collaborative learning, scaffold understanding, and promote academic achievement. Let's explore in depth the roles of tutors and tutees in this context:

At the heart of Class-wide Peer tutoring lays the role of the tutor, who serves as a guide, mentor, and facilitator of learning for their peer, the tutee. The tutor's responsibilities encompass a range of tasks aimed at supporting the tutee's comprehension, problem-solving skills, and overall academic growth. First and foremost, the tutor is tasked with guiding the tutee through the intricacies of algebraic problem-solving. This involves breaking down complex problems into manageable steps, articulating clear explanations, and modelling effective problem-solving strategies. By providing step-by-step guidance, the tutor empowers the tutee to approach algebraic problems with confidence and competence¹.

Furthermore, the tutor plays a crucial role in providing explanations that elucidate the underlying concepts and principles of algebra. Through clear and concise explanations, supplemented by visual aids and real-world examples, the tutor helps the tutee develop a deeper understanding of algebraic concepts such as variables, equations, and functions. In addition to guiding problem-solving and providing explanations, the tutor also serves as a model of critical thinking and meta-cognitive awareness. By sharing their own problem-solving processes, reasoning strategies, and thought-provoking questions, the tutor encourages the tutee to engage in reflective practice and develop their own analytical skills⁸.

Moreover, the tutor offers scaffolding support to assist the tutee in overcoming challenges and building upon their existing knowledge. Through targeted hints, prompts, and cues, the tutor helps the tutee navigate obstacles, clarify misconceptions, and make meaningful connections between algebraic concepts. Beyond academic support, the tutor plays a crucial role in fostering a positive and supportive learning environment. By offering praise, encouragement, and constructive feedback, the tutor nurtures the tutee's self-confidence, resilience, and motivation to learn. Through empathetic listening and effective communication, the tutor establishes a rapport with the tutee based on trust, respect, and mutual understanding².

Furthermore, the tutor monitors the tutee's understanding and progress throughout the tutoring session, adjusting their teaching strategies and support interventions accordingly. By assessing the tutee's comprehension levels, identifying areas of difficulty, and providing timely feedback, the tutor ensures that the tutoring experience is tailored to meet the tutee's individual learning needs⁶.

In summary, the tutor's role in Class-wide Peer tutoring in algebraic expressions is multifaceted, encompassing instructional, motivational, and interpersonal dimensions. By assuming the role of a knowledgeable guide and supportive mentor, the tutor empowers the tutee to navigate the complexities of algebra with confidence, competence, and enthusiasm.

Equally integral to the Class-wide Peer tutoring process is the role of the tutee, which actively engages in the learning experience, seeks guidance and support from the tutor, and takes ownership of their academic growth and development. First and foremost, the tutee is responsible for actively participating in the Class-wide Peer tutoring session, demonstrating a willingness to learn, ask questions, and engage in collaborative problem-solving activities. By actively contributing to the learning process, the tutee creates an interactive and dynamic learning environment where knowledge is co-constructed through dialogue and exchange³.

Furthermore, the tutee plays an active role in seeking clarification when faced with challenges or uncertainties. By asking questions, requesting explanations, and expressing their misunderstandings or misconceptions, the tutee demonstrates a commitment to understanding and mastering algebraic concepts. Moreover, the tutee is tasked with applying problem-solving strategies and techniques demonstrated by the tutor. By actively engaging in problem-solving activities, analysing problem contexts, and applying appropriate methods to arrive at solutions, the tutee develops critical thinking skills and mathematical proficiency².

In addition to applying problem-solving strategies, the tutee is responsible for articulating their understanding of algebraic concepts, procedures, and solutions to the tutor. By explaining their reasoning, justifying their solutions, and communicating their thought processes, the tutee demonstrates meta-cognitive awareness and deepens their understanding of algebraic principles⁹.

Furthermore, the tutee receives feedback from the tutor on their problem-solving approaches, solutions, and explanations. By listening attentively to feedback, reflecting on their achievement, and incorporating suggestions for improvement into their learning practices, the tutee engages in a process of continuous learning and growth.

Moreover, the tutee takes ownership of their learning by setting goals, monitoring their progress, and reflecting on their strengths and areas for growth. By actively participating in the Class-wide Peer tutoring process and taking responsibility for their academic success, the tutee develops self-efficacy, self-regulation, and a growth mind-set. Lastly, the tutee's role in Class-wide Peer tutoring in algebraic expressions is characterized by active engagement, inquiry, application, reflection, and ownership of learning. By assuming an active and responsible stance in the learning process, the tutee collaborates with the tutor to co-construct knowledge, deepen understanding, and achieve academic success in algebra⁸.

2.1.5 Problem-solving strategies in Algebraic Expressions

Problem-solving strategies in algebraic expressions encompass a diverse array of techniques and methodologies aimed at effectively navigating the complexities inherent in algebraic equations, inequalities, and word problems. At its core, algebra serves as a powerful tool for modelling real-world phenomena, analysing patterns, and solving problems through the manipulation of symbols and mathematical relationships. In this comprehensive exploration, we delve deeply into the concept of problem-solving strategies in algebraic expressions, elucidating fundamental principles, and delving into advanced methodologies that empower learners to surmount a wide spectrum of algebraic challenges⁹.

Algebra, as a branch of Mathematics, provides a systematic framework for representing relationships between quantities using symbols and expressions. The foundation of algebraic problem-solving lies in the ability to translate verbal descriptions or real-world scenarios into mathematical language, a process known as modelling. This modelling process involves identifying relevant variables, defining their relationships, and formulating equations or inequalities that capture the essence of the problem at hand. By abstracting complex situations into concise algebraic expressions, mathematicians, scientists, engineers, and practitioners across diverse fields can analyse, predict, and optimize outcomes with precision and rigor¹⁰.

Central to the problem-solving process in algebraic expressions is the notion of equation-solving. Equations serve as mathematical statements asserting the equality between two algebraic expressions, typically involving one or more variables. To solve equations, mathematicians employ a variety of techniques, including isolating variables, applying inverse operations, and manipulating expressions to transform the equation into a simpler form. This process often requires careful attention to algebraic properties and principles, such as the

distributive property, the associative property, and the commutative property, which govern the behaviour of mathematical operations¹¹.

One of the fundamental strategies in algebraic problem-solving is the systematic application of algebraic rules and properties to simplify expressions and equations. This entails recognizing patterns, identifying common factors, and leveraging algebraic identities to streamline computations and uncover hidden relationships. For instance, the process of factoring involves decomposing algebraic expressions into their constituent factors, which can reveal underlying symmetries and facilitate further manipulation. By factoring expressions, mathematicians can often identify solutions more efficiently and gain deeper insights into the structure of mathematical objects¹².

Moreover, problem-solving in algebraic expressions necessitates a firm grasp of fundamental concepts such as variables, constants, coefficients, and exponents. Variables represent unknown quantities that can take on different values, while constants are fixed numerical values. Coefficients denote the numerical factors multiplying variables in algebraic terms, influencing their magnitude and direction. Exponents, on the other hand, indicate the number of times a base is multiplied by itself and play a crucial role in expressing repeated multiplication and power relationships¹³.

In addition to equation-solving, algebraic problem-solving encompasses the manipulation of inequalities, which express relationships between quantities that are not necessarily equal. Inequalities are ubiquitous in mathematical modelling, offering a means of representing constraints, bounds, and comparative statements. Strategies for solving inequalities often parallel those for solving equations, with an emphasis on preserving inequality relationships through algebraic operations. Graphical representations, interval notation, and set notation provide alternative perspectives for visualizing and interpreting

solutions to inequalities, offering valuable insights into the behaviour of mathematical systems¹⁴.

Furthermore, problem-solving in algebraic expressions extends beyond symbolic manipulation to encompass analytical reasoning and critical thinking. Mathematicians and problem-solvers must employ deductive reasoning, logical inference, and strategic planning to navigate complex problem spaces and arrive at valid solutions. This entails breaking down problems into manageable subtasks, formulating hypotheses, and testing conjectures through systematic experimentation and validation. By cultivating a mind-set of curiosity, perseverance, and adaptability, learners can tackle challenging algebraic problems with confidence and creativity¹⁵.

An essential aspect of problem-solving in algebraic expressions is the ability to translate between different representations, including symbolic, graphical, numerical, and verbal formats. Each representation offers unique advantages and insights, allowing problem-solvers to approach problems from multiple perspectives and leverage diverse tools and techniques. Graphical representations, such as Cartesian graphs and coordinate planes, provide visualizations of algebraic relationships, facilitating the interpretation of solutions and the discovery of patterns. Numerical methods, including approximation algorithms and iterative techniques, offer computational approaches to solving algebraic problems with numerical precision and efficiency¹⁶.

Moreover, problem-solving in algebraic expressions often involves solving systems of equations, which consist of multiple equations with common variables. Systems of equations arise naturally in various contexts, including optimization problems, equilibrium analysis, and interdisciplinary applications. Techniques for solving systems of equations encompass algebraic methods such as substitution, elimination, and matrix algebra, as well as geometric

interpretations involving intersections of lines and planes in multidimensional space. By systematically solving systems of equations, mathematicians can unravel complex relationships and derive actionable insights from mathematical models¹⁷.

Another crucial aspect of problem-solving in algebraic expressions is the application of algebra to real-world scenarios and practical problems. Algebra serves as a versatile tool for modelling and analysing diverse phenomena across science, engineering, economics, and other fields. By translating real-world problems into algebraic expressions, practitioners can formulate mathematical models, make predictions, and inform decision-making processes. For example, algebraic expressions can be used to model population growth, economic trends, physical phenomena, and engineering systems, providing quantitative frameworks for understanding and addressing complex challenges¹⁸.

Furthermore, problem-solving in algebraic expressions fosters the development of essential skills and competencies, including critical thinking, logical reasoning, and mathematical fluency. By engaging in problem-solving activities, learners strengthen their ability to analyse problems, formulate strategies, and communicate solutions effectively. Collaborative problem-solving promotes teamwork, communication, and collective intelligence, enabling individuals to leverage diverse perspectives and expertise to tackle complex challenges. Moreover, problem-solving experiences cultivate resilience, perseverance, and adaptability, equipping learners with the mind-set and skills needed to thrive in dynamic and uncertain environments¹⁶.

The problem-solving strategies in algebraic expressions encompass a rich tapestry of techniques, methodologies, and principles aimed at empowering learners to navigate the complexities of algebraic equations, inequalities, and word problems. By mastering fundamental concepts, leveraging algebraic properties, and cultivating analytical reasoning

skills, problem-solvers can tackle a wide spectrum of algebraic challenges with confidence and creativity. Through collaborative inquiry, interdisciplinary exploration, and real-world application, algebraic problem-solving becomes not only a means of acquiring mathematical proficiency but also a pathway to deeper understanding, insight, and innovation¹⁵.

Problem solving technique is the process of solving questions that deal with understanding the problem by splitting it into parts, identifying the known and unknowns, proffering a solution method and solving it defined Problem solving technique as a cognitive process directed at transforming a problem from the given state to the goal state when the problem solver is not immediately aware of the solution method. Similarly, stated that great opportunity abound through problem solving technique for the learners to discover their mathematical talents, and further asserted that if the teacher challenges the curiosity of the students by setting problems proportionate to their knowledge and helps them solve their problems with stimulating questions, the teaching may sharpen their thinking ability. It was observed that it is through problem. solving technique that learners' thought-processes can be shared and translated into action, thereby making them to develop confidence in their ability to solve mathematical problems¹⁷.

Problem-solving achievement can be determined based on five broad independent factors, namely knowledge acquisition, and utilization, control, beliefs, as well as social and cultural contexts. Problem-solving skills become important when applying Mathematics in different situations. Students need to integrate the skills and concepts of problem-solving to solve specific mathematical situations. 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.

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 was pointed out other difficulties such as text difficulties, unfamiliar contexts, using inappropriate strategies, and a lack of solving skills. Students are unable to score well in Mathematics examination because they have a lack of algebraic skills that are required for other Mathematics subtopics. Students are required to have Algebraic problem-solving skills when learning and solving algebraic questions so they can better construct algebraic equations to come up with the correct solution¹⁶.

Therefore, actions must be taken to recognize the difficulties that both students and teachers face in learning and teaching Mathematics. If the teacher knows the difficulties experienced by students in learning Mathematics, especially algebra, then the teacher can determine a solution by designing algebraic learning that minimizes the difficulties experienced by students identified the students' difficulties in learning Mathematics revolved around conceptual processing, language, visual-spatial processing, organization, memory, attention, and psychosocial problems. Furthermore, conceptual errors that are always experienced by elementary school students are errors using symbols, general algebraic concepts, the abstract nature of algebra, and precision. Meanwhile, researchers found that students had difficulties translating a word to algebra or vice versa. Students who rely on memorizing rules will misuse or misapply mathematical expressions, especially in algebra. This case leads to problems in learning algebra, as the students fail to solve either word-based or diagram-based algebraic questions¹².

Pattern recognition is a fundamental aspect of problem-solving across various domains including algebra. When students encounter algebraic expressions or equations, they often look for patterns or regularities that can help them simplify or solve the problems. For instance, in quadratic equations, recognizing the pattern of the quadratic formula allows students to generalize the solution method, rather than memorizing individual solutions for different coefficients. By fostering pattern recognition skills, educators enable students to see beyond the surface complexity of algebraic expressions and uncover underlying structures that lead to more efficient problem-solving strategies⁹.

Generalize; on the other hand, involves extending the insights gained from recognizing patterns to solve similar problems. Once students identify a pattern in one problem, they can apply the same reasoning to solve the other problems with analogous structures. This ability to generalize is crucial for developing algebraic fluency, as it allows students to transfer their knowledge and skills to new contexts. For example, if students discover a pattern in a sequence of numbers, they can generalize it to predict future terms in the sequence or solve related problems. Ultimately, pattern recognition and generalization empower students to approach algebraic problem-solving with confidence and flexibility, enabling them to tackle a wide range of mathematical challenges¹⁴.

Meta-cognition, often described as thinking and thinking, plays a central role in effective problem solving. In the context of algebra, meta-cognitive strategies involve monitoring one's thought processes, evaluating the effectiveness of problem-solving strategies, and making adjustments as needed. For example, when solving a complex algebraic equation, students might pause to reflect on their approach, asking themselves questions such as 'is this method working?' or 'Are there alternative strategies I could try'¹⁴?

Encouraging meta-cognitive awareness in algebraic problem-solving empowers students to take ownership of their learning process. By reflecting on their problem-solving experiences, students can identify strengths and areas for improvement, leading to deeper conceptual understanding and more efficient strategies. Meta-cognitive strategies also promote self-regulated learning, as students learn to set goals, plan their approach to problem-solving tasks, and monitor their progress towards achieving those goals¹⁵.

Reflection is a key component of meta-cognition, allowing students to review their problem-solving processes and outcomes. By engaging in reflective practices, students can gain insights into their cognitive strengths and weaknesses, as well as the effectiveness of their problem-solving strategies. For example, after completing a problem-solving task, students might reflect on the strategies they used, the challenges they encountered, and the lessons they learned from the experience. This reflective process not only enhances students' understanding of algebraic concepts but also promotes a growth mind-set, encouraging them to view challenges as opportunities for learning and growth¹⁵.

Algebraic concepts can be represented in various forms, including symbolic, graphical, numerical, and verbal representations. Each representation offers unique insights into the underlying mathematical ideas and can be used to solve problems and communicate solutions. By leveraging multiple representations, educators provide students with diverse tools for understanding and reasoning about algebraic concepts¹⁵.

Symbolic representations, such as algebraic expressions and equations, are the language of algebra and allow students to manipulate mathematical symbols to solve problems. Graphical representations, such as graphs of functions or geometric figures, provide visual insights into algebraic relationships and can help students visualize patterns and trends.

Numerical representations, such as tables of values or numerical solutions, allow students to analyse algebraic expressions and equations using numerical data.

Verbal representations, such as word problems or written explanations, help students translate real-world situations into algebraic language and vice versa¹⁶. By integrating multiple representations into Algebraic problem-solving tasks, educators cater to diverse learning styles and provide students with multiple entry points into the mathematical concepts. For example, students who struggle with symbolic manipulation may find graphical representations more intuitive, while students who excel at abstract reasoning may prefer working with symbolic representations. Moreover, transitioning between different representations helps students make connections between abstract algebraic concepts and concrete real-world situations, deepening their understanding of mathematical ideas¹⁶.

Algorithmic Thinking and Procedural Fluency

Algorithmic thinking involves breaking down problems into step-by-step procedure or algorithms that can be systematically executed to achieve desired outcomes. In Algebraic problem-solving, developing algorithmic thinking skills is essential for efficiently navigating through the problem-solving process. For instance, when solving equation, learners follow a series of steps such as isolating the variable, applying inverse operations, and simplifying expressions to find the solution. By providing learners with structured problem-solving frameworks and algorithms, educators scaffold their understanding of algebraic procedures and promote procedural fluency. Procedural fluency refers to the ability to carry out Algebraic operations accurately, efficiently, and flexibly, enabling learners to tackle algebraic challenges with confidence and competence¹⁶.

Dynamic Visualization and Interactive Manipulation

Traditional algebraic problem-solving often relies on symbolic manipulation, which can be abstract and challenging for some learners. Integrating dynamic visualization tools and interactive manipulative into algebraic problem-solving activities provides learners with more intuitive and engaging ways to explore mathematical concepts. For example, dynamic geometry environments allow learners to manipulate geometric figures and observe how changes in parameters affect their properties. Similarly, Algebraic modelling tools enable learners to dynamically manipulate mathematical objects, visualize transformations and explore conjectures in real-time. By immersing learners in interactive, hand-on experience, educators stimulate curiosity, spark inquiry, and deepen conceptual understanding in Algebraic problem-solving¹⁶.

Modelling and Simulation

Algebraic problem-solving extends beyond abstract mathematical exercises; it has practical applications in modelling and solving real-world problems. Emphasizing modelling and simulation techniques allows learners to apply algebraic concepts in authentic, contextually rich problem-solving scenarios. For instance, in physics, learners may use algebraic equations to model the motion of objects or predict future outcomes based on given parameters. Similarly, in economic, algebraic models can be used to analyse trends make predictions or inform decision-making processes. By contextualizing abstract algebraic concepts within real-world contexts, educators motivate learners by demonstrating the relevance and applicability of algebraic skills in solving practical problems¹⁷.

Strategies Questioning and Scaffolding

Guiding learners through the problem-solving process employing strategic questioning techniques and scaffolding strategies that prompt them to articulate their reasoning, justify their strategies, and refine their approaches. For example, when solving word problems, educators

can ask probing questions that encourage learners to analyse the problem, identify relevant information, and develop a plan of action. Scaffolding involves providing support and guidance to learners as they work through challenging problems, gradually withdrawing support as they gain proficiency and independence. By posing open-ended questions, providing prompts, and offering targeted feedback, educators support learners in developing critical thinking skills and meta-cognitive awareness, fostering a deeper understanding of Algebraic concepts and problem-solving strategies¹⁸.

Collaborative Inquiry and Peer Learning

Learning is a social process, and collaborative inquiry and peer learning environments offer valuable opportunities for learners to engage with others, share ideas, and co-construct solutions collaboratively. For example, during group discussions or cooperative problem-solving tasks, learners can leverage diverse perspectives, share insights and collectively brainstorm strategies to tackle challenging problems. Peer feedback exchanges provide learners with valuable insights into alternative problem-solving approaches, helping them refine their strategies and deepen their understanding of Algebraic concepts¹⁸.

Cognitive Flexibility and Transfer

Algebraic problem-solving requires learners to adapt their thinking and problem-solving approaches to various contexts and domains. Developing cognitive flexibility—the ability to adapt one’s thinking in response to changing task demands— and transfer skills —the ability to apply knowledge and skills learned in one context to solve problems in different contexts – are essential for success in Algebraic problem-solving. For example, when encountering unfamiliar problems types, learners need to draw upon their existing knowledge and adapt their problem-solving strategies accordingly. By exposing learners to a variety of problem-solving scenarios and encouraging exploration of multiple solution paths, educators promote transferable skills

that extend beyond the confines of the Algebraic classroom, fostering a deeper understanding of Algebraic concepts and their broader applications¹⁸.

Inclusive education isn't just about accommodating diverse learners; it's about valuing and leveraging their unique perspectives and experiences. Promoting cultural and linguistic responsiveness in algebraic problem-solving instruction ensures that learning experiences are inclusive, equitable, and accessible to all learners. By acknowledging and valuing diverse cultural perspectives, linguistic backgrounds, and lived experiences, educators create learning environments where all learners feel affirmed, respected, and empowered to participate actively in problem-solving activities. This culturally responsive approach fosters a sense of belonging and community, enhancing motivation and engagement in algebraic problem-solving for all learners¹⁹.

Furthermore, while algebra often deals with abstract symbols and equations, employing visualization techniques can provide valuable insights and aid problem-solving. For instance, representing algebraic expressions graphically using tools like graphs and diagrams can help in understanding relationships between variables and identifying patterns. Furthermore, leveraging technology such as graphing calculators or computer software can enhance visualization capabilities, allowing for the exploration of complex algebraic structures in multiple dimensions.

Embracing dynamic modelling approaches can enrich problem-solving in algebra by incorporating the element of change over time or in response to varying parameters. Dynamic models involve expressing algebraic relationships as functions that evolve based on certain rules or conditions. This approach is particularly useful in contexts such as physics, engineering, and economics, where systems exhibit dynamic behaviour. By modelling dynamic processes

algebraically, problem-solvers can analyse trends, predict outcomes, and optimize achievement²⁰.

Effective Problem-solving strategies for students in solving algebraic expressions word problems include organizing problems by difficulty of comprehension and computation, providing scaffolding support, and utilizing the Explain, Practice and Assess (EPA) strategy. Other strategies that have been found to be effective include teaching students the most efficient method of Problem-solving while also arming them with a variety of Problem-solving heuristics. Additionally, the Reciprocal Teaching Strategy, Schema Based Instruction Strategy, and Visual Strategies have been shown to help students gain a better understanding of word problems. Students often use informal strategies such as systematic guess and check when solving algebraic word problems, and it is important to provide support mechanisms for students who struggle with these problems¹⁴.

Word problems can be tricky. Often it takes a bit of practice to convert an English sentence into a mathematical sentence, which is one of the first steps to solving word problems. In the table below, words or phrases commonly associated with mathematical operators are categorized. Word problems often contain these or similar words, so it's good to see what mathematical operators are associated with them.

Some examples follow:

- x is 5 $\diamond$ is 5 becomes $x=5 \diamond =5$
- Three more than a number becomes $x+3 \diamond +3$
- Four less than a number becomes $x-4 \diamond -4$
- Double the cost becomes $2 \cdot \text{cost} \diamond 2 \cdot \text{cost}$.
- Groceries and gas together for the week cost \$250
means $\text{groceries} + \text{gas} = 250$ $\text{groceries} + \text{gas} = 250$

- The difference of 9 and a number becomes $9 - x$. Notice how 9 is first in the sentence and the expression. Let's practice translating a few more English phrases into algebraic expressions.

Students who are new to the abstract nature of algebraic thinking can struggle with finding an entry point into a problem. Writing an equation is not simple, and knowing what to do with an equation can also seem confusing. But often some carefully modelled questions can help them find their way into the problem, put them on more familiar footing, and recognize that they often know the answer. 'If you think you can... or think you can't... you're right.'—Henry Ford

The world is replete with verbal challenges! Will my income meet the qualifications to rent that flat? What quantity of punch is required for the party? What carat weight of diamond can I purchase for my girlfriend? Should I travel by air or by car to my family reunion? What is the cost required to refuel the vehicle? What is the appropriate amount to tip at a restaurant? What is the appropriate number of socks to carry for a vacation? What size turkey should I purchase for Thanksgiving dinner, and at what time should I place it in the oven? If my sister and I purchase a gift for our mother, what is the individual contribution of each of us?

An examination has been conducted on the process of converting English phrases into algebraic expressions, incorporating fundamental mathematical terminology and symbols. We have translated English sentences into algebraic equations and addressed several word problems. The word problems utilised Mathematics in practical, real-world contexts. The situation was succinctly summarised in a single sentence, a variable was designated, and an equation was formulated to address the problem. This approach is effective provided that the context is known and the mathematical concepts involved are relatively straightforward¹⁹. Now, we'll expand our strategy so we can use it to successfully solve any word problem. We'll list

the strategy here, and then we'll use it to solve some problems. We summarize below an effective strategy for problem solving.

Examine the issue; Ensure comprehension of all terms and concepts; determine the objective of our inquiry; identify the specific objectives we aim to achieve. Select a variable to denote that quantity; formulate this as an equation. Restating the problem concisely in a single sentence, while incorporating all essential information, could prove beneficial. Subsequently, convert the English statement into an algebraic expression. Utilise effective algebraic methods to solve the equation. Verify the solution to the problem and ensure its validity. Please respond to the question using a full sentence²⁰.

2.1.6 Gender

Gender serves as an analytical framework that delineates the sociological roles, cultural responsibilities, and expectations assigned to men and women within a specific society or cultural context. Gender encompasses the personality traits, attributes, behaviours, values, relative power, influence, roles, and expectations (femininity and masculinity) that society assigns to the two sexes in a differential manner. Consequently, gender serves as a psychological construct and a cultural constant shaped by societal influences to distinguish the roles, behaviours, and mental and emotional characteristics of males and females.

The common misunderstanding surrounding Mathematics is the belief that it solely revolves around formulas and computations that must be committed to memory. This perspective has undermined and obstructed the endeavours of students more than any other factor^{20, 22}. This misconception has progressed to categorise Mathematics as a subject predominantly for males within the educational context of Nigerian society. Significant progress has been made in our country regarding the integration of gender considerations in

education in recent years. At this moment in time, opportunities abound for women to pursue and achieve careers that were once deemed unattainable by previous generations. The topic of gender influences various contexts^{21, 23, 24}.

2.1.7 Class-size

Class size refers to the ratio of pupils to teachers in a certain class, and educators universally recognise it as a significant and desired characteristic of a good educational system. As a result, stakeholders in educational literature, including academics, policymakers, and parents, have persistently debated the pedagogical implications of class size. Certain researchers assert that class size serves as a metric for evaluating the efficacy of the educational system. Class size necessitates the sensible coordination of educational infrastructures, contingent upon the available student population to achieve optimal productivity²⁵.

In Nigeria, the class size is increasingly becoming unmanageable, placing teachers in an untenable position regarding the provision of individualised attention to students. In Nigerian public schools, teachers' eye contact with students has diminished significantly, allowing less motivated students to establish committees at the rear of the classroom to engage in non-academic discussions during lessons. Teachers detest regular assignments and homework due of the overwhelming volume of books to evaluate and document. As the school population grows, class sizes expand, leading to concerns regarding student accomplishments²⁶.

The class size in public secondary schools significantly exceeds the approved limit of 30 to 40 students per classroom. The typical class size in higher education surpasses 200. Reports indicate that Nigerian schools may have class sizes of five hundred (500), seven hundred (700), or beyond one thousand (1000) students. These class sizes are deemed excessively large for optimal academic achievement of pupils. A substantial class size results in

an elevated teacher-student ratio. This disproportionate contact undermines the efficacy of educators and the teaching process itself²⁷.

The investigation utilised a survey method, employing questionnaires as the primary tools for data collection. While this study is connected to the current research, it did not reveal the influence of small or medium-sized classes on students' academic achievement. A study revealed that reducing class size by one student led to a half-point increase in grade point average among college students. Nonetheless, additional research indicates that decreasing class size has minimal or no effect on students' academic achievement, with no significant differences observed in achievement between larger and smaller classes among 300 level students. The findings regarding the influence of class size on students' academic achievement are mixed and lack definitive conclusions²⁸.

Investigations established not only the occurrence of class size manipulation but also uncovered the potential effects of this manipulation on students' academic achievement. A study analysed end-of-grade test results in Mathematics and reading for college students in North Carolina, utilising demographic data sourced from the North Carolina Education Research Centre. Classrooms displayed considerable indications of systematic assignment patterns influenced by factors such as income, learning level, parental education, and student capability⁶³.

Furthermore, it was discovered that African American children, those receiving free or reduced-price meals, and kids with learning disabilities were allocated to smaller classes. This indicates that students who historically faced academic difficulties were allocated to smaller classes at a far greater frequency than their academically successful counterparts. When classroom composition was disregarded, reduced class sizes demonstrated little impact on students' academic achievement. Nevertheless, when considering the class composition, a

minor yet statistically significant effect was seen, indicating that a reduction of one student in class size led to a 0.0052 standard deviation gain in student achievement⁶⁴.

Numerous investigations have suggested sequences of instructional strategies for teaching Basic General Mathematics to address the issue of low achievement in college examinations; however, the challenge remains unresolved. Improving students' academic achievement in General Studies Education Mathematics extends beyond merely enhancing instructional strategies. This indicates that instructional strategies represent just one of the many factors that can impact the teaching and learning process in this subject area⁶⁴. The examination of research conducted to enhance students' academic achievement in General Studies Education Mathematics indicates that the majority of the studies primarily concentrated on instructional strategies, with minimal consideration given to other pedagogical elements such as class size, among others⁶⁵.

Numerous studies have pinpointed factors such as class size, school location, and lecturer exposure as contributors to students' low achievement in Mathematics. However, the impact of class size on students' academic achievement in Basic General Mathematics remains underexplored in this region. The study of Mathematics, characterised by logical thinking and systematic reasoning, necessitates that educational programs for pupils and students incorporate a classroom environment conducive to the development of mathematical skills in learners.

No significant difference in student learning or student achievement and had mixed results regarding student engagement and student satisfaction ⁶³. A conducive classroom environment for the teaching and learning of Basic General Mathematics lies largely on the number of students a Mathematics teacher has to face at a time; this is referred to as the class size⁶⁶. A classroom is a place where one or more groups of people usually referred to as students or learners gather together to acquire knowledge from the teacher ⁶⁵.

This acquisition of knowledge is made possible through the help of a teacher following some prescribed curriculum, usually approved by the government or an educational agency so designated or empowered to do so. Classrooms may vary, depending on the size of the students, the categories of the student to be taught and the purpose for which instruction is to be given. It is for this reason that lecturers are charged with the responsibility of effectively managing the classroom in order to promote academic excellence within their classroom environment.

Class size is typically determined by administrative decisions, leaving lecturers with minimal or no influence over the matter. Most studies begin with the assumption that class size is a crucial factor influencing success, although a few studies have indicated that, under optimal conditions, class size may not play a significant role⁶⁶. Class size is an important factor with to academic achievement of students recorded class size to have negative coefficient with student's academic achievement in examination⁵⁷. There is a gap in the quality of students in crowded classrooms, using inadequate and absolute equipment, disillusioned teachers.

2.1.8 Attitude

An attitude represents a comprehensive assessment that can be either favourable or unfavourable regarding a specific entity or behaviour. This construct is based on a model of attitudes that incorporates expectancy value, where both the subjective value of the outcome and the strength of the belief play a role in shaping the attitude component of the model. This construct has been thoroughly examined over decades of study, leading to the definition of several components within the E-V model in educational psychology. Several expectancy-value models have been introduced in the fields of psychology and economics to incorporate elements of decision-making behaviour. One model that exemplifies this is Ajzen's theory of planned behaviour, which posits that volitional behaviour is influenced by particular attitudes

(i.e. the value component) along with perceived behavioural control (i.e. the outcome expectancy component), which is further elaborated upon in the current study.

The perspective on Mathematics significantly influences the processes of teaching and learning in the subject. The teaching method, the support provided by the school, the family dynamics, and the students' attitudes towards school all significantly influence their perceptions of Mathematics. An optimistic perspective on Mathematics propels students towards achievement in the discipline. Efforts to enhance the perception of Mathematics at an early stage lay the groundwork for advanced studies in the subject. A positive attitude towards Mathematics is essential for improved achievement in the subject³².

To explore the perspectives of students regarding the resolution of algebraic problems, numerous scholars have undertaken various studies. For example, numerous students struggle with algebra, leading to frequent mistakes when attempting to solve algebraic problems, which in turn restricts their access to educational and economic opportunities. Additionally, a survey revealed that student achievement in algebra ranks the lowest among all areas of Mathematics. This deficiency in algebraic knowledge is thought to stem from a negative attitude towards tackling algebraic problems³³.

Likewise, research carried out in Nigeria indicates that difficulties in Algebraic problem-solving are a primary factor contributing to failure in Mathematics. This situation results in students developing a negative attitude towards tackling algebraic problems. It has been observed that students often do not learn the process of problem-solving; instead, they tend to memorise solutions presented by teachers, mirroring traditional teaching methods. This situation has resulted in a lack of development in critical thinking and comprehension skills among secondary school students in Nigeria³⁴.

Reports suggest that Nigerian students display reluctance towards tackling algebraic problems, a trend that could be associated with their general view of Mathematics as a difficult and abstract field. Nonetheless, many students believe that solving algebraic problems is something meant for a select group, thus limiting it to those individuals deemed capable. Many students often encounter confusion when dealing with algebraic problems, especially when required to use a variable to represent an unknown quantity. Furthermore, learners frequently find it challenging to decipher equations that feature letters and numbers positioned next to each other³⁴.

A significant number of secondary school students struggle with learning algebra. The difficulties these students face in solving algebraic problems have led many of them to develop negative attitudes towards tackling any algebraic challenges. Mathematics holds significant importance, and proficiency in this subject is often viewed as essential for academic success, with algebra being a fundamental area within the discipline. A significant body of literature has been published regarding students' attitudes in relation to their problem-solving abilities in Mathematics. In education, attitude plays a crucial role in determining students' success. In 191, it was noted that attitudes influence the ways in which students engage with those in their environment, including friends, family, classmates, and even their lessons. Consequently, the attitude of students towards tackling algebraic problems will contribute to their success or lack thereof³⁹.

It is essential to address and overcome negative attitudes to ensure that students develop strong problem-solving skills as they progress in life. Consequently, it suggests that students need to adopt a positive mind-set when tackling algebraic problems in order to achieve success. Furthermore, in a study he conducted, it was observed that even when some students managed to perform well in other aspects of Mathematics, they consistently performed poorly in algebra.

This clarifies why previous studies have shown that a significant number of students need remedial support, particularly in algebra, as many face challenges in learning this subject. It has been asserted that algebra, a significant area of Mathematics, plays a crucial role in developing cognitive, critical, and analytical skills in the brain. It enhances the analytical abilities of students and equips them to address real-world challenges in a logical manner⁵⁰.

Furthermore, engaging with algebra fosters mental discipline. It guides individuals to analyse and develop solutions to diverse challenges in a systematic and rational manner. Additionally, it aids students in developing the ability to maintain reflection. Many Nigerian secondary school students exhibit difficulties in Mathematics, particularly in the domain of algebra. Attitudes towards solving algebraic problems encompass enjoyment, preference, and interest in these challenges, or conversely, a lack of enthusiasm. This suggests that students should have a fondness for algebra, take pleasure in the activities associated with it, and possess a genuine interest in algebraic problems. Conversely, attitudes significantly influence students' achievement in algebra. Individuals who feel uncertain about their ability to tackle algebraic problems often picture a poor grade even before starting an exam³⁶.

Pre-Conceived Ideas from Personal Experiences: Many of these students hold pre-conceived notions about the representation of algebraic equations, frequently relying on their personal experiences to shape their interpretations. This leads to the incorrect assumption that all algebraic equations and their symbolic notations are interconnected. The findings indicate that students engaging with algebraic expressions frequently rely on their recognition of visual notational patterns when making decisions, rather than adhering strictly to mathematical rules. Students frequently fail to consider the overarching goal or the underlying concepts of a problem, opting instead to search for an implied procedure within the equations and apply it directly. Moreover, algebraic equations, typically expressed in letter form, are perceived as

denoting a variety of unspecified values, with a systematic relationship observed between two such sets of values. Nonetheless, these equations frequently lead to significant confusion among students³⁵.

Teachers of algebra have a special obligation to lay the groundwork for their pupils to develop a deeper comprehension of the subject as they progress through the course. The challenges and misunderstandings that students have when learning algebra have been the subject of a great deal of research. But research shows that many kids struggle with algebra, which can be a stumbling block for those seeking jobs in STEM fields, business, engineering, and the like. According to studies, kids have a hard time with algebra because they don't know how to manipulate algebraic expressions and equations, and they don't understand symbols and letters. Someone brought up the possibility that students' insufficient or misconstrued prior knowledge could be at the root of these problems⁵⁰.

Studies have shown that students sometimes misinterpret letters as objects, and this misinterpretation stems from the methods employed by educators when introducing early simplifications of algebra. These methods are influenced by the algebraic content, which can lead to frustration among students. The three foundational understandings of abstract reasoning, language acquisition, and mathematical structure present unique challenges for students when solving problems in algebra³⁸.

The individual challenges presented by each factor can be significant barriers to solving algebraic problems; however, their combined effect creates an even greater challenge for numerous secondary school students in Nigeria striving to master algebra. Consequently, these students encounter a subpar initial experience with algebra, leading to an insufficient foundation for future learning, which ultimately fosters a negative attitude towards solving algebra. Students frequently overlook the distinctions between expressions and equations. The

challenges associated with mastering abstract reasoning, language acquisition, and mathematical structure in algebra necessitates teaching strategies that intentionally address the specific needs of learners²¹⁰.

Often, a focus on instrumental understanding of Algebra as a learning method results in students depending on memorisation and prescribed approaches. An individual with a practical grasp of the city can explore various routes to navigate from Point A to Point B. For example, students might acquire a specific method for solving equations like $ax + b = c$; however, when faced with equations of the type $ax + b = cx + d$, their established methods fall short in addressing the new structure. Students who possess solely procedural knowledge frequently find themselves disoriented when faced with unfamiliar scenarios, struggling to apply essential mathematical concepts and structures in those contexts³⁹.

2.2 Theoretical Framework

2.2.1 Social Learning Theory

Social Learning Theory, propounded by Albert Bandura, posits that individuals learn through observation, imitation, and modelling of behaviours exhibited by others. Within the realm of Algebraic expressions, this theory suggests that Class-wide Peer tutoring sessions, by facilitating social interactions and collaborative problem-solving, can provide valuable opportunities for students to observe and learn from each other⁵¹. In a classroom setting characterized by Class-wide Peer tutoring, students not only receive direct instruction from their peers but also witness diverse problem-solving strategies, explanations, and approaches. This exposure to varied perspectives and methodologies enhances students' understanding and mastery of Algebraic concepts⁵².

Moreover, Bandura's theory emphasizes the importance of self-efficacy- the belief in one's ability to succeed in learning. Through Class-wide Peer tutoring, students not only gain academic knowledge but also develop confidence in their mathematical abilities, thereby fostering a positive learning environment conducive to achievement⁵³.

2.2.2 Constructivism Theory

Constructivism, a theoretical framework rooted in the idea that learners actively construct their own understanding of the world through experiences and interactions, offers valuable insights into the learning process in Algebraic expressions education^{54,55}. Within the constructivist paradigm, learning is seen as a dynamic process of knowledge construction rather than passive absorption of information. In the context of Algebraic expressions, constructivist approaches advocate for student-centered, inquiry-based learning methodologies that engage learners in active problem-solving and exploration of mathematical concepts⁵⁶.

Class-wide Peer tutoring and problem-solving activities align closely with constructivist principles by providing opportunities for students to actively engage with Algebraic expressions, collaboratively explore solutions, and construct meaning through dialogue and reflection. By encouraging students to articulate their reasoning, justify their solutions, and engage in meta-cognitive processes, Class-wide Peer tutoring promotes deep understanding and conceptual development. Additionally, constructivism emphasizes the importance of scaffolding the provision of appropriate support and guidance to facilitate learning. Peer tutors, through their role as mentors and facilitators, scaffold their peers' learning by providing assistance, feedback, and encouragement, thereby promoting cognitive development and academic achievement.

2.2.3 Lev Vygotsky's Theory

Lev Vygotsky's Zone of Proximal Development (ZPD) framework offers valuable insights into the role of social interaction and collaborative learning in cognitive development. According to Vygotsky, the ZPD represents the gap between a learner's current level of independent functioning and their potential level of competence with the assistance of a more knowledgeable peer or instructor⁵⁹.

Class-wide Peer tutoring, by pairing students of varying skill levels and providing opportunities for collaborative problem-solving, leverages the concept of ZPD to facilitate learning and skill acquisition⁶⁰. In the context of algebraic expressions education, Class-wide Peer tutoring allows students to work together to solve problems, share strategies, and provide feedback⁶¹. By engaging in collaborative problem-solving activities within their ZPD, students can stretch their cognitive abilities, internalize algebraic concepts, and achieve higher levels of proficiency⁶². Furthermore, Class-wide Peer tutoring promotes social interaction and mutual support, fostering a sense of community and shared responsibility for learning among students⁶³.

Problem-based Learning (PBL) is an instructional approach that emphasizes the use of authentic, real-world problems to engage students in active learning. In PBL, students are presented with complex, open-ended problems that require critical thinking, collaboration, and application of knowledge to solve. Within the context of algebraic expressions education, problem-solving strategies are integral to PBL as students grapple with mathematical problems that have practical relevance and significance. Class-wide Peer tutoring complements PBL by providing opportunities for students to collaborate, share ideas, and work together to solve problems. By engaging in Class-wide Peer tutoring sessions focused on problem-solving, students can develop essential problem-solving skills, deepen their understanding of algebraic concepts, and transfer their learning to real-world contexts. Moreover, PBL promotes student

autonomy, inquiry, and meta-cognition, fostering a deeper engagement with algebraic expressions and enhancing students' academic achievement.

2.2.4 Cognitive Load Theory

Cognitive Load Theory (CLT) provides insights into the cognitive processes involved in learning and the management of cognitive resources. Cognitive load refers to the amount of mental effort required to process information and perform tasks. In the context of algebraic expressions education, problem-solving activities can impose cognitive demands on students as they manipulate variables, apply rules, and solve equations. Class-wide Peer tutoring, by providing additional support and scaffolding, can help alleviate cognitive load and facilitate learning. Peer tutors, through their role as guides and mentors, can help students manage cognitive resources more effectively, identify key concepts, and apply problem-solving strategies⁶⁷. By reducing extraneous cognitive load and promoting cognitive efficiency, Class-wide Peer tutoring enhances students' ability to comprehend algebraic expressions and achieve academic success⁶⁸.

The theoretical framework outlined above has significant implications for the design and implementation of educational interventions aimed at improving students' academic achievement in algebraic expressions. By integrating principles from social learning theory, constructivism, ZPD, PBL, and CLT, educators can design Class-wide Peer tutoring and problem-solving strategies that optimize learning outcomes. Moreover, the theoretical framework highlights the importance of fostering collaborative learning environments, promoting active engagement, and providing appropriate scaffolding and support to facilitate students' cognitive development and academic achievement. By leveraging these theoretical insights, educators can enhance the effectiveness of algebraic expressions education in Colleges

of Education in southwest Nigeria, ultimately empowering students to succeed in Mathematics and beyond.

2.3 Review of Empirical Studies

2.3.1 Class-wide Peer tutoring and Achievement in Algebraic Expression

The website indicates that CWPT fulfils all requirements for a "Proven Program" by demonstrating research outcomes aligned with the website's focus areas, achieving at least one outcome with a change of 20% or .25 standard deviations, presenting at least one outcome that shows a statistically significant and meaningful effect, including studies that utilise comparison groups, ensuring studies have sample sizes of 30 or more, and making research findings publicly accessible. Several studies indicate that CWPT offers limited benefits compared to more conventional approaches to classroom instruction for middle or high school students, including teacher-centred instruction or independent practice. It has been observed that while CWPT may enhance the positive social interactions of students with ADHD during tutoring sessions, it does not necessarily influence their social behaviour in different environments⁶¹.

A study was carried out to examine the effects of CWPT on secondary level students with emotional disorders in smaller classrooms within an alternative setting. The investigation assessed on-task behaviour alongside student academic advancement through pre and post-tests in biology and spelling. The individuals involved in the study demonstrated enhancements in their on-task behaviour. Notably, there was a rise in positive social interactions, with students observed complimenting one another, even beyond the CWPT procedure⁶².

The findings revealed a blend of academic outcomes, with middle school students demonstrating more significant improvements compared to their high school counterparts. Conflicting results were identified in a study examining the impact of CWPT on the positive

social behaviours of three elementary students diagnosed with attention deficit hyperactivity disorder (ADHD). In the CWPT condition, pairs of tutors and tutees engaged in a review of spelling words for duration of twenty to twenty-five minutes each day. The class was segmented into two groups, with points allocated based on the tutee's accurate spelling of a word or by successfully reproducing a corrected response three times. The team that did not succeed acknowledged the team that triumphed, and subsequently, the victorious team recognised the efforts of the team that fell short. The CWPT approach was subsequently integrated with peer coaching, allowing students to establish a daily behavioural goal that their peer coach would monitor. The findings of the study were varied. During the implementation of the CWPT program, there were no noticeable increases in positive social behaviours⁶³.

The integration of CWPT with a peer-coaching component resulted in an enhancement of students' positive social behaviours. Conflicting results regarding on-task behaviour emerged in a study examining the impact of CWPT on a student diagnosed with ADHD. In examining the impact of CWPT on math probes and on-task behaviour, an ABAB reversal study design was employed to implement the CWPT intervention. The application of curriculum-based measurements to evaluate academic progress revealed that the student subject demonstrated improvements in academic achievement throughout both intervention periods, experiencing only a minor decline during the second baseline period. Furthermore, the impact of CWPT on behaviours associated with ADHD was analysed through a thirty-second partial interval coding system. The findings from the ADHD behaviour probe indicated notable improvements in on-task behaviour⁶⁴.

This investigation examined the impact of the reciprocal Class-wide Peer tutoring strategy on the understanding of rational algebraic expressions and its influence on the Mathematics achievement of students at Guindulungan National High School. A total of forty

(40) Grade 8 students were randomly selected to participate in the study. This study utilised a quasi-experimental research design. The primary instrument of the study was a set of pre-test and post-test questions focused on rational algebraic expressions.

This method was employed to conduct quantitative analyses on the pre-test and post-test scores of the students. Frequency and percentage counts were employed to examine the academic achievement of students prior to and following the implementation of the reciprocal Class-wide Peer tutoring strategy. A T-test was employed to assess the significant difference in students' academic achievement in Mathematics prior to and following the reciprocal intervention.

Class-wide Peer tutoring strategy this test was set at 5% level of significance. The minimum t-value of 1.665 was used to determine the significance of the test. The results revealed that there is a significant increase in the students' Mathematics achievement in learning rational algebraic expressions using reciprocal Class-wide Peer tutoring strategy. This means that reciprocal Class-wide Peer tutoring strategy is effective in increasing students' Mathematics achievement¹. A growing body of research has shown the positive effects of Class-wide Peer tutoring on students' academic achievement, self-concept, attitude, social, and behavioural outcomes. There is, however, a paucity of research that focuses on peer tutoring interventions for Hispanic students¹.

This study investigated classroom practices alongside the behaviours of program teachers and students within a cross-age peer tutoring initiative implemented in elementary and middle schools primarily serving Hispanic students. Classroom observations were conducted to examine the execution of the peer tutoring program. The findings revealed that the program excelled in cultivating positive emotions and relationships among students, as well as creating a classroom atmosphere that encouraged warm and supportive interactions. The results also

revealed multiple shortcomings in the execution of the program. The findings can be utilised to enhance the effectiveness of upcoming peer tutoring initiatives in Mathematics².

This study determined the impact of Class-wide Peer tutoring Strategy on students' mathematical problem-solving proficiency regarding electricity concepts in physics inside Chinchaga Local Government, Niger State, Nigeria. The research utilised a Quasi-Experimental Research Design. The study's target group comprised 4,707 SSSII students from seven senior secondary schools in the Chinchaga Local Government Area, operated by the Niger State Government. The study's sample size comprises 107 SSSII students, selected by simple random approaches. The study was led by two research questions and two research hypotheses tested at a significance level of 0.05. The data collection tool employed was the Electricity Mathematical Problem-solving Test (EMPST), which was approved by two experts.

The trait test for assessing coefficient reliability is 0.78, use PPMC statistics. Means were employed to address the study topics, and null hypotheses were evaluated using the t-test statistic. The study's findings demonstrated that Class-Wide Peer Tutoring (CWPT) was more effective in enhancing students' academic progress compared to traditional teaching methods, and it also indicated that CWPT is not gender-biased. It was suggested, among others, that Mathematics and Physics educators should strive to integrate the CWPT technique into their instruction³.

The study aimed to investigate the efficacy of Class-wide Peer tutoring in enhancing Mathematics achievement. A total of 200 ninth-grade students from two secondary schools in Hoshiarpur, Punjab, India, were selected for the study, with 100 students assigned to the control group and 100 students to the experimental group. The experimental group received Mathematics instruction via the Class-wide Peer tutoring strategy, whilst the control group was taught using the standard lecture method. Both groups were equivalently matched according to

pre-test achievement in Mathematics. The Mathematics Achievement test created by the researcher for ninth graders was utilised as a data collection instrument. The study's findings indicated that pupils instructed through the Class-wide Peer tutoring strategy achieved considerably higher scores in Mathematics compared to those taught via traditional methods⁴.

This study examined the impact of Class-wide Peer Tutoring on the academic achievement of secondary school students in Mathematics within the Tai Local Government Area of Rivers State. A quasi-experimental design was employed. The experiment utilised two groups: the Class-wide Peer tutoring group and the control group. Two research questions and two hypotheses were established to direct the investigation. The study population comprised 2,950 senior high school pupils. The sample size comprised 260 SS1 pupils, selected from three schools within their complete classes. The "Mathematics Achievement Test (MPT)" was employed to gather data from the two groups. The experimental group received treatment, whereas the control group did not. A pre-test was administered to the groups prior to the initiation of instruction, followed by a post-test at the conclusion of the teaching period.

The data collected underwent analysis through mean and standard deviation to address the research questions, while ANCOVA was employed to test the null hypotheses at a significance level of 0.05. The results of the study indicated that: Across the entire class Peer tutoring improves the academic achievement of Mathematics students, leading to increased comfort and openness during interactions with their peers. Class-wide peer tutoring provides an opportunity for every participant to recognise their strengths and weaknesses. Based on the findings, the following recommendations are proposed: Across the entire class incorporating peer tutoring into the teaching of secondary school subjects is essential. Educators ought to periodically assign students topics for exploration prior to instruction, fostering an environment where they can articulate their findings regarding the concepts in their own words. An educator

implementing Class-wide Peer tutoring ought to establish a reward system to enhance and encourage students' on-task behaviour and participation⁵.

This study examined the impact of peer tutoring on the academic achievement of senior secondary school students in Mathematics within the Ahoada East Local Government Area of Rivers State. The investigation utilised a quasi-experimental research design featuring a pre-test and post-test non-equivalent group format. This was based on the observation that there has been inadequate achievement of students in both internal and external examinations in Mathematics among senior secondary school students in the schools. Two questions were developed and two hypotheses were established to direct the study. A total of one hundred and ninety-five (195) students were selected from a population of four thousand, one hundred and fifty-eight (4,158) SS 2 students.

The two instruments utilised for data collection were the Mathematics Achievement Test (MAT) and lesson notes (LN). The face and content validities of the instrument were assessed by three experts in Educational Measurement and Evaluation from the Department of Guidance and Counselling at Ignatius Ajuru University of Education. The MAT yielded a reliability coefficient of 0.76 through the test-re-test reliability method. The collected data were analysed utilising mean, standard deviation, and ANCOVA, all assessed at a significance level of 0.05. The findings indicated that students instructed in Mathematics through the Class-wide Peer tutoring Strategy outperformed their peers who were taught using the Conventional Teaching Method. It is advisable to integrate the Class-wide Peer tutoring strategy into the instruction of additional subjects⁶.

The study investigated the impact of Class-wide Peer tutoring on students' self-concepts in Mathematics. The Marsh questionnaire was utilised to assess students' Mathematics self-concepts prior to and following the implementation of a Class-wide Peer tutoring program. A

control group design utilising pre-test and post-test measures was implemented. The study involved a total of 376 students, aged 12 to 15 years, from grades 7 to 9. No statistically significant differences were observed between the pre-test and post-test results for any of the control groups. All grades in the experimental groups showed statistically significant improvements. The experimental group demonstrated an average increment of 13.4%, with the overall effect size categorised as medium (Hedges' $g = 0.48$). No statistically significant differences were observed across grades for the experimental group.

This study concluded that same-age and reciprocal Class-wide Peer tutoring can significantly enhance middle school students' self-concepts in Mathematics. The study yielded multiple recommendations for field practitioners: implement same-age and reciprocal tutoring instead of cross-age and fixed Class-wide Peer tutoring; organise tutoring programs for duration of four weeks or less, with two to four sessions lasting 25 minutes or less each week; and, incorporate a control group in research studies⁸.

2.3.2 Problem-solving and Achievement in Algebraic Expression

This study aims to explore the proficiency levels of students' basic skills and their attitudes towards algebra, as well as the relationship between these factors and their algebraic problem-solving skills. The Basic Skills Test (BST) and Problem-solving Test (PST) are conducted to assess the proficiency levels of BS and PSS, while the Algebraic Attitude Scale (AAS) is developed to evaluate the ATA. The questionnaire's reliability analysis yielded a Cronbach alpha of 0.842. The proficiency level of students' BS and their attitude is assessed through frequency, percentage distribution, mean, and weighted mean analysis. The Chi-square test is employed to analyse the relationship between PSS and the factors ATA and BS. The

findings indicate a significant relationship between students' PSS and their levels of ATA and BS¹¹.

This study sought to investigate students' problem-solving abilities in arithmetic operations related to algebraic forms, utilising the Indonesian realistic Mathematics education approach, known as Pendidikan Matematika Realistik Indonesia (PMRI), at secondary school number 17 in Palembang. The principles and characteristics of PMRI were evident in the learning process, material, and assessment utilised. The technique for data collection involved the activities of two students and a written test designed to assess students' problem-solving abilities. The written assessment, which focused on the indicators of problem-solving capability, was administered following the learning process.

The findings of this study suggested that the context of Palembang facilitates students' understanding of algebraic arithmetic operations. The principles and characteristics of PMRI significantly contribute to the improvement of students' problem-solving abilities. In summary, learners engage in problem-solving by creating models that reflect their mathematical concepts. Furthermore, students should be equipped to formulate problem-solving strategies that utilise a range of procedures¹².

Mathematics serves as a mechanism for attaining educational and economic objectives within a nation or culture. Algebra has consistently been a fundamental subject in Mathematics globally. This is likely because algebra serves as the gateway to advanced complex arithmetic computations. This study investigated the proficiency in algebraic equations as determinants of secondary school students' academic achievement in Mathematics within Benin Metropolis. Four research questions were formulated to do this. The study employed a survey design. The research population comprised all public junior secondary schools in Benin Metropolis, Edo

State. A sample of one thousand one hundred and forty (1,140) pupils from thirty-eight junior secondary schools is utilised for the study.

The data collection tool was an achievement test developed by the researcher, derived from previous Basic Education Certificate Examinations administered by the National Examination Council for the 2018, 2019, 2020, and 2021 academic years. The instrument's validity was assumed to have been established by the National Examination Council, the entity responsible for administering examinations in Nigeria. The instrument's reliability was determined using the Kuder-Richardson Formula 20, yielding reliability indices of 0.90 and 0.93, respectively. The obtained data were evaluated via mean and standard deviation, two-way Analysis of Variance, and Pearson Product Moment Correlation Coefficient (r).

The study's findings indicated a low level of proficiency among students in solving algebraic equations and Mathematics. A notable correlation was found between the ability to solve algebraic equations and students' academic achievement in Mathematics, with gender not playing a role in students' proficiency in algebraic equations or their overall achievement. It was suggested, among other recommendations, that educators should implement diverse teaching strategies to enhance students' understanding of mathematical concepts¹³.

Algebraic problem-solving represents a method of thought and reasoning that enables students to develop models, explore relationships, and address challenges. Nonetheless, students possess a limited comprehension of how to formulate and solve algebraic problems. This investigation seeks to identify the primary challenges encountered by Year Six students in the context of algebraic problem-solving. This investigation employed a quantitative research design that included 80 students chosen through purposive sampling. This study employs criterion-referenced tests that feature word and diagram algebraic problem-solving items. The analysis of the data was conducted utilising GNU PSPP software. The descriptive statistics

indicated that the primary challenge encountered by Year Six students in solving algebraic word problems was related to text difficulties and unfamiliar contexts.

In the context of diagrammatic algebraic problem-solving, students faced significant challenges related to visual-spatial awareness. The Chi-Square test was employed to determine the statistical correlation coefficient between gender and challenges encountered in solving algebraic problems. The findings indicated a positive correlation between gender and recognition difficulties, as well as between gender and sign substitution errors. The results of this study could motivate students to enhance their algebraic problem-solving abilities. This study offers valuable insights for educators aiming to enhance their instruction in algebraic problem-solving for Year Six students¹⁴.

This study focused on enhancing student achievement in multiplication and division concepts by employing a problem-solving approach. This approach involves classroom action research, comprising two cycles, with each cycle including two meetings. The steps involved in this study encompass planning, executing actions, observing and assessing, and reflecting on the outcomes. The methods employed for data collection included observation sheets and the assessment of cycle tests. The analysis employed descriptive methods to determine the percentages of teacher engagement, student participation, and student achievement throughout the learning process.

The data processing results indicate a rise in the percentage of teacher instruction over the two cycles, with the initial meeting of the first cycle recorded at 65.38% and the subsequent meeting at 69.23%. The initial meeting in the second cycle demonstrated a rise from 78.84% to 92.30% by the second meeting. The percentage of student learning activities across the two cycles demonstrated a positive trajectory, starting at 67.85% during the first meeting of cycle 1 and increasing to 74.99% by the second meeting.

During the second cycle, the initial meeting achieved a participation rate of 87.49%, which increased to 93.74% by the subsequent meeting. Utilising a problem-solving approach has the potential to improve student outcomes. The findings from the preliminary cycle test reveal a traditional completeness percentage of 60%, along with an average score of 59. The second cycle, on the other hand, shows a significant enhancement, reaching a completeness percentage of 90% and a mean score of 86.95¹⁵.

An instructional approach that shows promise in enhancing students' problem-solving skills is the open-ended approach (OEA). OEA emphasises identifying the appropriate response instead of providing a singular solution to the issue at hand. This study examined the achievement and problem-solving abilities in Mathematics among Grade 8 students at Binuangan National High School using an open-ended approach (OEA). The study aimed to: identify the levels of achievement in Mathematics among students exposed to OEA versus those exposed to non-OEA; assess the problem-solving skills of students in both groups in terms of: (a) self-confidence in solving problems; (b) effort put into solving problems; and (c) procedures followed to solve problems; compare the levels of achievement in Mathematics between the two groups; and examine the differences in problem-solving skills between students exposed to OEA and those exposed to non-OEA.

The study utilised a quasi-experimental research design. The pre-test results of both the experimental group and the control group indicated low levels of student achievement. However, following their exposure to OEA, the post-test results for the experimental group demonstrated significant improvements in student achievement. Students exposed to OEA exhibited enhanced problem-solving skills when compared to those in both the OEA and non-OEA groups. Between the pre-test and post-test, OEA significantly enhanced students' academic achievement levels. Further findings indicated that students who experienced OEA

demonstrated notably superior problem-solving abilities compared to those who did not engage with OEA¹⁶.

Problem-solving involves comprehending the challenges and the processes that influence students' outcomes in Mathematics education. The objectives of the study include: outlining students' comprehension of problem-solving and their outcomes in Mathematics; examining the effects of gender and grade level on students' problem-solving comprehension and Mathematics outcomes; and investigating the impact of students' problem-solving comprehension on their Mathematics results. The sample consists of all students in the fourth to sixth grades at two primary schools, totalling 263 respondents. The sample comprises 244 respondents, including 123 females and 121 males, as well as 74 low-grade and 170 high-grade students, respectively. The team calculated and converted scores into values.

Statistical tests were conducted using linear regression analysis and the t-test. The average scores for students' Mathematics learning outcomes and problem-solving comprehension are 69.679 and 66.889, respectively. The average problem-solving understanding of female students is higher than that of male students, while the average Mathematics learning outcomes for male students surpass those of female students. The mean problem-solving understanding of low-grade students is higher than that of high-grade students, whereas the mean Mathematics learning results of high-grade students surpass those of low-grade students. Gender does not affect students' understanding of Mathematics problem-solving or their learning outcomes.

The grade level significantly affects students' comprehension of problem-solving, yet it does not have a notable impact on their Mathematics learning outcomes. The understanding of problem-solving among students significantly impacts their Mathematics learning outcomes,

evidenced by a p value of 0.000. The findings and results have implications for assisting students in processing information and building mathematical knowledge¹⁷

2.3.3 Gender and Achievement in Algebraic Expression

Gender issues have consistently been a central topic in the study of Mathematics education. Initial investigations primarily centred on the variations in gender concerning students' academic achievement, engagement, and perceptions related to Mathematics. Since that time, the focus on exploring this topic has varied. Gender issues served as a significant area of inquiry within Mathematics education research during the 1980s and 1990s. Nonetheless, in recent decades, attention to this topic has diminished. For instance, in more recent editions of the Research in Mathematics Education in Australasia (RiMEA) 4-year reviews, it has been noted that the National Council of Teachers of Mathematics (NCTM) handbooks have not prioritised gender as a specific focus, but rather included it within a wider discussion on equity. In earlier editions of both the RiMEA reviews and the NCTM handbooks, entire chapters were dedicated to the topic of gender.

This Special Issue aims to revitalise interest in the field and present readers with a variety of ideas—across theoretical, methodological, and empirical dimensions—from contemporary scholars. The disparity in academic achievement between genders has garnered significant focus over the years. Research indicates that despite the absence of gender disparities in maths achievement, female students demonstrate heightened levels of anxiety regarding the subject, and this divide between genders tends to widen over time. This study examines the variations between genders in the sources of information that contribute to perceived self-efficacy in Mathematics and explores how these sources may evolve with age. A total of 347 surveys were gathered from six private schools in Lebanon, utilising instruments

created by Ellen Usher and Frank Pajares. Confirmatory factor analysis serves to validate the measurement tool within a non-Western context.

A structural component is subsequently incorporated into the model to address age considerations. The findings suggest that older girls are more prone to receiving negative feedback from the four sources, which consequently contributes to a decline in their perceived self-efficacy in maths. The results suggest that various socialisation processes are functioning, thus lending credence to theories of social roles²².

Research indicates that men tend to display over-confidence in Mathematics more often than women. The relationship between gender and problem-specific confidence judgements remains underexplored, particularly in terms of how this relationship may vary with problem difficulty. In order to explore the connection between gender, the difficulty of problems, and confidence judgements specific to those problems, we analyse data from 349 women and 279 men. These participants were tasked with solving 13 challenging and intricate Mathematics problems and subsequently reporting their confidence in the accuracy of their solutions.

Findings indicated that men exhibited greater confidence than women, and that the disparity in confidence between genders diminishes as the complexity of the problems increases. Women demonstrated superior calibration compared to men, and the disparity in calibration between genders widened as the difficulty of the problems increased. As the difficulty of the problems escalated, women, unlike men, shifted from a state of under-confidence to over-confidence. This study employs a mixed-methods research design to compare the academic achievement of males and females in STEM subjects at the university level with their achievement at the senior high school level.

The elements influencing the disparities in academic achievement between genders at both stages of the educational hierarchy were examined as well. The findings indicate that male

students outperformed female students in academic achievement at the senior high school level. However, at the tertiary level, female students demonstrated an improvement in their academic achievement compared to their male counterparts. While gender stereotypes significantly influenced disparities in academic achievement at the high school level, elements such as teaching methods and styles, parental motivation and support, along with advocacy initiatives for women's empowerment, played a crucial role in enhancing the academic success of females at the tertiary level.

Conversely, the involvement of males in extra-curricular activities and various economic pursuits, which are associated with wider socio-economic factors like economic hardship, financial limitations, and gendered beliefs, tends to impact their academic achievement at that level. It is advisable to prioritise the inclusion of more females in STEM fields and professions, while also recognising the significance of addressing the needs and participation of males. This necessitates ongoing education and awareness regarding gender stereotypes, along with policy measures to support both males and females in STEM, contributing to comprehensive national development²⁴.

The gender stratification hypothesis posits that increased societal gender equity is associated with reduced gender disparities in Mathematics achievement and attitudes. This study utilises data from the Program for International Student Assessment (PISA) across 56 countries to conduct a comprehensive empirical examination of the gender stratification hypothesis. We utilise an innovative two-stage empirical approach to examine the relationship between societal gender equities and the disparities in Mathematics achievement and attitudes across genders. Initially, we employ a semi-parametric Oaxaca-Blinder (OB) approach to analyse the gender disparities in each country, breaking them down into components attributable to observable gender differences and those that remain unaccounted for. In the

second stage, we analyse the connections between the unexplained components of the gender gaps and the gender equity measures specific to each country.

The findings underscore the significance of gender equity within the labour market as a key factor in understanding the differences in the gender math gap across various countries. Our findings indicate that a reduced gender wage gap is notably linked to a diminished unexplained portion of the gender math gap that benefits boys. The findings regarding gender gaps in maths attitudes provide varied evidence for the gender stratification hypothesis. Despite the fact that females currently surpass males in higher education enrolment, they continue to be significantly under-represented in Mathematics-related disciplines, with little indication of progress over the past decades. In order to gain insights into the factors contributing to this under-representation, we analyse PISA 2012 data encompassing 251,120 15-year-old students across 61 countries, focussing on the educational intentions of boys and girls in relation to their achievement on maths assessment tests.

We examine the correlation between math achievement and the proportion of males and females who want to major in or work in Mathematics. We begin by demonstrating that, across genders, there is a positive and linear relationship between mathematical aspirations and actual achievement in maths classes. Secondly, the correlation between the two is more pronounced in boys than in girls. For students who struggle the most in Mathematics, the gender gap in their aspirations to major in or work in Mathematics is practically non-existent, but it widens as students' progress through the grades. Finally, compared to the overall student population, the gender disparity in math achievement is worse for girls among those who plan to major in math. While the majority of studies have shown that girls are less enthusiastic about Mathematics than boys, this is not always the case.

The complex process by which a national culture that promotes high math accomplishment dampens enthusiasm in math schoolwork, especially among girls because of their greater obedience to peer pressure, is what I believe to be the driving force behind the observed disparity in interest between the sexes. More than half a million eighth graders from fifty different nations participated in the TIMSS assessments in 2011 and 2015, putting the theory's predictions to the test. As expected, there was a strong negative correlation between national achievement levels and national levels of interest in Mathematics education.

The difference was most pronounced among girls, with high interest among girls in countries with low achievement and low interest in Mathematics, and low interest among girls in countries with high achievement and low interest in Mathematics. Another finding that highlights the significance of knowing gender disparities better is the correlation between gender variations in math schooling interest and gender differences in math accomplishment⁵⁶. The influence of gender on academic achievement in Mathematics among senior secondary school students in Bayelsa State showed the research strategy used for the study was a survey. Participants in this study were all ninth graders from 39 public (mixed) secondary schools in the Sagbama and Southern-Ijaw LGAs of Bayelsa State, who were enrolled in Senior Secondary School Two (SSS II). The research used a stratified sampling strategy to select 1,754 SSS II students from 12 different public secondary schools.

The appropriate data was collected using the Mathematics Objective Test (MOT). The instrument was validated by experts in the fields of Mathematics and educational measurement. Using the Cronbach reliability test, we found that the MOT was 0.85 reliable. To get the answer to the study question, we employed standard deviation and mean as descriptive statistics. To test our hypothesis, we used an independent t-test with a significance threshold of 0.05⁵⁷.

A statistically substantial gender gap exists in students' mathematical achievement, with boys generally outperforming girls. Everyone from parents and teachers to school administrators and curriculum writers to business owners and the general public should work together to change students' mind-set about Mathematics from seeing it as a fixed trait to something that can be honed through hard work and the application of knowledge when problems arise⁵⁸.

A study was conducted in the Cape Coast Metropolis of Ghana to examine the disparities between male and female senior high school students regarding their understanding and achievement in core Mathematics. The sequential explanation mixed method was employed as the specific mixed approach. The research included 393 seniors from various high schools, with 212 men and 181 females chosen using a stratified sampling technique that was convenient, easy, and purposeful. A Mathematics exam, an interview protocol, and Mathematics Perception Questionnaires (MPQ) were used to gather data. We used descriptive and inferential statistics to examine the quantitative data from the math exams and questionnaires, and we used thematic analysis to examine the qualitative data from the interviews.

There was a statistically significant gender gap in students' mathematical achievement, with girls doing better than boys. Compared to male students, female students felt that their parents and teachers offered more help when it came to Mathematics. There was also no statistically significant difference in how men and women saw Mathematics, according to the findings. Mathematics was viewed positively by both males and girls due to its pervasiveness in daily life and its potential to propel success in various other domains. The research concludes that education officials should ensure that male and female students have equal access to core

Mathematics courses and that secondary school maths instructors should model inclusive pedagogy in order to raise the achievement of their male and female students⁵⁹.

Results show that male and female pupils in western China's secondary schools perform differently in Mathematics. Results showed that girls outperformed boys on the Western High School Mathematics Academic Proficiency Test (WHSMAPT) in a number of subjects, including sets, complex numbers, plane vectors, statistics, trigonometric functions, analytic geometry, and functional knowledge modules. The study used two research frameworks—the knowledge structure and the ability structure—to analyse the test scores. In the course modules covering common logic, inequalities, algorithms, probability, sequence, solid geometry, and derivatives, there were no discernible gender disparities. Female students outperformed male students on tests measuring fundamental abilities, mathematical computations, and data processing. In terms of mathematical abstraction, logical reasoning, and intuitive imagination, there were no discernible gender differences among the pupils. To make sure that everyone has an equal chance of success, maths curricula and tests should take gender into account⁸⁰.

This study seeks to verify gender disparities and determine if boys' and girls' attitudes towards Mathematics have any impact on their achievement. Eight hundred ninety-seven elementary school pupils (450 males and 447 females) made up the sample. Although the impact sizes were minor, the results corroborate prior research suggesting that girls generally displayed fewer positive views towards Mathematics compared to their male counterparts. This was especially true with regard to poorer motivation, weaker perceptions of competence, and greater rates of anxiety. While there were no discernible variations in academic achievement between the sexes, as predicted, there was a marked disparity in the explanatory power of attitudes towards Mathematics between boys and girls ($R^2 = 0.194$ and $R^2 = 0.103$, respectively)⁸¹.

Introducing the influence of accomplishment emotions on academic achievement, the findings of the regression analysis for each sample confirm the well-known favourable impact of felt self-efficacy on Mathematics achievement. Since this variable isn't included in the regression equation that explains females' achievement⁷⁹, it appears that test anxiety in Mathematics exclusively impacts guys' grades negatively. We explore the relationship between perceived competence, anxiety, and academic achievement via the lens of control-value theory. Since boys are more likely to be self-assured, driven to stand out, and enthusiastic about Mathematics, their anxiety levels may influence their achievement. While females may experience high rates of anxiety, their outcomes may be affected more by the importance put on Mathematics, since they may not feel they have much control over the situation⁸⁰.

2.3.4 Class-size and Achievement in Algebraic Expression

Examining how larger classes impacted the achievement of pupils in Nigeria's Cross River State in their last year of elementary school was the primary goal of this research. This study used an ex-post facto research strategy. Stratified and simple random selection procedures were used to choose a sample of 1600 upper basic nine students from 81 out of 464 secondary schools in Cross River State. An independent t-test and a one-way analysis of variance were among the data analysis approaches utilised. Students in urban areas outperformed those in rural areas in Mathematics and basic science, suggesting that class size had a substantial impact on students' achievement in these and other upper-level fundamental courses. Once again, the academic achievement of children in upper basic nine was significantly affected by class size⁷⁷.

A number of suggestions were put out, including those rural kids, who do not have the same access to metropolitan life and educational opportunities, should have access to contemporary facilities and teaching materials, and that class numbers should be kept relatively

small in order to promote effective learning. Regardless of whether their school is located in an urban or rural area, all children in the upper basic nine should have access to a conducive learning environment, which includes large classrooms, modern labs, easily accessible libraries, recreational areas, and more.

It looked studied the relationship between class size and the math grades of high school seniors. It used an experimental design with pre- and post-tests. Ninety seniors from three different secondary schools in the Nigerian city of Port Harcourt, Rivers state, were hand-picked for this study. A recognised and reliable instrument with a reliability value of 0.72 was utilised to collect data: the Mathematics Achievement Test (MAT) with multiple choice. To steer the investigation, one research topic and three hypotheses were developed. The hypotheses were tested using T-test analysis at a significance threshold of 0.05⁷⁷. According to the results, the experimental group outperformed the control groups by a substantial margin. On the Mathematics achievement exam, there was no statistically significant difference between the genders of the students in the big and small classes.

The National Policy on Education, which states that no more than one teacher should be presented for every forty students, was one of the suggestions made. In addition, schools should implement a class reduction strategy and construct more classrooms with sufficient learning resources to boost student success⁷⁸.

This study aims to investigate the influence of class size on the academic achievement of students in specific public senior secondary schools located in the Sabon Gari Local Government Area of Kaduna State. This study analysed the impact of class size on students' academic achievement and instructional strategies. A self-administered questionnaire served as the instrument for data collection in this study. A total of two hundred (200) students from four

chosen public secondary schools were utilised for the study. The study involved students from senior secondary two (SS2) and three (SS3)⁷⁶.

A random selection of students was made, resulting in one hundred and seventy (170) correctly filled and collected questionnaires, while thirty (30) questionnaires were either not collected or filled out incorrectly. The analysis utilised descriptive statistics, along with percentages and frequencies. Research indicates that a large class size negatively impacts students' academic achievement in chemistry⁷⁸. Class-size was noted to have significant implications for instructional strategy and the academic achievement of students. It is advisable for the class size to be substantial to promote interaction between teachers and students, facilitating effective teaching and learning. Policymakers should prioritise the enhancement of funding for secondary school education in Nigeria.

Additionally, school supervisors and inspectors ought to focus on managing the number of students in each class to prevent overcrowding⁷⁷. This study aims to assess the connection between classroom size and the academic achievement of secondary school students. The particular objectives examined encompass the following: The goal is to determine if there exists a mechanism that can help identify the factors influencing large, small, or optimal class sizes, aiming to find a balance between size and achievement. The study employs a survey research design. The study was meticulously designed to align with the objectives of the research project, utilising primary data sources. The subjects of this investigation are educators employed in public secondary institutions within the Enugu North Local Government Area.

The 2015 census data issued by the Post Primary School Management Board (PPSMB) indicates that there are nine (9) secondary schools and seven hundred sixty-one (761) teachers in Enugu North LGA. The data treatment approach employed was the utilisation of tables. This study suggests that class size significantly affects the suitability of instructors' educational

tactics. The psychological effects of class size on students' academic achievement indicate that students experience shyness in larger classes, making self-expression challenging. Additionally, the environment tends to become noisy and stressful, increasing the likelihood of students missing lessons without the teacher's awareness in larger class settings.

Consequently, there is sufficient justification to concur that substantial class sizes exert psychological effects on students' academic achievement. The report advises that, where class size reduction is unfeasible within a certain timeframe owing to factors beyond the control of school authorities, instructors and school administration should implement rotating student group creation and study²⁵.

Class size and student achievement were the foci of this research in Tanzania's Kwimba District, which is located in the capital city of Mwanza. The goals were to look at how low student success is when classes are too big and how difficult it is for instructors to handle big classes in Kwimba District's public secondary schools. To frame the investigation, the researcher turned to socio-constructivist and constructivist theories of learning. In addition, it gathered and analysed field data using a mixed research strategy in a convergent parallel design.

Similarly, the researcher collected data from the participants through the use of questionnaires and interviews. The instruments were tested using a split-half approach to ensure reliability and validity. The results showed a correlation coefficient of 0.82, indicating that the data gathering tools were validated. In the end, SPSS was used to display and analyse the quantitative and qualitative data that was collected. The researcher used content analysis to sift through qualitative material, classifying it into themes, integrating it, and finally summarising the results for the report.

Students do worse in large classes due to insufficient resources, lower student achievement, and ineffective classroom instruction; this holds true regardless of class size,

which has an effect on academic achievement. Additionally, the study determined the difficulties teachers had with large class numbers, and the results demonstrated inadequate classroom instruction, ineffective class management, and student disruptions during instruction and learning²⁶.

This study primarily aims to investigate how the size of a classroom affects the academic achievement of Nigerian secondary school pupils. Here are some of the specific aims that were examined: The purpose of this study is to look at how much of an impact class size has on students' achievement in secondary school and how that impact plays out in terms of the mediation of instruction and student learning. This investigation made use of a survey research strategy. The research project's goals informed the meticulous execution of the study's design, which relied on primary sources of data. Public secondary school educators in the Enugu North Local Government Area make up the study's population. The population of Enugu North LGA is estimated as seven hundred sixty-one (761) teachers and nine (9) secondary schools, according to the 2015 census number issued by the Post Primary School Management Board (PPSMB). (2015PPSMB).

The data was processed using tables. The study's results suggest that high class sizes have a negative impact on students' academic achievement. When there are too many students in a classroom, it becomes difficult for the teacher to effectively distribute and demonstrate course material, particularly to the students seated in the back of the room. The report suggests that policymakers in Nigeria give increasing financing for secondary school education high priority, among other things. School administrators and inspectors should pay closer attention to the number of students enrolled in each class and take measures to prevent classroom overcrowding in order to improve academic success in secondary schools, which can be improved with greater money²⁷.

Students and teachers alike see huge class sizes as a barrier to education, despite the fact that many business schools employ them for efficiency reasons. Research on the effects of class size is equivocal, with a strong focus on academic achievement outcomes like test scores and little attention given to classroom dynamics, despite the fact that this is a contentious subject. Our hope is that by looking at classroom dynamics and subjective educational outcomes (such as student learning outcomes and satisfaction), we may broaden the scope of class size research. Large class sizes are a major issue for the majority of Nigeria's public universities.

At Nigeria's Kebbi-State polytechnic Dakin-Gari, this study looked at how students fared in an introductory computer science course (CMP 111) when the class size was large. Using an experimental and a control group, the study used a quasi-experimental research strategy to address the research question (RQ). National Diploma I (ND I) students at Kebbi-State Polytechnic Dakin-gari's School of Applied Sciences, Department of Computer Science and Science Laboratory Technology, were divided into an experimental group with a small class size and a control group with a larger class size.

The students in the former group were taking an introductory computer science course. Fifty students made up the experimental group, which had a smaller class size, while one hundred and fifty (150) students made up the control group, which had a larger class size. That being said, two hundred students were involved in the research. The data was analysed with SPSS-V21 using an independent sample t-test.

The data was obtained using a 20-item essay test with a reliability value of 0.76. One (1) research question and one (1) null research hypothesis (H_0) at the 0.05 level of significance served as the compass for the inquiry. Students' academic achievement was found to be impacted by class size, with smaller classes achieving better results than their larger

counterparts. Consequently, the results of this study indicate that the size of the classroom has a substantial impact on students' achievement in the course.

Results showed an adverse link between student achievement and class size. In terms of academic achievement, pupils in smaller classes fared better than those in larger ones. Reduced class numbers allow for more one-on-one time between teachers and their pupils, which in turn leads to higher quality learning outcomes. This outcome supports the study's recommendation that college administrations pay close attention to class sizes to promote high academic attainment²⁹.

2.3.5 Attitude and Achievement in Algebraic Expression

Numerous demographic, environmental, cognitive, and non-cognitive variables impact academic success. Study abilities, self-assurance, self-efficacy, and personality attributes are the non-cognitive variables that have been extensively studied for their ability to predict mathematical accomplishment. Using statistically valid samples of American students, very little practical research has investigated the role of beliefs and attitudes as predictors of mathematical achievement.

This study applies the theory of planned behaviour (TPB) to the PISA 2012 data in order to deduce why high school students did so well on the maths section of the exam. In addition to important demographic factors, the results showed that students' attitudes, subjective norms, and perceived behavioural control beliefs accounted for 30.7% of the variation in Mathematics achievement, 59.4% of the variability in behavioural engagement with Mathematics learning, and 21.1% of the variability in intentions to pursue and major in Mathematics in the future.

The findings of this study have important implications for several areas of educational research and practice. Firstly, they suggest that an attitude-behaviour framework can be useful

for understanding academic achievement. Secondly, they stress the importance of students' beliefs in their own abilities and control over their own learning when it comes to Mathematics. Thirdly, they suggest that students' attitudes towards Mathematics have a direct impact on their intentions to take math classes³⁰.

Using the active learning heuristic problem-solving (ALHPS) method as a mediator, this study investigated how students' attitudes and achievement on Mathematics word problems (MWTs) relate to one another. The purpose of this research was to examine whether there is a connection between students' dispositions towards ATLPWTs and their achievement in the classroom. The ATMI-SF, an adapted multidimensional measuring instrument with a beta coefficient of .75, and the pre- and post-tests for linear programming accomplishment were used for data collection.

The study utilised a quantitative technique and a quasi-experimental design with a non-equivalent control group that was implemented before and after the exam. Eight public and private secondary schools in Uganda supplied the 608 participants, 291 of whom were male and 317 of whom were female, in their eleventh grade. Using SPSS version 26, the data were analysed using the PROCESS macro (v.4).

The results showed that students' academic achievement was positively and directly correlated with their ATLPWTs. Therefore, students' attitude had a direct and beneficial effect on their achievement while completing word problems using linear programming. This research adds to what is already known about the relationship between motivation, success, and attitude in Mathematics education. In sum, the results have important real-world consequences that help bolster theoretical and conceptual frameworks for improving students' achievement in maths and their outlook on solving mathematical word problems³¹.

This study aimed to explore the present attitudes and challenges faced by female students regarding Mathematics at the Department of Mathematics, Injibara College of Teachers' Education (hereafter referred to as Injibara CTE). A mixed methods approach was employed, utilising a concurrent embedded strategy alongside a descriptive survey design. A questionnaire survey was conducted with 85 female students from the Mathematics department, employing a thorough sampling technique.

Additionally, in-person interviews were conducted with the head of the Mathematics department and the college deans to collect relevant information regarding the challenges encountered by female students in learning Mathematics. Data analysis techniques included both quantitative methods, such as mean, standard deviation, t-test, and post hoc test, as well as qualitative approaches like thematic analysis and narration. The internal consistency reliability was assessed by calculating and reporting Cronbach's alpha coefficients to confirm the validity of the instrument.

This study revealed that female students in the Mathematics department exhibited a positive attitude towards Mathematics, both overall and when analysed by specific components (affective, cognitive, and behavioural). Furthermore, they demonstrated a constructive approach throughout both pre-service and in-service training programs. The analysis revealed a statistically significant difference in attitudes between the two programs, with a preference for the pre-service program.

The obstacles encountered by female students in learning Mathematics were associated with students themselves, teachers, peers, material resources, and administrative factors. Suggestions encompass: Mathematics educators ought to motivate female students while employing suitable teaching strategies, instructional resources, and evaluation methods; higher education institutions should supply the necessary materials for effective Mathematics

education; and further investigation should be pursued in this domain to guarantee validity and reliability³².

Australia has observed a decrease in the number of students selecting Mathematics and science subjects during their senior secondary years, which contradicts economic forecasts indicating a growing demand for skills in these areas. During the junior secondary years, a decline in student engagement with these subjects is often observed. However, factors like self-concept, utility value, and intrinsic value play a crucial role in influencing decisions regarding subject selection. Latent profile analysis was employed to investigate the relationship between attitudes towards the two subjects, utilising data from a sample of 10,051 Australian Grade 8 students collected by TIMSS 2015, which resulted in the identification of six distinct groupings.

Although, a majority of students showed a general openness to both subjects, there were several who either opposed both or demonstrated a clear preference for one over the other. Positive attitudes towards both subjects were mutually beneficial; better attitudes towards both were linked to higher achievement in each. However, boys tended to exhibit more positivity towards both subjects, thus reaping greater benefits from this relationship compared to girls. The discussion includes the implications for educational inquiry and the practices of educators³³.

This investigation examined the attitudes of students towards Mathematics in Grade XI within the Saptari district. This investigation employs a quantitative approach utilising a survey design. This study aimed to investigate the attitudes of higher secondary level students towards Mathematics and the factors influencing their perceptions at grade XI. A total of 230 students were chosen from 8 community-based schools, which were selected using a systematic sampling method.

The data were gathered using a questionnaire schedule. This study utilised 40 statements from a questionnaire to gather quantitative data. The gathered data were systematically organised, tabulated, analysed, and interpreted utilising percentage and chi-square tests to assess the students' attitudes towards Mathematics in grade XI at a significance level of 0.05. The findings of this study indicated that the majority of students exhibited a positive attitude towards Mathematics in grade XI.

However, numerous students are encountering various challenges, including low confidence levels, mathematical anxiety, insufficient qualifications of guardians, home environment issues, and influences from social culture and traditions. The primary factors influencing the attitudes of higher secondary level students towards Mathematics were identified³⁴.

This study examined secondary students' attitudes towards Mathematics learning influenced by many factors, including students' perceptions of the subject, instructors' pedagogical methods, and the classroom atmosphere. It aimed to determine the causes behind preferences for Mathematics and the correlation between attitude and achievement. The researchers utilised the ABC Model and Walberg's Theory of Productivity to examine students' attitudes towards Mathematics and related aspects. Data, both quantitative and qualitative, were gathered from 140 secondary school pupils.

The gathered data were examined with percentages and analytical methods. This research examines and elaborates on the relationship between elements that facilitate learning opportunities and attitudes towards Mathematics education. The findings indicated that attitudes towards Mathematics are affected by three primary factors: opportunities for learning, material coverage, and the quality of teaching practices. The determinants affecting students'

preference for or aversion to Mathematics included their attitudes, teaching methods, and social psychological environmental elements³⁵.

This study aims to examine the influence of determinants of students' mathematical attitudes (namely, attitude, subjective norms, and perceived behavioural control) on intentions, behavioural engagement, and mathematical achievement, as outlined by the theory of planned behaviour (TPB). Data gathered online within the setting of China are utilised to formulate and then evaluate research hypotheses via structural equation modelling. Attitude and subjective norms directly or indirectly influence intentions, behavioural engagement, and mathematical accomplishment.

Furthermore, intentions significantly influence behavioural engagement, which in turn affects mathematical success. Perceived behavioural control is acknowledged to be indirectly associated with intentions, primarily influencing conduct and subsequently affecting Mathematics accomplishment solely through behaviour. In conclusion, the findings of this study will enhance the existing literature on mathematical accomplishment and will also guide policymakers on programs aimed at enhancing students' beliefs and attitudes towards Mathematics to elevate their mathematical achievement³⁶.

The connection between students' attitudes towards Mathematics and their achievement in the subject has attracted significant interest from scholars. Nonetheless, the findings concerning this relationship exhibit a certain level of inconsistency. This study sought to identify the profiles of students' attitudes towards Mathematics and explore their relationship with Mathematics achievement. We conducted an examination of data from the Trends in International Mathematics and Science Study carried out in Singapore in 2019, utilising latent profile analysis. Four profiles of attitudes towards Mathematics were identified: very negative (5.44%), negative (41.38%), neutral (38.77%), and positive (14.41%).

The literature was further validated, illustrating that students' attitudes towards Mathematics are a complex, multi-dimensional construct that includes elements such as enjoyment of Mathematics, perceived value of Mathematics, and confidence in Mathematics. Furthermore, we found a constructive correlation between students' perceptions of Mathematics and their achievement in the subject. The findings indicate that certain students are more inclined to achieve high levels of success in Mathematics: (a) individuals who enjoy studying Mathematics and engage in related activities, (b) those who perceive that learning Mathematics leads to favourable outcomes (such as academic success and career opportunities), and (c) individuals who have confidence in their mathematical skills. Consequently, it is essential for educators to analyse students' perceptions of Mathematics and offer suitable assistance to foster the growth of a favourable attitude towards the subject³⁷.

This study examined the attitudes of undergraduate Mathematics students ($N = 267$) towards proving. The students were enrolled in a course designed to introduce them to the fundamentals of proof, positioned at the start of the Mathematics curriculum and spanning one term. At the start and conclusion of the course, four attitude variables were assessed using a novel self-report instrument: self-efficacy, anxiety, appreciation, and motivation. The instrument drew upon two established tools focused on attitudes towards Mathematics and self-efficacy related to proof. Our investigation focused on the relationship between four attitude variables and the students' prior skills and gender at the course's outset. We also examined the evolution of these attitude variables throughout the course and their impact on the students' academic achievement in the final project.

The findings suggest a connection between students' previous achievement and their self-efficacy, anxiety, and motivation related to proofs at the onset of the course. Female students' demonstrated reduced efficacy and motivation compared to their male counterparts.

Throughout the focus course, there was a notable increase in students' self-efficacy alongside a decrease in their anxiety levels. The disparities in self-efficacy and motivation by gender remained evident throughout the duration of the course. Moreover, strong motivation at the outset of the course was a reliable indicator of successful outcomes in the final project. Our findings indicate that an introductory course on proving can positively influence students' attitudes. We recommend considering these attitudes in teaching, as they may impact students' academic success. Finally, we encourage scholars and practitioners to thoughtfully explore strategies to address gender disparities in Mathematics³⁸.

A considerable portion of students experiences a marked decline in their attitudes towards Mathematics as they progress through secondary education. Therefore, it is crucial to enhance students' attitudes towards Mathematics, as these attitudes can adversely impact their conceptual understanding and overall achievement in the subject. However, the lack of a clear unified construct of Mathematics attitudes creates ambiguity that hinders the ability to draw broad conclusions about improving students' overall Mathematics attitudes.

Consequently, a systematic review of 95 studies was conducted, concentrating on Mathematics attitudes to elucidate the construct and measurement of these attitudes, while also offering a comprehensive overview of the connections between Mathematics attitudes and Mathematics achievement. It was proposed that a multidimensional definition be adopted, viewing attitudes towards Mathematics as a blend of specific mathematical cognitions (such as value, gender roles/beliefs, confidence, and self-concept), affects (including enjoyment and anxiety), and behavioural intentions (i.e., the willingness and tendency to invest more time in learning Mathematics subjects).

The analysis subsequently examined the connections among each sub-dimension of attitudes and achievement in Mathematics. Overall, there was a negative correlation between

anxiety and gender roles with Mathematics achievement ($r = -.27$ to $-.48$; $-.21$). In contrast, factors such as enjoyment, self-concept, confidence, perceived value, and behavioural intentions showed a positive relationship with achievement ($r = .27$ to $.68$; $.21$ to $.76$; $.34$ to $.42$; $.11$ to $.30$; $.21$ to $.34$, respectively) ⁸⁸.

Consequently, the attitudes towards Mathematics seem to consist of three main components, each with various sub-dimensions that distinctly influence Mathematics achievement. In future studies, it is essential to a) clearly define the components of Mathematics attitudes that will inform the investigation, b) implement measures that align with these selected components, and c) explore how each sub-dimension of Mathematics attitudes contributes both uniquely and collectively to Mathematics ability⁸³.

Despite economic predictions of a growing demand for scientific and mathematical abilities, fewer students in Australia are opting to study these subjects in senior secondary school. During junior high, many kids lose interest in these classes, yet attitudes like self-concept, utilitarian value, and intrinsic worth play a big role in deciding what to study utilising data from 10,051 Australian Grade 8 students collected by TIMSS 2015, we conducted an examination utilising latent profile analysis to determine the link between attitudes towards both topics. The results showed six distinct categories. While the majority of students showed some interest in both topics, a sizeable minority either flat-out refused to do either or had a clear bias towards one⁸³.

Both subjects benefited from an optimistic outlook, and higher levels of optimism were linked to improved achievement in both; however, females reaped fewer benefits from this correlation than boys did. Discussion centres on what this means for the future of educational research and classroom instruction. This study examines the mathematical engagement and

success of 312 junior high school pupils determine what factors influence students' mathematical involvement and how it relates to their mathematical success in the classroom.

A study found that students' levels of cognitive engagement with Mathematics had the strongest correlation with their math academic achievement, while students' levels of emotional engagement had the weakest. The results demonstrate a strong relationship between students' Mathematics learning engagement and their math academic achievement in junior high school demonstrate that higher levels of mathematical involvement correlate with higher levels of mathematical academic accomplishment. While this study found no significant effect of gender on students' mathematical engagement, it did find that students' geographic location did have an effect.

A study seeks to analyse the levels of attitudes among grade X students, how those attitudes impact the creation of learning behaviours, and how those behaviours ultimately affect students' academic achievements in Mathematics. It also aims to establish these relationships as a model for achievement⁸⁷. When assessing and interpreting the qualitative data; it was thematically examined to identify categories, and then integrated with the results of the quantitative data. The study indicated that students' achievement varied across ecological areas and rural-urban origins, but that most students had good attitudes and learning habits.

There was no statistically significant difference in success between the sexes, and the results disprove the idea that rural students performed worse than their urban counterparts. Most of the class praised the instructor and said they did better in arithmetic when they used more behaviourist approaches. Results showed that students' attitudes and learning behaviours had a favourable and statistically significant impact on their outcomes. A positive outlook on Mathematics is associated with more effective learning habits, which in turn lead to greater accomplishments, according to the positive correlations between these three variables surveyed

high school seniors in the Eti-osa educational area of Lagos state on their perspectives on Mathematics instruction^{84, 85, 86}. Two hypotheses and one research question served as the study's compass.

A descriptive survey research strategy was used in this investigation. Participants were second-year high school students from the Eti-osa Educational district. Based on factors such as population size and accessibility, a sample of 200 students was randomly selected from 10 out of around 40 senior secondary schools in the Eti-osa Local Government Education region⁸⁷.

A survey called the Students' Mathematical Attitude Inventory (SMAI) served as the research tool. The instrument's validity was checked by specialists from NOUN's Faculty of Education. A subset of the initial sample population ($n=30$) from the Apapa Local Government Area in Lagos State's secondary schools was used to establish the instrument's dependability. Every two weeks, the exercise was done again. We estimated the reliability using the test-retest technique based on the findings of the analysed data. The reliability index was 0.86, which was regarded appropriate for the research. Independent sample test (IST), descriptive statistics, and frequency distribution were used to analyse the field data. At the 0.05 threshold of significance, the hypotheses were examined.

It was discovered that in the Eti-osa educational region of Lagos State, there were no discernible variations in the learning attitudes of male and female senior secondary school pupils with regard to Mathematics, as well as between public and private schools. The results informed the recommendations, one of which was that the Lagos state government, educators, and parents work together to change the way kids feel about Mathematics. Numerous academics have paid close attention to the impact of students' attitude on their mathematical proficiency.

The results concerning these impacts, however, are not entirely consistent. The research team in this study set out to determine whether and how students' mental attitudes towards Mathematics impacted their achievement in Mathematics classes at the secondary level at AJ&K. Specifically, this study set out to do three things:(1) examine students' attitudes towards Mathematics at the secondary level in AJ&K;(2) compare students' attitudes towards Mathematics and their academic accomplishment in Mathematics (by gender); and(3) determine the impact of students' attitudes on their academic achievement in Mathematics at the secondary level in AJ&K. Both quantitative and descriptive methods were used in the study⁸⁹.

The study's population consisted of all tenth graders from District Bagh AJ&K's government secondary schools. The District Bagh Government Secondary Schools had a total of 1076 pupils, with 458 males and 618 girls enrolled in the tenth grade. A stratified random sampling strategy was used to collect the sample. The researcher used a proportional stratified random selection approach to choose 444 students, including 192 males and 252 females. In order to gather information, researchers developed a questionnaire using a five-point Likert scale. Students' mathematical accomplishments were found to be influenced by their mood.

Students' achievement in school was positively correlated with their parents' level of education, occupational position, and social standing. Motivating kids to reach their mathematical objectives was suggested. Determine whether there is a correlation between high school pupils' mathematical attitudes and their mathematical achievement. A validated questionnaire and documentary analysis were the primary tools for data collection in this descriptive correlation study. Using weighted mean and Pearson r , the collected data were examined and understood. The kids' comments indicated a generally good attitude towards Mathematics. In addition, the pupils are getting very close to reaching competency level in

Mathematics. The results showed that the way a student feels about the topic has an effect on how well they do in it. In order to corroborate the findings of this study, more research on the same topic may be undertaken. It is possible to expand the scope by including more variables⁸⁹.

Research on the correlation between students' mathematical mind-set and their mathematical achievement has received a great deal of attention. The results about this association, however, are not entirely consistent. Consequently, the purpose of this research was to characterise students' perspectives on Mathematics and to investigate the connection between these perspectives and students' achievement in Mathematics. This study used latent profile analysis to look the 2019 Trends in International Mathematics and Science Study data that was collected in Singapore. There were four distinct attitudes towards Mathematics that we were able to identify: extremely unfavourable (5.44%), negative (41.38%), neutral (36.77%), and positive (14.41%). We also verified what previous research has shown: those students' attitudes towards Mathematics are best described as an integrated multi-dimensional construct that includes three dimensions: "like Mathematics," "value Mathematics," and "confidence in Mathematics."

In addition, we found that students' outlook on Mathematics and their achievement in Mathematics were positively correlated. According to these findings, students who (a) enjoy math and engage in math-related activities are more likely to have high Mathematics achievement; (b) believe that learning Mathematics will lead to positive outcomes (like success in school and job opportunities), and (c) have faith in their own mathematical abilities are more likely to have high Mathematics achievement. Therefore, it is the responsibility of educators to assess their students' attitudes towards Mathematics and to offer suitable assistance in order to foster the growth of an optimistic attitude towards Mathematics. When students have a positive

outlook on Mathematics, they not only perform better, but their overall accomplishment and ability to apply Mathematics in real-life situations are also affected.

Our study on students' perspectives on linear programming (LP) Mathematics word problems (LPMWPs) is detailed in this article. A non-equivalent control group was utilised in an explanatory sequential quasi-experimental design that went as follows: pre-intervention, intervention, post-intervention. There were 851 participants total, including 359 boys and 492 girls from 8 different public and private secondary schools in Uganda who were in eleventh grade. Eight schools, four in central Uganda and four in eastern Uganda, were selected using cluster random sampling. In order to test students' attitude towards LPMWPs, the ATMI-SF was modified (with $\alpha = 0.75$) to serve as a multidimensional assessment instrument. It turned shown that most students felt negatively about LPMWPs.

There was a positive correlation between usefulness and enjoyment, motivation, and confidence, and a negative correlation between the three on a weekly basis. The data also did not show any statistically significant correlation between students' views on LPMWPs and demographic variables such as age, gender, school location, school status, or school ownership. Factors such as students' academic history, school traits, and perceptions about the transition from elementary to secondary school, as well as theoretical and/or psychometric constraints, may help to explain the disparity. Other empirical findings on students' attitude towards studying Mathematics word problems have been acknowledged, and this study adds to them⁹⁰.

Helped various educational stakeholders understand how to gauge students' feelings about LPMWPs, which might lead to the development of intervention and remediation plans to help students shift their thinking. Researchers concluded that math educators should pique their kids' curiosity about the subject from a young age. To improve students' comprehension, achievement, and motivation in solving mathematical word problems, it may be helpful to use a

variety of teaching strategies in the classroom. Taken together, the results provide credence to the theoretical framework for bettering the acquisition of LP and other mathematical word problems⁹⁰

2.4 Conceptual Model

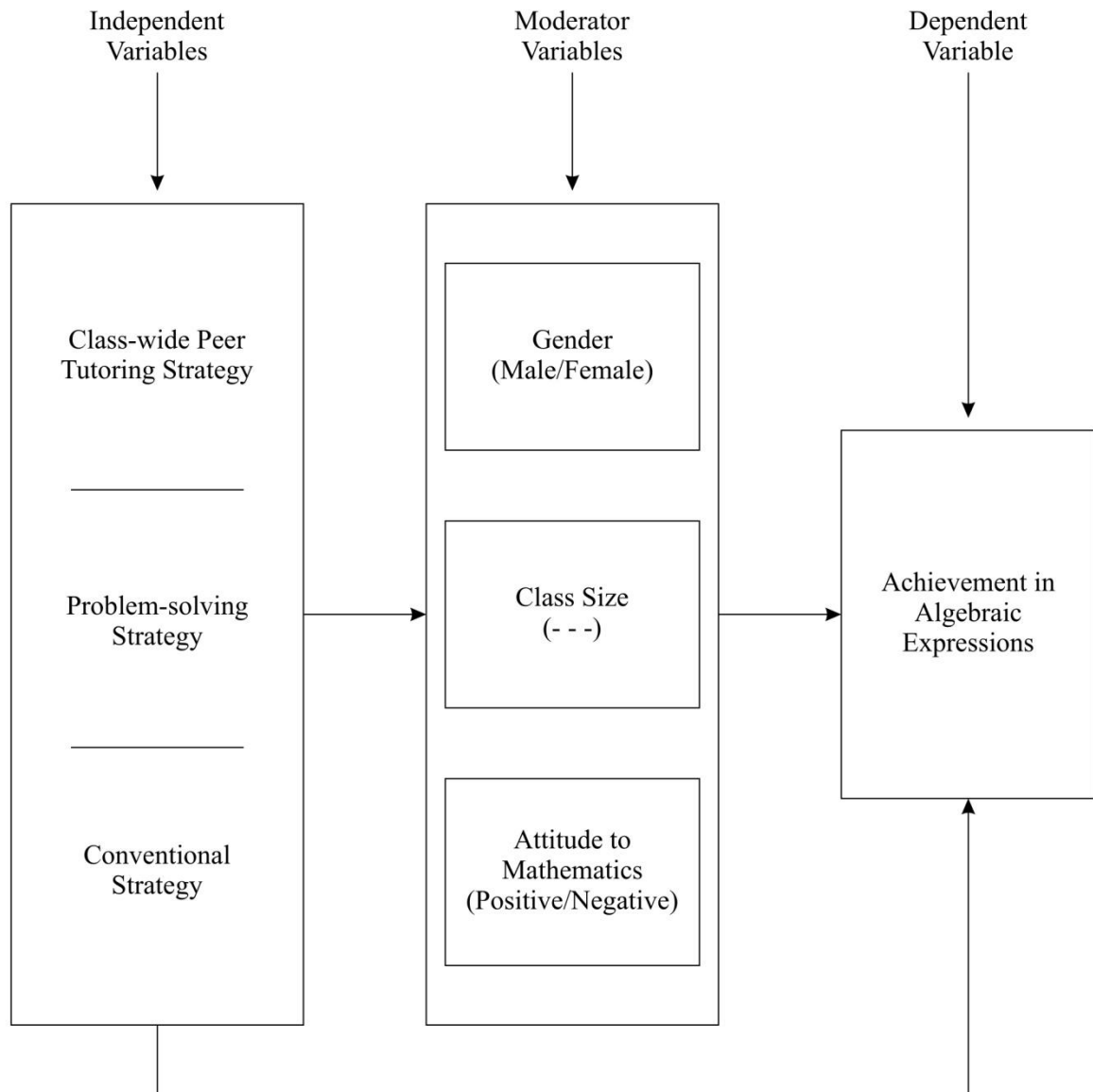


Fig 2.1

Source: Researcher's Field Work 2024

The conceptual model depicts how the different variables interact with one another. There is a connection between the dependent variable, mediating variable and the two independent variables. The effect that the independent factors have on the students' academic achievement, which is the dependent variable, will be investigated.

2.5 Summary of Gap in Literature Reviewed

In conclusion, the roles of tutors and tutees in Class-wide Peer tutoring in Algebraic expressions are integral to the success of the instructional approach. Tutors serve as knowledgeable guides, mentors, and facilitators of learning, while tutees actively engage with the material, seek assistance, and take ownership of their learning journey. Together, tutors and tutees form a dynamic learning partnership characterized by collaboration, inquiry, and mutual support, ultimately leading to enhanced understanding, proficiency, and achievement in algebraic expressions. By embracing their respective roles and responsibilities, tutors and tutees contribute to a positive and enriching learning environment where mathematical concepts are explored, understood, and applied with confidence and competence.

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Chapter Three

Methodology

This chapter delves into the methodology employed in this investigation. It encompasses the design of the study, the population involved, the sampling method, and a detailed description of the research instruments. Validity of research instruments, reliability of research instruments, and administration of research instruments collection, and data analysis.

3.1 Research Design

This study used pre-test and post-test quasi-experimental control group using 3x2x2x2 factorial matrix with a non-randomized control group and non-equivalent intact groups. It focused on the effects of class-wide peer tutoring and problem-solving strategies at three levels (2 treatment groups and a control group). Class-wide peer tutoring and problem-solving strategies and conventional strategies are instructional strategy which served as the treatment group for the experimental and control groups. The dependent variable was the students' academic achievement in pre-test and post-test of Algebraic expressions.

Table 3.1: Research Design Layout

Group	Pre-test	Treatment	Post-test	Moderating variables	Achievement
E ₁	Q ₁	X ₁	Q ₄	Gender	Students' scores
E ₂	Q ₂	X ₂	Q ₅	Attitude	Algebraic
E ₃	Q ₃	X ₃	Q ₆	Class-size	Expression Test

Source: The Researcher, 2024

E_1 – Experimental 1 for Class-wide Peer tutoring

E_2 – Experimental 2 for Problem-solving strategies

E_3 –Conventional Method

Q_1 - Pre-test for treatment group 1

Q_2 - Pre-test for treatment group 2

Q_3 - Pre-test for control group

Q_4 - Post-test for treatment group 1

Q_5 - Post-test for treatment group 2

Q_6 - Post-test for control group

X_1 - Treatment1

X_2 - Treatment 2

3.2 Population of the Study

The study's population consisted of all first-year students enrolled in Federal Colleges of Education located in Southwest Nigeria, specifically including Federal College of Education (Special) Oyo in Oyo State, Federal College of Education Osiele in Abeokuta, Ogun State, and Federal College of Education Iwo in Osun State. The population of 100 level Basic General Mathematics for students in Federal College of Education Special, Oyo, was 160 students, while in the total student population at Federal College of Education Abeokuta was 130 and at Federal College of Education Iwo, Osun State, the total were 90 students. The overall population for this study was 380, Basic General Mathematics for students of the schools in consideration as at the time of conducting this study.

Table 3.2: Population of the Study

Federal College of Education (Special) Oyo, Oyo State	Federal College of Education Osiele Abeokuta, Ogun State	Federal College Education, Iwo, Osun State	Total Population
160	130	90	380

Source: Record Office of the Examination Unit in each of the College

3.3 Sample and Sampling Techniques

A multi-stage sampling technique was employed to choose the participants for the study. The initial phase included employing a simple random sampling technique to select three Federal Colleges of Education that fulfilled the criteria of having qualified lecturers proficient in diverse methods of teaching and learning Algebraic expressions. Secondly, a random sampling technique was employed to select the Basic General Mathematics students as participation for the study. Finally, the study consists of three intact classes of 100 level Basic General Mathematics students. The two experimental groups (E1 & E2) participated in class-wide peer tutoring and problem-solving strategies, whereas the control group (E3) received instruction through conventional teaching strategy.

3.4 Description of Research Instruments

This study utilised three research instruments: the Algebraic Expressions Students' Academic Achievement Test (AESAAAT), the Questionnaire on Students Attitude (QSA), and three Lesson Plan Format (LPF). These tools were designed to facilitate the teaching and learning of Algebraic expressions, which is central to the study

3.4.1 Algebraic Expressions Students' Academic Achievement Test (AESAAT)

The achievement tests were constructed to evaluate students' understanding of concepts related to Algebraic expressions. The focus was on the core concept of Basic General Mathematics II, specifically 'Algebraic Expressions,' which is part of the curriculum for NCE 1 in the second semester. The assessment comprises 50 multiple-choice questions, with four options, labelled A to D. These questions are designed to align with six levels of cognitive domains: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation.

3.4.2. Questionnaire on Students Attitude (QSA)

A self- structure questionnaire that contained 10 items which measured students' attitude toward Algebraic expressions was administered.

3.4.3. Lesson Plan Format (LPF)

Lesson plans were developed by the researcher in order to guide the teaching of Algebraic expressions in NCE 1 with course code GSE 122.

3.5 Description of the Research Instruments

Algebraic Expressions Students' Academic Achievement Test (AESAAT) was answered by the students in Basic General Mathematics II. It was divided into 4 sections. Section A consists of demographic data which include gender, class size, level, and name of institution. Section B comprised 50 multiple choice questions which was self-structured to test the students' academic achievement in Basic General Mathematics II, Section C consists of Questionnaire on Students Attitude (QSA) and Section D contained the Lesson Plan Format (LPF)

Find below table of specification for AESAAT

Table 3.3: Table of Specifications

	Topic /Theme	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total	%
1	Expansion & Factorization	3	2	2	1	1	1	10	20
2	Simple Algebraic equations	3	2	2	1	1	1	10	20
3	Simple words problems	2	2	3	1	1	1	10	20
4	Ratio, percentage, simple and compound interest	2	2	3	1	1	1	10	20
5	Variations	2	1	3	2	1	1	10	20
	TOTAL	12	9	13	6	5	5	50	100
	%	24	18	26	12	10	10	100	

Source: The Researcher, 2024

Experimental Group I (Class-wide Peer tutoring strategy)

Develop a detailed lesson plan outlining the objectives and key concepts of Algebraic expressions (e.g., variables, constants, coefficients, terms, and simplification).

- Arrange the classroom to facilitate easy interaction between pairs of students and ensure that all students can see the board or screen for whole-class instruction.
- Provide a brief introduction to Algebraic expressions, including key terms and basic concepts.
- Explain the Peer tutoring process and its benefits and teach students on how to be effective tutors and tutees. This includes how to ask and answer questions, provide feedback, and encourage each other.
- Pair students strategically, matching those with stronger understanding of Algebraic expressions with those who may need more explanations.
- All students should have the opportunity to be both a tutor and a tutee at different times.

- Begin with direct instruction on a specific aspect of Algebraic expressions (evaluate and simplifying expressions).
- Demonstrate solving a few problems on the board, explaining each step clearly.
- Distribute worksheets or practice problems for the peer tutoring session. Each pair should work together, with the tutor explaining concepts, guiding the tutee through problems, and providing feedback.
- Monitor the pairs, offering support and clarifications as needed.
- After a set period, have students switch roles, allowing the tutee to become the tutor and vice versa. This ensures both students get the chance to teach and learn.
- After the peer tutoring session, bring the class together for a group discussion.
- Provide a short quiz or set of problems to assess student understanding.

Experimental Group II (Problem-solving strategy)

- Start with a brief introduction to Algebraic expressions, explaining key terms such as variables, constants, coefficients and terms.
- Present a specific problem related to Algebraic expressions to the class. Ensure the problem is clear and understandable.
- Guide students in understanding the problem. Break down the problem into smaller parts if necessary.
- Discuss strategies to solve the problem. This can include identifying the operations needed, determining the order of steps, and deciding which formulae or rules to apply.
- Work through the problem step-by-step with the class. Write each step on the board and explain the reasoning behind it.
- After solving the problem, review each step to ensure everyone understands the process.
- Provide students with additional problems to practice on their own or in small groups.

- Allow the students to share their solutions and explain their reasoning to the class.
- Assess the students' understanding through a quiz or class work that includes a variety of problems related to Algebraic expressions.

Experimental Group III (Conventional Strategy)

- Develop a detailed lesson plan with clear objectives and key topics to cover (e.g., variables, constants, coefficients, terms, expressions, and simplification).
- Begin with an engaging introduction to capture students' interest and provide context for why Algebraic expressions are important.
- Introduce key concepts step-by-step, starting with the basics of Algebraic expressions.
- Break down the process of constructing and simplifying Algebraic expressions.
- Provide students with practice problems to work on in class.
- Pause periodically to ask questions that check for understanding.
- Provide a range of problems, from basic to more challenging, to cater to different skill levels.
- Assess the students by including a variety of question types, such as multiple-choice, short answer, and problem-solving questions.

3.6 Validity of Research Instrument

The validation of the research instrument was done by the supervisor and three Lecturers in the Department of Science Education at Lead City University in Ibadan, Nigeria. The AESAAT that was constructed initially comprised 50 objective questions, which underwent a thorough review by experts to ensure its legitimacy in terms of both face, content and construct validity of the instrument. All corrections and suggestions were implemented prior to the production of the final draft.

3.7 Reliability of Research Instrument

A pilot study was carried out to assess the reliability of the Basic General Mathematics Students' Academic Achievement Test (AESAAAT) utilising 100 Level students. The research tool was applied to a similar population that was not involved in the primary study. The reliability value of the instrument was determined using the Kuder Richardson (KR-20) formula. The internal consistency of the BGMSAAT was 0.87. The reliability value of Questionnaire on Students Attitude (QSA) using Cronbach Alpha was ($r=0.76$).

3.8 Administration of Research Instrument(s)

Prior to the administration of the instruments to the students, an introductory letter was secured from the Head of Department (HOD), Science Education, Lead City University Ibadan, and subsequently sent to the Heads of the selected Federal Colleges of Education. Prior to the administration of the instruments, the approval of the Lecturers and the collaboration of the chosen students were obtained. In addition to the two weeks allocated for training the research assistants and conducting the pre-test across all groups, the study spanned a total of eight weeks. This included six weeks dedicated to the treatment phase, followed by two weeks for administering the post-test. The team and the assistants waited for all the participating students to complete the achievement test before collecting the instruments.

3.9 Method of Data Analysis

The collected data underwent analysis through descriptive statistics, employing frequency counts, tallies, and percentages. The seven hypotheses formulated for the study underwent testing through Analysis of Covariance (ANCOVA) at a significance level of 0.05 to show the significant effect of class-wide peer tutoring, problem-solving and conventional

strategies, gender, class-size, attitude, interaction effect of class-wide peer tutoring, problem-solving, conventional teaching strategies, gender, class-size and attitude on students' academic achievement in Algebraic expressions. The Estimated Marginal Means of effect of class-wide peer tutoring, problem-solving and conventional strategies, gender, class-size, attitude, interaction effect of class-wide peer tutoring, problem-solving, conventional teaching strategies, gender, class-size and attitude on students' academic achievement in Algebraic expressions were determined.

Chapter Four

Results and Discussion of Findings

This chapter provides an overview of the analytical results and engages in a discussion of the findings. The findings and their discussion were articulated in relation to the demographic characteristics of the participants, along with the hypotheses outlined.

4.1 Demographic Data Analysis

These are the socio-demographic characteristics of the participants.

Table 4.1: Distribution of the Participants by Gender

Gender	Frequency	Percent	Cumulative Percent
Female	244	64.2	64.2
Male	136	35.8	100.0
Total	380	100.0	

Source: Field Survey, 2024

Table 4.1 revealed that 244 (64.2%) of the participants were female, while 136 (35.8%) were male. This means that most of the participants were female.

Table 4.2: Distribution of the Participants by Groups

Group	Frequency	Percent	Cumulative Percent
Conventional strategy	90	23.7	23.7
Class-wide Peer tutoring strategy	160	42.1	65.8
Problem-solving strategy	130	34.2	100.0
Total	380	100.0	

Source: Field Survey, 2024

Table 4.2 revealed that 90 (23.7%) of the participants were exposed to conventional strategy of teaching as control group at Federal College Education Iwo, Osun State, 160 (42.1%) of the participants were exposed to class-wide peer tutoring at Federal College of Education Special, Oyo, Oyo State, while 130 (34.2%) of the participants were exposed to Problem-solving strategies at Federal College Education Osiele, Abeokuta, Ogun State, The numbers of the participants varied under each group because they were randomly sampled from intact group of each College population.

4.2 Test of Hypotheses

H₀₁: There will be no significant main effect of class-wide peer tutoring, problem-solving and convectional strategies on students' academic achievement in Algebraic expressions.

Table 4.3a: Analysis of covariance of main effect of class-wide peer tutoring, problem-solving and conventional strategies on students' academic achievement in Algebraic expressions

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3480.523 ^a	3	1160.174	235.866	0.000	0.653
Intercept	4305.764	1	4305.764	875.371	0.000	0.700
Pre-test	0.033	1	0.033	0.007	0.934	0.000
Group	3464.415	2	1732.207	352.161*	0.000*	0.652
Error	1849.464	376	4.919			
Total	211209.000	380				
Corrected Total	5329.987	379				

a. R Squared = .653 (Adjusted R Squared = 0.650) * denote significant at $p \leq 0.05$

Source: Field Survey, 2024

Table 4.3a indicated a significant main effect of the class-wide peer tutoring, problem-solving and convectional strategies on students' academic achievement in Algebraic expressions ($F_{(2, 379)} = 352.161$ $p < 0.05$, partial $\eta^2 = 0.653$). The null hypothesis was rejected. The findings suggest that implementing class-wide peer tutoring and problem-solving and intervention strategies had a notable and independent impact on students' academic achievement in Algebraic expressions. The partial eta squared value of 0.65 indicated a contributing effect size of 65%. The findings indicate that students exhibited improved achievement following the implementation of class-wide peer tutoring and problem-solving and convectional strategies.

Table 4.3b: Estimated Marginal Means of Class-wide Peer tutoring, Problem-solving strategies on students' academic achievement in Algebraic expressions.

Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Convectional strategy	17.843 ^a	0.234	17.383	18.304
Class-wide Peer tutoring strategy	25.012 ^a	0.176	24.667	25.357
Problem-solving strategy	24.902 ^a	0.196	24.517	25.287

Source: Field Survey, 2024

Table 4.3b showed that participants exposed to class-wide peer tutoring strategy (treatment group 1) had the highest post-test mean ($\bar{x}$) score of 25.012 on students' academic achievement in Algebraic expression, followed by those in problem-solving strategy (treatment group 2) with post-test mean ($\bar{x}$) score of 24.902 compared to other participants in the control group with post-test mean ($\bar{x}$) score of 17.843. This means that participants exposed to class-wide peer tutoring strategy of learning (treatment group 1) and problem-solving strategies (treatment group 2) performed better than those in the control group, the difference is sufficient

to justify the effect of class-wide peer tutoring strategy (treatment group 1) and problem-solving strategy (treatment group 2) over conventional strategy of Algebraic expressions.

H₀₂: There will be no significant main effect of gender on students' academic achievement in Algebraic expressions

Table 4.4a: Analysis of covariance of main effect of gender on students' academic achievement in Algebraic expressions

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	16.141 ^a	2	8.071	0.573	0.5650	0.003
Intercept	5211.924	1	5211.924	369.769	0.0000	0.495
Pre-test	15.995	1	15.995	1.135	0.2870	0.003
Gender	0.033	1	0.033	0.002	0.9610	0.000
Error	5313.845	377	14.095			
Total	211209.000	380				
Corrected Total	5329.987	379				

a. R Squared = 0.003 (Adjusted R Squared = -0.002)

Source: Field Survey, 2024

Table 4.4a showed no significant main effect of gender on students' academic achievement in Algebraic expressions ($F_{(1; 379)} = 0.002$ $p > 0.05$, partial $\eta^2 = 0.000$). The null hypothesis was therefore not rejected. This implies that gender as a factor independently and significantly do not affect the students' academic achievement in Algebraic expressions. Also, the pair eta squared value of 0.000 showed the contributing effect size of only 0.0%.

Table 4.4b: Estimated Marginal Means of gender on students' academic achievement in Algebraic expressions

Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Female	23.283 ^a	0.240	22.811	23.756

Male	23.264 ^a	0.322	22.630	23.897
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Source: Field Survey, 2024

Table 4.4b showed that although female participants had higher post-test mean ($\bar{x}$) score of 23.283 than the male counterparts with post-test mean ($\bar{x}$) score of 23.264, there is little or no difference among the two gender in term of their mean scores. The difference is not statistically significant. This means that after neglecting other factors, gender is not a key factor that significantly affects the students' academic achievement in Algebraic expressions.

H₀₃: There will be no significant main effect of class-size on students' academic achievement in Algebraic expressions

Table 4.5a: Analysis of covariance of main effects of class size on students' academic achievement in Algebraic expressions

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3480.523 ^a	3	1160.174	235.866	0.000	0.653
Intercept	4305.764	1	4305.764	875.371	0.000	0.700
Pre Test	0.033	1	0.033	0.007	0.934	0.000
Class size	3464.415	2	1732.207	352.161	*0.000	0.652
Error	1849.464	376	4.919			
Total	211209.000	380				
Corrected Total	5329.987	379				

a. R Squared = 0.653 (Adjusted R Squared = 0.650) * denote significant at $p \leq 0.05$

Source: Field Survey, 2024

Table 4.5a indicates a substantial main effect of class size on students' academic achievement in Algebraic expressions ($F_{(2,379)} = 352.161$ $p < 0.05$, partial $\eta^2 = 0.653$). The null hypothesis was consequently rejected. This indicated that class size, as a moderator factor, had a significant impact on students' academic achievement in algebraic expressions. The partial eta squared value of 0.65 indicates a contributing effect size of 65%.

Table 4.5b: Estimated Marginal Means of effect of class size on students' academic achievement in Algebraic expressions

class size	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
90 (Control)	17.843 ^a	0.234	17.383	18.304
130 (treatment 1)	24.902 ^a	0.196	24.517	25.287
160 (Treatment 2)	25.012 ^a	0.176	24.667	25.357

Source: Field Survey, 2024

Table 4.5b showed an increasing trend in the class-size of the groups. Those with 90 participants has a post-test mean score ($\bar{x}$) score of 17.843, those with 130 participants has post-test mean score ($\bar{x}$) score of 24.902 and those with 160 participants has a post-test mean score of ($\bar{x}$) score of 25.012.

H₀₄: There will be no significant interaction effect of class-wide peer tutoring, problem-solving, convectional strategies and gender on students' academic achievement in Algebraic expressions

Table 4.6a: Analysis of covariance of interaction effect of class-wide peer tutoring, problem-solving convectional strategies, and gender on students' academic achievement in Algebraic expressions

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3485.170 ^a	6	580.862	117.443	0.000	0.654
Intercept	4244.098	1	4244.098	858.106	0.000	0.697
Pre-test	0.018	1	0.018	0.004	0.951	0.000
Gender	0.034	1	0.034	0.007	0.934	0.000
Group	3272.188	2	1636.094	330.799	0.000	0.639
Gender Treatment	4.582	2	2.291	0.463	0.630	0.002
Error	1844.817	373	4.946			
Total	211209.000	380				
Corrected Total	5329.987	379				

a. R Squared = 0.654 (Adjusted R Squared = 0.648)s

Source: Field Survey, 2024

Table 4.6a indicated no significant interaction effect of class-wide peer tutoring, problem-solving convectional strategies, and gender on students' academic achievement in Algebraic expressions ($F_{(2, 379)} = 0.463$ $p > 0.05$, partial $\eta^2 = 0.002$). The null hypothesis was therefore not rejected. This implies that the interaction effect of the treatment and gender do not significantly affect the students' academic achievement in Algebraic expressions. Also, the partial eta squared value of 0.002 showed the contributing effect size of only 0.02%.

Table 4.6b: Estimated Marginal Means of class-wide peer tutoring, problem-solving, convectional strategies and gender on students' academic achievement in Algebraic expressions

Group	Gender	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	Female	17.982 ^a	0.295	17.402	18.561
	Male	17.605 ^a	0.387	16.843	18.367
Class-wide Peer tutoring	Female	24.972 ^a	0.215	24.549	25.395
	Male	25.092 ^a	0.307	24.488	25.696
Problem-solving strategies	Female	24.826 ^a	0.249	24.336	25.317
	Male	25.021 ^a	0.315	24.401	25.642

Source: Field Survey, 2024

Table 4.6b showed that for the control group, both female and male participants have close mean of 17.982 and 17.605, respectively. It is also clear from the table that class-wide peer tutoring had a slight mean difference between both gender, with female participants mean score ($\bar{x}$) of 24.972, while the mean of male participants is a bit higher ($\bar{x}$) = 25.092. For problem solving strategy, the female participants had a mean score ($\bar{x}$) = 24.826 while the male participants had a mean score of ($\bar{x}$) of 25.021. Though, the difference in the mean scores was not significant, the male participants seem to be more responsive to both treatments than the female participants.

H₀₅: There will be no significant interaction effect of class-wide peer tutoring, problem-solving, convectional strategies and attitude on students' academic achievement in Algebraic expressions.

Table 4.7a: Analysis of covariance of interaction effect of Class-wide peer tutoring, problem-solving, convectional strategies and attitude on students' academic achievement in Algebraic expressions

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4435.262 ^a	6	739.210	507.016	0.000	0.891
Intercept	3955.079	1	3955.079	2712.744	0.000	0.879
Pre-test	5.753	1	5.753	3.946	0.048	0.010
Group	3064.881	2	1532.440	1051.084	0.000	0.849
Attitude	957.053	1	957.053	656.432	0.000	0.638
Group Attitude	1.641	2	0.821	0.563	0.570	0.003
Error	543.820	373	1.458			
Total	210021.000	380				
Corrected Total	4979.082	379				

a. R Squared = 0.891 (Adjusted R Squared = 0.889)

Source: Field Survey, 2024

Table 4.7a indicated no interaction effect of class-wide peer tutoring, problem-solving, convectional strategies and attitude on students' academic achievement in Algebraic expression ($F_{(2; 379)} = 0.563$ $p > 0.05$, partial $\eta^2 = 0.003$). The null hypothesis was not rejected. The findings indicated that the interaction between the treatment and attitude has no significant impact on the academic achievement of students in Algebraic expressions. The partial eta squared value of 0.003 indicates that the contributing effect size is 0.03%.

Table 4.7b: Estimated Marginal Means of class-wide peer tutoring, problem-solving, convectional strategies and attitude on students' academic achievement in Algebraic expressions

Group	Attitude	Mean	Std. Error	95% Interval	Confidence
				Lower Bound	Upper Bound
Control	Avoidance	16.396 ^a	0.167	16.067	16.725
	Constant practices	19.788 ^a	0.196	19.402	20.174
Class-wide Peer tutoring strategy	Avoidance	23.243 ^a	0.134	22.980	23.505
	Constant practices	26.622 ^a	0.137	26.353	26.891
Problem-solving strategy	Avoidance	23.204 ^a	0.159	22.893	23.516
	Constant practices	26.308 ^a	0.144	26.025	26.592

Source: Fieldwork 2024

Table 4.7b indicated that, while the interaction effect of attitude was not statistically significant for academic achievement, the calculated marginal mean clearly demonstrated a practical impact of attitude on students' academic achievement in Algebraic expressions. In the control group exhibiting an avoidance attitude, the mean score obtained was 16.396, whereas those engaged in consistent behaviours had a higher mean score of 19.788. In the class-wide peer tutoring, those with an avoidance attitude have a mean score of 23.243, whereas those with a consistent practice attitude have a better mean score of 26.622. Participants in the problem-solving techniques group exhibiting an avoidance attitude, achieved a mean score of 23.204, but those with a consistent practice attitude attained a better mean score of 26.308. This indicates that regardless of the teaching group or strategy employed, students' attitudes towards learning will significantly influence their academic achievement, even in Algebraic expressions.

H₀₆: There will be no significant effect of gender and attitude on students' academic achievement in Algebraic expressions

Table 4.8a: Analysis of covariance of interaction effect of gender and Attitude on students' academic achievement in Algebraic expressions

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Squared	Eta
Corrected Model	1333.879 ^a	4	333.470	34.306	0.000	0.268	
Intercept	4792.589	1	4792.589	493.037	0.000	0.568	
Pre-test	1.226	1	1.226	0.126	0.723	0.000	
Attitude	1269.700	1	1269.700	130.620	0.000	0.258	
Gender	3.144	1	3.144	0.323	0.570	0.001	
Attitude * Gender	11.034	1	11.034	1.135	0.287	0.003	
Error	3645.202	375	9.721				
Total	210021.000	380					
Corrected Total	4979.082	379					

a. R Squared = 0.268 (Adjusted R Squared = 0.260)

Source: Field Survey, 2024

Table 4.8a showed that no significant interaction effect of gender and attitude on students' academic achievement in Algebraic expression ($F_{(1, 379)} = 1.135$ $p > 0.05$, partial $\eta^2 = 0.003$). The null hypothesis is therefore not rejected. This implies that the interaction effect of gender and attitude do not significantly affect the students' academic achievement in Algebraic expressions. Also, the partial eta square value of 0.003 showed the contributing effect size of only 0.03%.

Table 4.8b: Estimated Marginal Means of gender and Attitude on students' academic achievement in Algebraic expressions

Attitude	Gender	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Avoidance	Female	21.451 ^a	0.285	20.892	22.011
	Male	21.286 ^a	0.368	20.562	22.010
Constant practices	Female	24.922 ^a	0.280	24.370	25.473
	Male	25.468 ^a	.390	24.702	26.234

Source: Field Survey, 2024

Table 4.8b revealed that for the female participants with avoidance attitude had a mean score ($\bar{x}$) = 21.451 while those with constant practices had a mean score of 24.922. In like manner, male participants with avoidance attitude had a mean score ($\bar{x}$) = 21.286 while those with constant practice attitude performed better with mean score ($\bar{x}$) = 25.468.

H₀7: There will be no significant effect of treatment class-wide peer tutoring, problem-solving, conventional strategies, gender and attitude on students' academic achievement in Algebraic expressions

Table 4.9a: Analysis of covariance of effect of treatment class-wide peer tutoring, problem-solving, convention strategies, gender and attitude on students' academic achievement in Algebraic expressions

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4444.510 ^a	12	370.376	254.274	0.000	0.893
Intercept	3908.599	1	3908.599	2683.374	0.000	0.880
Pre-test	4.670	1	4.670	3.206	0.074	0.009
Group	2776.888	2	1388.444	953.210	0.000	0.839
Attitude	858.183	1	858.183	589.169	0.000	0.616
Gender	2.242	1	2.242	1.539	0.216	0.004
Group Attitude	1.543	2	0.771	0.530	0.589	0.003
Group Gender	1.492	2	0.746	0.512	0.600	0.003
Attitude Gender	0.091	1	0.091	0.062	0.803	0.000
Group Attitude Gender	4.174	2	2.087	1.433	0.240	0.008
Error	534.572	367	1.457			
Total	210021.000	380				
Corrected Total	4979.082	379				

a. R Squared = 0.893 (Adjusted R Squared = 0.889)

Source: Field Survey, 2024

Table 4.9a showed that no significant effect of treatment class-wide peer tutoring, problem-solving, conventional strategies, gender and attitude on students' academic achievement in Algebraic expressions ($F_{(2, 379)} = 1.433$ $p > 0.05$, partial $\eta^2 = 0.008$). The null hypothesis was therefore not rejected. This implied that the effect of treatment class-wide peer tutoring, problem solving, conventional strategies, gender and attitude do not significantly

affect the students' academic achievement in Algebraic expressions. Also, the pair eta square value of 0.008 showed the contributing effect size of only 0.08%.

Table 4.9b: Estimated Marginal Means of class-wide peer tutoring, problem-solving, convectional strategies, gender and attitude on students' academic achievement in Algebraic expressions

Group	Attitude	Gender	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Control	Avoidance	Female	16.230 ^a	0.220	15.797	16.664
		Male	16.623 ^a	0.257	16.117	17.130
	Constant practices	Female	19.900 ^a	0.233	19.442	20.357
		Male	19.522 ^a	0.364	18.806	20.238
Class-wide Peer tutoring Strategy	Avoidance	Female	23.179 ^a	0.164	22.856	23.502
		Male	23.369 ^a	0.228	22.920	23.819
	Constant practices	Female	26.464 ^a	0.166	26.138	26.790
		Male	26.958 ^a	0.243	26.481	27.435
Problem-solving strategy	Avoidance	Female	23.197 ^a	0.201	22.801	23.592
		Male	23.218 ^a	0.257	22.712	23.724
	Constant practices	Female	26.193 ^a	0.183	25.833	26.553
		Male	26.479 ^a	0.230	26.027	26.931

Source: Field Survey, 2024

Table 4.9b indicated that the groups recorded approximately the same mean for both genders. For those participants with avoidance attitude in control group; female ($\bar{x}$) = 16.230 and male ($\bar{x}$) = 16.623, while those with constant practices attitude in the same group; female ($\bar{x}$) = 19.900 and male ($\bar{x}$) = 19.522. Likewise in the class-wide peer tutoring group, those with avoidance attitude; female ($\bar{x}$) = 23.179 and male ($\bar{x}$) = 23.369, while those with constant practice attitude; female ($\bar{x}$) = 26.464 and male ($\bar{x}$) = 26.958. Also, in the problem solving strategies group, those with avoidance attitude; female: ($\bar{x}$) = 23.197 and male ($\bar{x}$) = 24.218,

while those with constant practices; female ($\bar{x}$) = 26.193 and male ($\bar{x}$) = 26.479. This implied that the gender of the students, the attitude of the students is not a factor to determine the academic achievement of the students in Algebraic expressions.

4.3 Discussion of the Findings

The study determined the effect of class-wide peer tutoring and problem-solving strategies on students' academic achievement in Algebraic expressions in Federal Colleges of Education Southwest Nigeria. This section presented the discussion of the results relating it with previous studies. The demographic information of the students revealed in the table 4.1 of the study that more female, 244 (64.2%) participated, while 136 (35.8%) were males.

The number of male and female students participated were not equal because of the variation in the population of the students in each of the Federal Colleges of Education selected.

Table 4.2a and b revealed that 90 (23.7%) of the participants were exposed to conventional method of teaching as control group, 160 (42.1%) of the participants were exposed to class-wide peer tutoring, while 130 (34.2%) of the participants were exposed to problem-solving strategy. The numbers of the participants varied under each group because the study used intact classes.

The hypothesis which states that there will be no significant main effect of class-wide peer tutoring, problem-solving and convectional strategies on students' academic achievement in Algebraic expressions in Table 4.3a and b revealed that there was a significant main effect of class-wide peer tutoring, problem-solving and convectional strategies on students' academic achievement in Algebraic expressions. The null hypothesis H_{01} which states that there will be no significant main effect of class-wide peer tutoring, problem-solving and convectional strategies on students' academic achievement in Algebraic expression was therefore rejected.

This implied that the introduction of class-wide peer tutoring, problem-solving and convectional strategies as intervention independently and significantly affected the students' academic achievement in Algebraic expressions. It showed that students performed better with the introduction of class-wide peer tutoring, problem-solving and convectional strategies, while the estimated marginal mean of class-wide peer tutoring (treatment group 1) result had the highest post-test mean score followed by those in problem-solving strategy (treatment group 2) compared to other participants in the control group as shown in Table 4.3b that participants were exposed to class-wide peer tutoring (treatment group 1) had the highest post-test mean ($\bar{x}$) score on students' academic achievement in Algebraic expression, followed by those in problem-solving strategy (treatment group 2) with post-test mean of ($\bar{x}$) score compared to other participants in the control group with post-test mean.

This means that participants exposed to class-wide peer tutoring strategy of teaching (treatment group 1) and problem-solving strategy (treatment group 2) performed better than those in the control group, the difference is sufficient to justify the effectiveness of class-wide peer tutoring (treatment group 1) and problem-solving strategy (treatment group 2) over conventional strategy of Algebraic expressions. In the pursuit of optimising students' academic achievement in Algebraic expressions, this result agreed with the exploration of a plethora of strategies and interventions by educators and researchers. Among these, class-wide peer tutoring and problem-solving strategy has emerged as a promising approach to enhance learning outcomes^{2, 11}.

These pedagogical methods leverage the potential of peer interactions and the step-by-step resolution of Mathematics problems, enabling students to collaborate and enhance their comprehension of Algebraic expressions concepts. The class-wide peer tutoring strategy enables students to engage in self-directed learning within a structured environment, where one

student takes on the role of tutor, while the others serve as tutees. Students with higher intelligence are designated as tutors, while those with lower intelligence take on the role of tutees in the learning process. By engaging with one another, both groups of students have the opportunity to gain insights from each other through play, conversation, idea exchange, and occasionally through disagreements^{1, 2}. Problem-solving strategy can empower students to depict complex Mathematical problems and enhance their Algebraic expressions competency.

Previous educational research has focused on various problem-solving strategies, including the use of real-life scenarios, visualization tools, and step-by-step approaches^{2, 11}. Understanding how these strategies affect students' academic achievement in Algebraic expressions is crucial for tailoring teaching strategy to the specific needs of this demographic³. The hypothesis which states that there will be no significant main effect of gender on students' academic achievement in Algebraic expressions in Table 4.4a and b revealed that there was a significant main effects of gender on students' academic achievement in Algebraic expressions. The null hypothesis was therefore not rejected. This implied that gender as a factor independently and significantly do not affect the students' academic achievement in Algebraic expressions, while the estimated marginal means showed that gender as a factor was seen not to be independently and significantly affecting the students' academic achievement in Algebraic expressions.

Although, female participants had a higher post-test mean than their male counterparts. The difference is not statistically significant implying that aside other factors; gender is not a key factor that significantly affects the students' academic achievement in Algebraic expressions. This aligned with a study that compared the contents tested in TIMSS, including geometry, measurement, fractions, and algebra. The findings indicated that Singaporean

students consistently scored significantly higher than Malaysian students, irrespective of gender^{7, 12}.

Numerous studies have indicated varying levels of achievement in science subjects among secondary school students based on gender, whereas other research has found no significant gender impact on achievement at this educational stage⁵. This may be one of the reasons in more editions of the Research in Mathematics Education in Australasia (RiMEA) 4-year reviews that the National Council of Teachers of Mathematics (NCTM) handbooks have not prioritised gender, instead incorporating it into a wider discussion on equity.

However, studies conducted revealed a significant gender difference in Algebraic expression achievement, favouring male compared to female students⁷. Research findings indicated that the academic achievement of female students in Algebraic expressions was notably inferior to that of male students. The disparity in achievement between female and male could be attributed to differences in mathematical attitudes. While significant attention has been directed towards the accomplishments of female in Algebraic expression, it has also been noted that male exhibited underachievement in comparison to their female counterparts⁵.

The hypothesis three, which posited that there will be no significant main effect of class size on students' academic achievement in Algebraic expressions, as reported in the Tables 4.5a and b. The null hypothesis was rejected. This indicated that class size, as an independent factor, had a significant effect on students' academic achievement in Algebraic expressions. Additionally, the estimated marginal means revealed a significant main effect of class size on students' academic achievement in Algebraic expressions. Suggesting that class size is a factor that independently and significantly influenced students' academic achievement in Algebraic expressions.

A noticeable rise in the size of the groups was observed. This indicated that an increase in group size agreed with heightened motivation to learn. In contrast to a study carried out in Cross River State which yielded results indicating a significant effect of class size on the academic achievement among upper basic nine students notably, urban students outperformed their rural peers in core subjects such as Mathematics and Basic Science⁶.

Nonetheless, the suggestions included that class sizes in educational institutions ought to be kept relatively small to promote effective learning, and that contemporary facilities and instructional materials should be made available for rural students who do not have access to the advantages of urban life and learning experiences. Moreover, it was recommended that a supportive learning environment, including spacious classrooms, well-equipped laboratories, accessible library facilities, and recreational amenities, should be provided to all upper basic nine students, regardless of whether they are in urban or rural schools. The discrepancy may arise from the different groups involved in the study. Therefore, the group could indicate the impact it has on class size⁶.

The fourth hypothesis posited that there will be no significant interaction effect of class-wide peer tutoring, problem-solving, convectional strategies and gender on students' academic achievement in algebraic expressions. The null hypothesis was consequently not rejected. The findings indicated that the interaction between the groups and gender did not have a significant impact on the academic achievement of students in Algebraic expressions.

Additionally, the marginal estimated means reveal that there was no significant interaction effect of class-wide peer tutoring, problem-solving strategies and gender on students' academic achievement in Algebraic expression. The interaction effect of groups and gender did not significantly affect the students' academic achievement in Algebraic expressions.

For the control group, both female and male participants had close means. It was also cleared that class-wide peer tutoring had a slight mean difference between both genders likewise for problem solving strategy. Though, the differences in the mean scores were not significant, the male participants seem to be more responsive to both treatment than the female participants. Several studies have showed differential achievement in science subjects in secondary schools as a result of gender, while some other studies found no gender influences on achievement at the secondary school level⁷.

Consequently, this situation thus demands for developing learner's problem skill and introducing new teaching strategy. This is why the class-wide peer tutoring strategy should be tested in classroom instruction to assess its effectiveness on students' achievement in mathematical problem-solving strategies related to electrical concepts in Physics. The key factor is that these students receive instruction grounded in evidence-based practices that foster the success of each individual⁸.

The hypothesis five which stated that there will be no significant interaction effect of class-wide peer tutoring, problem-solving, conventional strategies and attitude on students' academic achievement in Algebraic expressions. The null hypothesis was therefore not rejected. This implied that the interaction effect of the groups and attitude significantly affected the students' academic achievement in Algebraic expressions. There was no significant interaction effect of class-wide peer tutoring, problem solving, convectional strategies and attitude on students' academic achievement in Algebraic expressions.

Although, an interaction effect of groups and attitude was not statistically significant on their academic achievements, the estimated marginal mean depicted that there was a significance of attitude on the students' academic achievement in Algebraic expressions. In the control group for those with avoidance attitude, they recorded a mean score lower, while those

with constant practices recorded a mean score which is higher. For the class-wide peer tutoring, those with avoidance attitude has a lower mean score, while those with the attitude of constant practices had a higher mean score. Those in the problem-solving strategy group with avoidance attitude recorded a mean score lower than those with the attitude of constant practices who had a higher mean score. This implied that irrespective of the group/strategy of teaching used, the attitude of the students towards learning will highly be determined by their academic achievement including Algebraic expressions^{9, 10}.

Female participants in the control group with 90 participants had a post-test very close to that of the male participants. Those in the treatment group 1 with class-size of 130 had a clear difference between the male and the female post-test mean. Also, the male in the treatment group 2 showed a higher post-test mean than those of female. Though there were clear differences in the post-test mean of the two treatment groups between the two genders, the differences were not statistically significant.

However, it showed a practically significant influence. In a particular research, findings of the study, concludes that class size has significant impact on the appropriateness of teachers' instructional strategies. Regarding the psychological effects of class size on students' academic achievement, it was found that female students tend to feel shy about speaking in larger classes and struggle to express themselves effectively. Additionally, the environment often becomes noisy and stressful, which can lead to missed lessons without the teacher's awareness in larger class settings. It is reasonable to conclude that large class sizes significantly affected students' academic achievement, particularly among female.

The study suggested that in situations where reducing class size is not feasible within a certain timeframe due to factors outside the control of school authorities, it is advisable for

teachers and school management to implement rotational group formations for students during study sessions¹¹.

The findings from hypothesis six indicated that there will be no significant interaction effect of gender and attitude on students' academic achievement in Algebraic expressions. The null hypothesis was consequently not rejected. The findings indicated that the interaction between gender and attitude did not have a significant impact on students' academic achievement in Algebraic expressions.

The estimated marginal means indicated that there was no significant interaction effect of gender and attitude on students' academic achievement in Algebraic expressions. Furthermore, the interaction of gender and attitude was determined not to significantly influence the academic achievement of students in Algebraic expressions.

Female participants with avoidance attitude had a lower mean score compared with those with constant practices. In the same vein, male participants with avoidance attitude had a lower mean score to those with constant practice attitude who performed better. Showing that irrespective of gender, attitude towards learning is paramount. In a study on how four attitude variables were related to the students' prior skills and their gender at the beginning of the course, how the attitude variables changed during the course, and how they affected the students' academic achievement in the final course project.

The findings suggested a connection between students' previous achievement and their self-efficacy, anxiety and motivation related to proofs at the onset of the course. Female students demonstrated reduced efficacy and motivation levels compared to their male counterparts. Throughout the course, there was a notable increase in students' self-efficacy alongside a reduction in anxiety levels. The disparities in self-efficacy and motivation by gender remained evident throughout the duration of the course^{7, 12}.

Furthermore, strong motivation at the outset of the course was a significant predictor of successful outcomes in the final project. The results indicated that an introductory course on proving can positively influenced students' attitudes, which should be considered in teaching since they can impact students' academic achievement. A considerable proportion of students experience a marked decline in their attitudes towards Mathematics during their secondary education years. Therefore, it is crucial to enhance students' attitudes towards Mathematics, as these attitudes can adversely influence their conceptual understanding and achievement in the subject. However, the lack of a clear and unified construct regarding attitudes towards Mathematics creates ambiguity that hinders the ability to draw broad conclusion about enhancing students' overall attitudes in this subject¹³.

Lastly, the findings from hypothesis seven indicated that there will be no significant interaction effect of treatment (class-wide peer tutoring, problem solving and conventional strategies), gender, and attitude on students' academic achievement in Algebraic expressions. The null hypothesis was not rejected. This indicated that the combined influence of the treatment (class-wide peer tutoring, problem solving, and conventional strategies), gender, and attitude did not had a significant impact on the academic achievement of students in Algebraic expressions.

The estimated marginal means revealed that the interaction of treatment (class-wide peer tutoring, problem solving and conventional strategies), gender, and attitude did not significantly influenced students' academic achievement in Algebraic expressions. The groups documented a nearly identical average for each gender. In the control group, participants exhibited an avoidance attitude showed a similar mean score for both female and male.

Conversely, those with a constant practices attitude in the same group demonstrated a higher mean score for both genders. Similarly, participants in the class-wide peer tutoring

group, and those in the problem-solving strategy group. This suggested that regardless of the treatment administered and the gender of the students; the attitude of the student plays a significant role in determining their academic achievement, even in the context of Algebraic expressions. It is not surprising that the impact of students' attitudes and learning behaviours on their achievements was found to be positive and statistically significant. The observed positive outcome among students' attitudes, learning behaviours and achievements indicated that a favourable attitude towards Mathematics can lead to enhanced learning behaviours, which in turn contributed to greater achievements, and this conclusion appeared to be reciprocal^{4, 13}.

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Chapter Five

Conclusion

5.1 Summary of Findings

The research determined the effects of class-wide peer tutoring and problem-solving strategy on Federal Colleges of Education students' academic achievement in Algebraic expressions in Southwest, Nigeria. Seven hypotheses were formulated and tested using ANCOVA to determine the significance of instructional strategies on dependent variable. The research utilised a $3 \times 2 \times 2 \times 2$ factorial quasi-experimental design, featuring pretest-posttest assessments, and non-randomised control and non-equivalent intact groups.

The research highlights class-wide peer tutoring, problem-solving strategy and conventional strategy throughout three tiers, consisting of two treatment groups and one control group. Class-wide peer tutoring and problem-solving strategy functioned as independent variables for the experimental groups, whereas the conventional strategy was utilised for the control group. The dependent variable was the achievement in Algebraic expressions.

Gender functioned as the moderating variable, categorised into two levels: male and female. The study's population comprised all NCE 1 students in Federal Colleges of Education in Southwest, Nigeria, specifically Federal College of Education (Special) Oyo in Oyo State, Federal College of Education Osiele in Abeokuta, Ogun State, and Federal College of Education Iwo in Osun State.

The target population for this study comprised of 380 students. The effect of class-wide peer tutoring and problem-solving strategies had a significant main impact on students' academic achievement in Algebraic expressions. The null hypothesis was therefore rejected. The results indicated that the implementation of class-wide peer tutoring and problem-solving strategies as intervention significantly and independently influenced students' academic achievement in Algebraic expressions.

The results demonstrated that students showed enhanced achievement with the introduction of class-wide peer tutoring and problem-solving strategies. Furthermore, it indicated that there was no significant main effect of gender on students' academic achievement in Algebraic expressions. This indicated that gender, as an independent variable, did not significantly affected students' academic achievement in Algebraic expressions.

The findings revealed that there was no significant interaction effect of class-wide peer tutoring, problem-solving, conventional strategies, and attitude on students' academic achievement in Algebraic expressions. The results demonstrated that the effects of groups and attitude significantly not affected students' academic achievement in Algebraic expressions.

Although, the interaction effect of the group and attitude was not statistically significant regarding academic achievements, the computed marginal mean distinctly illustrated a practical effect of attitude on students' achievement in Algebraic expressions.

Participants in the problem-solving strategy group with an avoidance attitude earned a mean score higher than those with a constant practicing attitude. This suggested that, irrespective of the instructional group or methodology utilised, students' attitudes towards learning will markedly affected their academic achievement in Algebraic expressions.

5.2 Conclusion

It was concluded that teaching strategies, especially class-wide peer tutoring and problem-solving strategies, significantly improved students' academic achievement in Algebraic expressions. Gender did not play a significant role in determining students' academic achievement, nor did class-size affected their learning achievement. The wider the groups the tendency of the students' achievement increases. Which implied that the students performed better as the group number increases. Attitude towards learning, although not statistically significant in all analyses, remains a key factor, with students exhibiting constant practice outperforming those with avoidance attitudes. This suggested the importance of fostering a positive attitude alongside effective teaching strategies to enhance students' academic achievement in Algebraic expressions.

5.3 Recommendations

Based on the findings of the study, the following recommendations were made:

1. Colleges should incorporate class-wide peer tutoring and problem-solving strategies into their teaching for solving Algebraic expressions.
2. Colleges should continue to adopt gender-neutral teaching strategies, ensuring that both male and female students are equally supported in their learning.
3. Colleges should create programme that will help foster positive attitudes in students toward learning.
4. Lecturers should be trained in the use of two innovative teaching strategies in order to improve the students learning outcomes.
5. Gender dynamics and attitudinal dispositions of students should be improved and maintained.

6. Educators should incorporate a combination of class-wide peer tutoring and problem-solving strategies with gender-sensitive and attitudinal dispositions of students to improve their academic achievement.
7. Students should provide sufficient support and resources for teaming population of students for learning equity.

5.4 Contributions to Knowledge

The study served as reference materials for other researchers in the areas of effect of class-wide peer tutoring and problem-solving strategies on students' achievement in other areas of Mathematics concepts.

5.5 Suggestions for Further Studies

Further studies could explore the long-term effects of class-wide peer tutoring and problem-solving strategies on students' academic achievement in other areas of Mathematics. .

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Appendix I

Algebraic Expression Lesson Note for NCE 1 Control Group: FIRST WEEK

Level: 100

Course Code: GSE 122

Course Title: Basic General Mathematics II

TOPIC: Expansion and Factorization of Simple Algebraic Expressions

Subtopic: Simple Algebraic Expression

Time: 1 Hour

Instructional Materials: College series, Textbook, Public address system and charts.

References Book: Macrae M. P., Kalejaiye A.O., Chima Z. I., Garba G. U., Ademosu M. O., Channon J. B., Smith, A. M., & Head H. C. (2008). *New General Mathematics for Senior Secondary Schools* / Ninth Impression Malaysia Pearson Education Limited Pp.1-7, 51-57, 81-82, 103-108, 141-145.

Learners Entry Behaviour: Students are familiar with addition of numbers

Behavioural Objective: At the end of the lecture student should be able to:

- Define Algebra
- Solve problems on algebraic expressions

Teaching Procedures:

Definition of Algebra

Algebra is that branch of Mathematics that uses letters in place of numbers. E g $3xy$, $30 + 2x$ etc.

Remember that in algebra, letters stand for numbers. The numbers can be whole or fractional, positive or negative.

In algebra, directed numbers with positive (+) and negative (-) signs are not for addition or subtraction, rather they are the signs of numbers to which they are attached.

Multiplication

- $(+ve) \times (+ve) = +ve$
- $(-ve) \times (+ve) = -ve$
- $(+ve) \times (-ve) = -ve$

- $(-ve) \times (-ve) = +ve$

Division

- $(+ve) \div (+ve) = +ve$
- $(-ve) \div (+ve) = -ve$
- $(+ve) \div (-ve) = -ve$
- $(-ve) \div (-ve) = +ve$

Example 1

Simplify the following expressions:

- $4 \times (-3x)$
- $(-2y) \times (-8y)$
- $6p - 2q + 4r - 2p + 3q + 5r$

Solution

- $4 \times (-3x) = (+4) \times (-3) \times x$
 $= - (4 \times 3) \times x$
 $= -12x$
- $(-2y) \times (-8y) = (-2) \times y \times (-8) \times y$
 $= (-2) \times (-8) \times y \times y$
 $= + (2 \times 8) \times y^2$
 $= +16y^2$ or just $16y^2$
- $6p - 2q + 4r - 2p + 3q + 5r$
 Collecting like terms
 $6p - 2p - 2q + 3q + 4r + 5r$
 $= 4p + q + 9r$

Expansion and Factorization

Example 2: Expand the following

- $(a+b)(c+d)$
- $(2x+3y)(4x-y)$

Solution

- $(a+b)(c+d) = c(a+b) + d(a+b)$
 $= ac + bc + ad + bd$
- $(2x + 3y)(4x - y) = 2x(4x - y) + 3y(4x - y)$
 $= 8x^2 - 2xy + 12xy - 3y^2$
 $= 8x^2 + 10xy - 3y^2$

Exercises:

Simplify the following expressions

- $3(6a + 3b) + 5(2a - b)$
- $7(a - b) - 8(a - 2b)$
- $2(5x + 8y) + 3(2x - y)$
- $(b-3)(b-7)$

Assignment

- $(m+2n)(m+3n)$
- $(x-4y)(x-3y)$
- What is Algebra

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Algebraic Expression Lesson Note for NCE 1 Control Group: (AELN)

SECOND WEEK

Level: 100

Course Code: GSE 122

Course Title: Basic General Mathematics II

TOPIC: Simple Word Problems on Algebra Expression

Subtopic: Word Problems

Period: First Period

Time: 1 Hour

Instructional Materials: College series, Textbook, Public address system and charts.

References Book: Macrae M. F., Chima Z. I., Garba G. U., Ademosu M. O., Kalejaiye A. O. (2017). *New General Mathematics for Senior Secondary Schools 2* Ninth Impression Malaysia Pearson Education Limited Pp. 35-40, 74-106, 195-200, 222-224.

Learners Entry Behaviour: Students are familiar with addition of numbers

Behavioural Objective: At the end of the lecture student should be able to:

- Solve simple word problems on Algebra Expression
- Solve problems on Linear Equations

Teaching Procedure:

Solving Linear: To solve an equation generally means to find the value of the unknowns that satisfy the equation i.e. the value that given the equation to be true.

Example 1: Solve the following equations

- $3x + 2 = 8$
- $5y = 8 + 3y$

Solution

- $3x + 2 = 8$
 $3x = 8 - 2$
 $3x = 6$
 $x = 6/3$

$$x = 2$$

- $5y = 8 + 3y$

$$5y - 3y = 8$$

$$2y = 8$$

$$y = 8/2$$

$$y = 4$$

Problems on Linear Equation

Example 2

A certain number is added to 2 and the result gives 9. What is the number?

Solution

Let x be the number

$$2 + x = 9$$

$$x = 9 - 2$$

$$x = 7$$

Example 3

A number is multiplied by 4, the result is the same in adding 30 plus 2 times the number. Find the number.

Solution

Let x represent the number

$$4x = 30 + 2x$$

$$4x - 2x = 30$$

$$2x = 30$$

$$x = 30/2$$

$$x = 15$$

Worked example 4

From a certain number subtract 4, multiply the result by 3 and then add 8. If the final result is 20, find the number.

Solution

Let the original number be x

Subtract 4, this gives $x - 4$

Multiply the result by 3, this gives $3(x - 4)$

Add 8, this gives $3(x-4) + 8$

This result is equal to 20

$$3(x-4) + 8 = 20$$

$$3x - 12 + 8 = 20$$

$$3x - 4 = 20$$

$$3x = 20 + 4$$

$$3x = 24$$

$$x = 24/3$$

$$x = 8$$

Therefore the original number is 8

Exercise

- A mother is 15 years older than her son. The mother's age is 5 years more than twice her son's age. How old are they?

Assignment

1. A girl is 5 years older than her brother. 4 years ago the ration of their ages was 4:3. Find their percentages.
- If 5 times a whole number is subtracted from 82, the result is 10. Find the number.

Algebraic Expression Lesson Note for NCE 1 Control Group: (AELN)

THIRD WEEK

Level: 100

Course Code: GSE 122

Course Title: Basic General Mathematics II

TOPIC: Ratio, Percentages, Simple and Compound Interests

Subtopic: Ratio, Percentage, Simple and Compound Interests

Period: First Period

Time: 1 Hour

Instructional Materials: College series, Textbook, Public address system and charts.

Reference Book: Macrae M.F. et al. (2017). *New General Mathematics for Senior Secondary Schools* 3 Ninth Impression Malaysia Pearson Education Limited Pp. 14-19, 35-43, 124-130, 149-155, 161-168, 170-173.

Learners Entry Behaviour: Students are familiar with addition of numbers

Behavioural Objective: At the end of the lecture, student should be able to:

- Solve problems on ratio and percentage
- Solve simple and compound interest.

Teaching Procedure:

Introduction

Ratio: When we are faced with the problem by comparing like quantities we can use ratios, e.g. heights, numbers, ages, lengths, weights etc. The ratio of a quantity to another quantity is which is usually denoted by the expression $a:b$ is equal to the quotient a/b or fraction a/b . So ratio is another way of expressing fractions.

Example 1: Express in its simplest form, the ratio 27 days to 21 days

Solution

27 days: 21 days = 27:21

Divide both sides by 3, it becomes 9:7 or $9/7$

Example 2

Determine the ratio of 1 hour to 25 minutes

Solution

Since 1 hour contains 60 minutes, we can write the ratio as 60:25 or in fraction $60/25$. Since $60/25 = 12/5$ the ratio will be expressed as 12:5

Percentages

The term percent, represented by the symbol %, is a mathematical term meaning one hundredth. Thus, example $50\% = 50 \text{ hundredth} = 50/100 = 0.50$ and $37\% \text{ hundredth} = 37/100 = 0.37$.

Example 1

- a. Express 24% as a fraction
- b. Express $7/20$ as a percentage

Solution

- $24\% = 24/100 = 6/25$
- $7/20 = 7/20 \times 100 = 35\%$

Example 2

- Express 37%
 $37\% = 37/10 \div 100$
 $= 27/10 \times 1/100$
 $= 37/1000$
 $= 0.037$
- 0.375 as a percentage
 $= 375/1000 \times 100/1$
 $= 37.5\%$

To change a percentage to a fraction

$$92\% = 92/100$$

$$= 0.92 \text{ (as a decimal fraction)}$$

$$= 23/25 \text{ (as a common fraction)}$$

Simple Interest and Compound Interest

Simple Interest

When an investor gives out money to be borrowed, the borrower must pay back the money originally borrowed called the **principal** and also charge for the use of the money called **interest**. The amount of interest is based on three ratios: the principal, the ratio of interest and

the time span of the loan. At simple interest the borrowed P, the interest I on principal is P times (x) year (T) of annual rate R is given by

Interest (I) = Principal (P) x Time (T) x Rate ®

$I = PTR$

The maturity value A = Principal x Interest

$A = P + I$

Example 1

Mary Jay requests 2 years loan of #6, 500 at Grantee Trust Bank. The bank approves the loan annual interest rate of 14%

- What is the simple interest on the loan?
- What is the maturity value of the loan?

Solution

- $P = \text{#}6,500$, $T = 2$ years, $\text{Rate } \text{®} = 14\%$

Substituting these values unit, $I = PRT/100$ we get

$$I = \frac{6500 \times 2 \times 14}{100} = \text{#}1,820$$

- The maturity value is defined as the sum of the principal and the interest. Hence, the maturity value of this loan is equal to $A = P + I$

$$A = \text{N}6,500 + \text{#}1,820$$

$$A = \text{#}8,320$$

Example 2

Find the simple interest on Mary Jay's loan of #6,500, if the loan offered at a rate of 21% and is due in 3 months. What is the maturity value of the loan at these terms?

Solution

$I = \text{#}6,500$, $R = 21\%$, $T = 3/12$

Therefore,

$I = \frac{PRT}{100}$

$$= \frac{6500 \times 3 \times 21}{12 \times 100} = \text{#}341.25$$

The maturity value of the loan now equals

$$A = P + I$$

$$A = \text{#}6500 + \text{#}341.25$$

$$A = \text{#}6841.25$$

Compound Interest

In simple interest, the principal remains the same year after year but in compound interest, the interest earned in the following year investment is added to the principal and the amount thus obtained becomes the principal on the second year. This is repeated year after year.

When this happens we say that the investment is made at compound interest.

Example 1

Find the compound interest on #600 for 3 years at 6% per annum.

Solution

$$\text{Amount on 1}^{\text{st}} \text{ year} = 600 \times 1 \times 6 = \text{#}36$$

$$\text{Amount at end of 1}^{\text{st}} \text{ year} = P + I = \text{#}600 + \text{#}36 = \text{#}636$$

$$\text{Amount on 2}^{\text{nd}} \text{ year} = 636 \times 1 \times 6 = \text{#}38.16$$

$$\text{Amount at end of 1}^{\text{st}} \text{ year} = P + I = \text{#}636 + \text{#}38.16 = \text{#}674.16$$

$$\text{Amount on 3}^{\text{rd}} \text{ year} = 674 \times 1 \times 6 = \text{#}40.4496$$

$$\text{Amount at end of 1}^{\text{st}} \text{ year} = P + I = \text{#}674.16 + \text{#}40.4496 = \text{#}714.6096$$

$$\text{Amount (A)} = P (1 + R/100)^n$$

$$\text{Hence, } P = 600, R = 6\%, n = 3$$

$$600 (1 + 6)^3$$

$$= 600(1 + 0.06)^3$$

$$= 600(1.06)^3$$

$$= 600 \times 1.191016$$

$$= \text{#}714.6069$$

Evaluation Questions

- Find the compound interest on #400 for 3 years at 10% p.a. find the amount at the end of the 3 years.
- Change these numbers to percentages (a) 0.222 (b) 2 (c) 0.105
- How much tax will be collected on a purchase of a new automobile valued at ₦20.000 if the tax rate is 8 %?

Algebraic Expression Lesson Note for NCE 1 Control Group: (AELN)

FOURTH WEEK

Level: 100

Course Code: GSE 122

Course Title: Basic General Mathematics II

TOPIC: Factorization by Grouping of Terms

Subtopic: Factorization

Period: First Period

Time: 40 minutes

Instructional Materials: College series, Textbook, Public address system and charts.

References Book: God man A. & Talbert J. F. (2010) Additional Mathematics for West Africa
Malaysia: Long Man Group UK Limited, Pp. 1-11, 16-19 & 134-138.

Learners Entry Behaviour: Students are familiar with addition of numbers

Behavioural Objectives: At the end of the lecture student should be able to:

- Solve problems on the factorization of expression
- Solve problems on the factorization of the difference of two squares

Procedure:

Introduction

Factorization

To write an expression as the product of its factors which usually involves the introduction of brackets is all about factorizing an expression or factorization. The nature of expression to be factorized determines the process or ways of factorization. They involve:

- By taking out common factors
- Grouping items of the expressions
- Quadratic expressions
- Perfect square
- Difference of two squares

1. By taking our common factors

Worked example 4

Complete the bracket in the statement.

$$\bullet \quad 8r - 20v = 4(\quad)$$

Solution

4 is the HCF of $8r$ and $20v$. Divide $8r$ and $20v$ by 4 to find the terms inside the bracket.

$$8r \div 4 = 2r \text{ and } 20v \div 4 = 5v$$

$$8r - 20v = 4(2r - 5v)$$

$$2. \quad 2a^3 - 5a^2 - a$$

Solution

The common factor is 'a'

$$2a^3 - 5a^2 - a$$

$$= a(2a^2 - 5a - 1)$$

$$3. \quad 15a^3b^4c - 6a^2b^5c^2$$

Solution

The HCF of the two terms is $3a^2b^4c$

$$15a^3b^4c - 6a^2b^5c^2$$

$$= 3a^2b^4c (5a - 2bc)$$

$$4. \quad 5x^2 + 15x$$

Where $5x$ is the HCF

$$= 5x(x + 3)$$

Factorization by Grouping of Terms

Worked examples

$$\text{Factorize } 3x - 2dy + 3y - 2dx$$

Solution

The terms $3x$ and $3y$ both have 3 in common. The terms $2dx$ and $2dy$ both have $2d$ in common. Group the given terms in this order

$$3x - 2dy + 3y - 2dx$$

$$= 3x + 3y - 2dx - 2dy$$

$$3(x+y) - 2d(x+y)$$

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

2. Factorize $12x^2 + 3x - 4x - 1$

The elements $12x^2$ and $3x$ have $3x$ in common. The terms $-4x$ and -1 have -1 in common.

$$12x^2 + 3x - 4x - 1$$

$$= 3x(4x + 1) - 1(4x + 1)$$

$= (4x + 1)(3x - 1)$ since the expressions $3x(4x+1)$ and $-1(4x+1)$ both have $(4x + 1)$ in common.

3. $2dx + 2dy + c(x+y)$

$$= (2dx + 2dy) + (cx + cy)$$

$$= 2d(x+y) + c(x+y)$$

$$= (x+y) (2d+c)$$

4. $5ax - 5bx - a + b = (5ax - 5bx) - (a+b)$

$$= 5x(a-b) - 1(a-b)$$

$$= (5x-1)(a-b)$$

Factorization of Quadratic Expressions

The general form of quadratic expression is $ax^2 + bx + c$ where a , b , and c are real constant $a \neq 0$. Consider these two linear expressions $(x+a)$ and $(x+b)$

i.e. $(x+a)(x+b) = x(x+b) + a(x+b)$

$$= x^2 + bx + ax + ab$$

$$= x^2 + x(b+a) + ab$$

Or

$$= x^2 + (a+b)x + ab$$

Worked Examples

Factorize

- $x^2 + 6x + 8$

1st Step: Find the two terms such that their product is $+8x^2$ and their sum is $+6x$ (the middle term)

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

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

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

- $a^2 + 8a - 20 = a^2 + 10a - 2a - 20$

$$= a(a+10) - 2(a+10)$$

$$= (a+10)(a-2)$$

- $8x^2 - 14x - 9$

1st step: $8x^2 \times (-9) = -72x^2$

2nd step: factors of $-72x^2$

$$-72x \text{ and } +x = -71x$$

$$-36x \text{ and } +2x = -34x$$

$$-18x \text{ and } +4x = -14x \text{ (stop)}$$

3rd step:

$$8x^2 - 14x - 9 = 8x^2 - 18x + 4x - 9$$

$$= 2(4x - 9) + 1(4x - 9)$$

$$= (4x-9)(2x+1)$$

- $6a^2 + 15a + 9$

3 is a common factor. First take out the common factor

$$6a^2 + 15a + 9$$

$$= 3(2a^2 + 5a + 3)$$

$$= 2a^2 \times (+3) = +6a^2$$

Factors of $+6a^2$

$$+6a \text{ and } a = +7a$$

$$+3a \text{ and } +2a = +5a \text{ (Stop)}$$

$$= 6a^2 + 15a + 9$$

$$= 3(2a^2 + 5a + 3)$$

$$= 3(2a^2 + 3a + 2a + 3)$$

$$= 3 [a(2a+3) + 1(2a+3)]$$

$$= 3(2a+3)(a+1)$$

- $x^2 + 5xy + 6y^2$

$$= x^2 + 3xy + 2xy + 6y^2$$

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

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

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

$$= 2x(x+1) + 1(x+1)$$

$$= (x+1)(2x+1)$$

- $5 - 7m - 6m^2 = 5 - 10m + 3m = 6m^2$

$$= 5(1-2m) + 3m(1-2m)$$

$$= (1-2m)(5+3m)$$

- $3u^2 + 5uv - 2v^2 = 3u^2 + 6uv - uv - 2v^2$

$$= 3u(u+2v) - v(u+2v)$$

$$= (u+2v)(3u-v)$$

- $2a^2 + 7a - 15$

1st Step: Find the two terms such that their product is $-30a^2$ and their sum is $+7a$ (the middle term)

Factors of $-30a^2$

$$-10a \text{ and } +3a = -7a$$

$$+10a \text{ and } -3a = +7a \text{ (Stop)}$$

3rd step: replace +7a in the given expression with +10a -3a

$$\begin{aligned} 2a^2 + 7a - 15 &= 2a^2 + 10a - 3a - 15 \\ &= 2a(a+5) - 3(a+5) \\ &= (a+5)(2a-3) \end{aligned}$$

Factorization of Difference of Two Squares

Expression of the form $a^2 - b^2$ is called difference of two squares.

$$\begin{aligned} (a+b)(a-b) &= a^2 - ab + ab - b^2 \\ &= a^2 - b^2 \end{aligned}$$

$$\text{Hence } a^2 - b^2 = (a+b)(a-b)$$

Worked examples 7

Factorize the following

- $x^2 - y^2$
- $y^2 - 4$
- $36 - 9a^2$
- $25m^2 - 16m^2$
- $5a^2 - 45$
- $4y^2 - 1$
- $(a+8)^2 - (a+5)^2$

Solution

- $x^2 - y^2 = (x+y)(x-y)$
- $y^2 - 4 = (y)^2 - (2)^2$
 $= (y+2)(y-2)$
- $36 - 9a^2 = (6)^2 - (3a)^2$

$$= ((6+3a)(6-3a))$$

- $25m^2 - 16m^2 = (5m)^2 - (4a)^2$

$$= (5m+4n)(5m-4n)$$

- $5a^2 - 45 = 5(a^2-9)$

$$= 5(a^2-3^2)$$

$$= 5(a+3)(a-3)$$

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

- $(a+8)^2 - (a+5)^2 = \text{Let } A = a+8, B = a+5$

$$= A^2 - B^2 = (A+B)(A-B)$$

$$(a+8)^2 - (a+5)^2 = (a+8+a+5)(a+8-a-5)$$

$$= (a+a+8+5)(a+8-a-5)$$

$$= (2a+13)(3)$$

$$= 3(2a+13)$$

Exercises

- $3x + 9b + 5ax + 15ab$

- $4a - 7b + 28bx - 16ax$

- $2pr - sq + 2qr - ps$

- $2c^2 - 8cm - 3cm + 12m^2$

- $12eq - 4eh - 6fq + 2fh$

- $4m^2 - n^2$

- $u^2 - 16v^3$

- $25k^2 - 16$

- $8px - 4qx + 8rx$

Assignment

- $m n - 3nx - 6xy + 3xy$
- $a^2n + am^3 - mn - an$
- $y^2 + 2y - 5y - 10$
- $15gh - 5gm + 6dh - 2dm$
- $4by - y + 8br - 2$

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Algebraic Expression Lesson Note for NCE 1 Control Group: (AELN)

FIFTH WEEK

Level: 100

Course Code: GSE 122

Course Title: Basic General Mathematics II

TOPIC: Variations: Direct and Inverse

Subtopic: Direct and Inverse

Period: First Period

Time: 1 Hour

Instructional Materials: College series, Textbook, Public address system and charts.

Reference Book: Olosunde G. R. & Nnaji C. C. (2015) Algebraic Expressions II In V. I. Aleburu & S. A. Taiwo (Eds.) *Fundamentals of General Studies Education*, 1, 103-126.

Learners Entry Behaviour: Students are familiar with addition of numbers

Behavioural Objective: At the end of the lecture student should be able to:

- Solve problems on variations

Procedure:

Variation: Direct and Inverse

In algebra, unknown quantities are represented by letters, such as x and y called value. The value of one variable is often called to the values of others. Two very special relationships often.

- Y is said to be directly proportional to x if their relationship is expressed in the term $y = kx$
- Y is said to be inversely proportional to x in their relationship is expressed in the term $y = k/x$

In each case, k is a number whose value is constant, it is called constant of proportionality.

Note: In direct proportion, y gets larger as x gets larger while in an inverse proportion, as x gets larger, y gets smaller.

Example 1

Determine the value of k assuming that x and y are directly proportional and $y = 15$, when $x = 3$

Solution

Hence, $y = kx$ substituting given

$$15 = k \times 3$$

To solve, divide both sides of the equation by 3 to get $k = 5$

Example 2

Determine the value of k given that x and y are inversely proportional and $y = 15$, when $x = 3$

Solution

Inverse proportions $y = k/x$

Substituting yields $15 = k/3$

This time we multiply both sides by 3 to get $k = 45$. Once we have determined the value of k , we can use the equation to solve problems.

Exercises

The amount of money Jim earns is directly proportional to the number of hours he works. If he works 40 hours, he will earn #200. How much will be earned if he works 55 hours?

Assignment

- $5a^3 - 3a^2h$
- $4a^4 + 2a^3b - 10a^2b^2$
- $a^2 + 8a + 15$
- $m^2 + 4m - 21$
- $7 - 22x + 3x$

Algebraic Expression Lesson Note for NCE 1 EXPERIMENTAL GROUP

FIRST WEEK

Level: 100

Course Code: GSE 122

Course Title: Basic General Mathematics II

TOPIC: Expansion and factorization of simple algebraic expressions

Subtopic: Simple Algebraic Expression

Time: 1 Hour

Instructional Materials: College series, Textbook, Public address system and charts.

References Book: Macrae M. P., et al. (2008). *New General Mathematics for Senior Secondary Schools* Ninth Impression Malaysia Pearson Education Limited Pp.1-7, 51-57, 81-82, 103-108, 141-145.

Learners Entry Behaviour: Students are familiar with addition of numbers

Behavioural Objective: At the end of the lecture student should be able to:

- Define Algebra
- Solve problems on algebraic expressions

Teaching Procedures:

Definition of Algebra

Algebra is that branch of Mathematics that uses letters in place of numbers. E g $3xy$, $30 + 2x$ etc.

Remember that in algebra, letters stand for numbers. The numbers can be whole or fractional, positive or negative.

In algebra, directed numbers with positive (+) and negative (-) signs are not for addition or subtraction, rather they are the signs of numbers to which they are attached.

Multiplication

- $(+ve) \times (+ve) = +ve$
- $(-ve) \times (+ve) = -ve$

- $(+ve) \times (-ve) = -ve$
- $(-ve) \times (-ve) = +ve$

Division

- $(+ve) \div (+ve) = +ve$
- $(-ve) \div (+ve) = -ve$
- $(+ve) \div (-ve) = -ve$
- $(-ve) \div (-ve) = +ve$

Example 1

Simplify the following expressions:

- $4 \times (-3x)$
- $(-2y) \times (-8y)$
- $6p - 2q + 4r - 2p + 3q + 5r$

Solution

- $4 \times (-3x) = (+4) \times (-3) \times x$
 $= -(4 \times 3) \times x$
 $= -12x$
- $(-2y) \times (-8y) = (-2) \times y \times (-8) \times y$
 $= (-2) \times (-8) \times y \times y$
 $= + (2 \times 8) \times y^2$
 $= +16y^2$ or just 4^2y^2
- $6p - 2q + 4r - 2p + 3q + 5r$
 Collecting like terms
 $6p - 2p - 2q + 3q + 4r + 5r$
 $= 4p + q + 9r$

Expansion and Factorization

Example 2: Expand the following

- $(a+b)(c+d)$
- $(2x+3y)(4x-y)$

Solution

- $(a+b)(c+d) = c(a+b) + d(a+b)$
 $= ac + bc + ad + bd$
- $(2x + 3y)(4x - y) = 2x(4x - y) + 3y(4x - y)$
 $= 8x^2 - 2xy + 12xy - 3y^2$
 $= 8x^2 + 10xy$

Exercises:

Simplify the following expressions

- $3(6a + 3b) + 5(2a - b)$
- $7(a - b) - 8(a - 2b)$
- $2(5x + 8y) + 3(2x - y)$
- $(b-3)(b-7)$

Assignment

- $(m+2n)(m+3n)$

- $(x-4y)(x-3y)$

Appendix II

Algebraic Expression Lesson Note for NCE 1 EXPERIMENTAL GROUP

SECOND WEEK

Level: 100

Course Code: GSE 122

Course Title: Basic General Mathematics II

TOPIC: Simple Word Problems on Algebra Expression

Subtopic: Word Problems

Period: First Period

Time: 1 Hour

Instructional Materials: College series, Textbook, Public address system and charts.

References Book: Macrae M. F. et. al. (2017) *New General Mathematics for Senior Secondary Schools 2* Ninth Impression Malaysia Pearson Education Limited Pp. 35-40, 74-106, 195-200, 222-224.

Learners Entry Behaviour: Students are familiar with addition of numbers

Behavioural Objective: At the end of the lecture student should be able to:

- Solve simple word problems on Algebra Expression
- Solve problems on Linear Equations

Teaching Procedure:

Solving Linear: To solve an equation generally means to find the value of the unknowns that satisfy the equation i.e. the value that given the equation to be true.

Example 1: Solve the following equations

- $3x + 2 = 8$
- $5y = 8 + 3y$

Solution

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

$$3x = 6$$

$$x = 6/3$$

$$x = 2$$

- $5y = 8 + 3y$

$$5y - 3y = 8$$

$$2y = 8$$

$$y = 8/2$$

$$y = 4$$

Problems on Linear Equation

Example 2

A certain number is added to 2 and the result gives 9. What is the number?

Solution

Let x be the number

$$2 + x = 9$$

$$x = 9 - 2$$

$$x = 7$$

Example 3

A number is multiplied by 4, the result is the same in adding 30+2 times the number. Find the number.

Solution

Let x represent the number

$$4x = 30 + 2x$$

$$4x - 2x = 30$$

$$2x = 30$$

$$x = 30/2$$

$$x = 15$$

Worked example 4

From a certain number subtract 4, multiply the result by 3 and then add 8. If the final result is 20, find the number.

Solution

Let the original number be x

Subtract 4, this gives $x-4$

Multiply the result by 3, this gives $3(x-4)$

Add 8, this gives $3(x-4) + 8$

This result is equal to 20

$$3(x-4) + 8 = 20$$

$$3x - 12 + 8 = 20$$

$$3x - 4 = 20$$

$$3x = 20 + 4$$

$$3x = 24$$

$$x = 24/3$$

$$x = 8$$

Therefore the original number is 8

Exercise

- A mother is 15 years older than her son. The mother's age is 5 years more than twice her son's age. How old are they?

Assignment

1. A girl is 5 years older than her brother. 4 years ago the ration of their ages was 4:3. Find their percentages.
- If 5 times a whole number is subtracted from 82, the result is 10. Find the number.

Algebraic Expression Lesson Note for NCE 1 EXPERIMENTAL GROUP

THIRD WEEK

Level: 100

Course Code: GSE 122

Course Title: Basic General Mathematics II

TOPIC: Ratio, Percentages, Simple and Compound Interests

Subtopic: Ratio, Percentage, Simple and Compound Interests

Period: First Period

Time: 1 Hour

Instructional Materials: College series, Textbook, Public address system and charts.

Reference Book: Macrae M.F., et al. (2017). *New General Mathematics for Senior Secondary Schools* 3 Ninth Impression Malaysia Pearson Education Limited Pp. 14-19, 35-43, 124-130, 149-155, 161-168, 170-173.

Learners Entry Behaviour: Students are familiar with addition of numbers

Behavioural Objective: At the end of the lecture, student should be able to:

- Solve problems on ratio and percentage
- Solve simple and compound interest.

Teaching Procedure:

Introduction

Ratio: When we are faced with the problem by comparing like quantities we can use ratios, e.g. heights, numbers, ages, lengths, weights etc. The ratio of a quantity to another quantity is which is usually denoted by the expression $a:b$ is equal to the quotient a/b or fraction a/b . So ratio is another way of expressing fractions.

Example 1: Express in its simplest form, the ratio 27 days to 21 days

Solution

27 days: 21 days = 27:21

Divide both sides by 3, it becomes 9:7 or $9/7$

Example 2

Determine the ratio of 1 hour to 25 minutes

Solution

Since 1 hour contains 60 minutes, we can write the ratio as 60:25 or in fraction $60/25$. Since $60/25 = 12/5$ the ratio will be expressed as 12:5

Percentages

The term percent, represented by the symbol %, is a mathematical term meaning one hundredth. Thus, example $50\% = 50 \text{ hundredth} = 50/100 = 0.50$ and $37\% \text{ hundredth} = 37/100 = 0.37$.

Example 1

- Express 24% as a fraction
- Express $7/20$ as a percentage

Solution

- $24\% = 24/100 = 6/25$
- $7/20 = 7/20 \times 100 = 35\%$

Example 2

- Express 37%
 $37\% = 37/10 \div 100$
 $= 27/10 \times 1/100$
 $= 37/1000$
 $= 0.037$
- 0.375 as a percentage
 $= 375/1000 \times 100/1$
 $= 37.5\%$

To change a percentage to a fraction

$$92\% = 92/100$$

$$= 0.92 \text{ (as a decimal fraction)}$$

$$= 23/25 \text{ (as a common fraction)}$$

Simple Interest and Compound Interest

Simple Interest

When an investor gives out money to be borrowed, the borrower must pay back the money originally borrowed called the **principal** and also charge for the use of the money called **interest**. The amount of interest is based on three ratios: the principal, the ratio of interest and the time span of the loan. At simple interest the borrowed P, the interest I on principal is P times (x) year (T) of annual rate R is given by

Interest (I) = Principal (P) x Time (T) x Rate ®

$I = PTR$

The maturity value A = Principal x Interest

$A = P + I$

Example 1

Mary Jay requests 2 years loan of #6, 500 at Grantee Trust Bank. The bank approves the loan annual interest rate of 14%

- What is the simple interest on the loan?
- What is the maturity value of the loan?

Solution

- $P = \text{\#}6, 500$, $T = 2$ years, $\text{Rate } \text{\textcircled{R}} = 14\%$

Substituting these values unit, $I = PRT/100$ we get

$$I = 6500 \times 2 \times 14 = \text{\#}1, 820$$

100

- The maturity value is defined as the sum of the principal and the interest. Hence, the maturity value of this loan is equal to $A = P + I$

$$A = \text{\#}6, 500 + \text{\#}1, 820$$

$$A = \text{\#}8, 320$$

Example 2

Find the simple interest on Mary Jay's loan of #6,500, if the loan offered at a rate of 21% and is due in 3 months. What is the maturity value of the loan at these terms?

Solution

$$I = \text{\#}6,500, R = 21\%, T = 3/12$$

Therefore,

$$I = PRT$$

$$\begin{aligned}
 & \frac{100}{12} \times 3 \times \frac{21}{100} \\
 & = \text{\#}341.25
 \end{aligned}$$

The maturity value of the loan now equals

$$\begin{aligned}
 A &= P + I \\
 A &= \text{\#}6500 + \text{\#}341.25 \\
 A &= \text{\#}6841.25
 \end{aligned}$$

Compound Interest

In simple interest, the principal remains the same year after year but in compound interest, the interest earned in the following year investment is added to the principal and the amount thus obtained becomes the principal on the second year. This is repeated year after year.

When this happens we say that the investment is made at compound interest.

Example 1

Find the compound interest on #600 for 3 years at 6% per annum.

Solution

$$\text{Amount on 1}^{\text{st}} \text{ year} = 600 \times 1 \times \frac{6}{100} = \text{\#}36$$

$$\text{Amount at end of 1}^{\text{st}} \text{ year} = P + I = \text{\#}600 + \text{\#}36 = \text{\#}636$$

$$\text{Amount on 2}^{\text{nd}} \text{ year} = 636 \times 1 \times \frac{6}{100} = \text{\#}38.16$$

$$\text{Amount at end of 1}^{\text{st}} \text{ year} = P + I = \text{\#}636 + \text{\#}38.16 = \text{\#}674.16$$

$$\text{Amount on 3}^{\text{rd}} \text{ year} = 674 \times 1 \times \frac{6}{100} = \text{\#}40.4496$$

$$\text{Amount at end of 1}^{\text{st}} \text{ year} = P + I = \text{\#}674.16 + \text{\#}40.4496 = \text{\#}714.6096$$

$$\text{Amount (A)} = P \left(1 + \frac{R}{100}\right)^n$$

$$\text{Hence, } P = 600, R = 6\%, n = 3$$

$$600 \left(1 + \frac{6}{100}\right)^3$$

$$= 600(1 + 0.06)^3$$

$$= 600(1.06)^3$$

$$= 600 \times 1.191016$$

$$= \text{\#}714.6069$$

Evaluation Question

- Find the compound interest on #400 for 3 years at 10% p.a. find the amount at the end of the 3 years.
- Change these numbers to percentages (a) 0.222 (b) 2 (c) 0.105

- How much tax will be collected on a purchase of a new automobile valued at ₦20.000 if the tax rate is 8 %?

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Algebraic Expression Lesson Note for NCE 1 EXPERIMENTAL GROUP

FOURTH WEEK

Level: 100

Course Code: GSE 122

Course Title: Basic General Mathematics II

TOPIC: Factorization by Grouping of Terms

Subtopic: Factorization

Period: First Period

Time: 40 minutes

Instructional Materials: College series, Textbook, Public address system and charts.

References Book: God man A. et al. (2010) Additional Mathematics for West Africa Malaysia: Long Man Group UK Limited, Pp. 1-11, 16-19 & 134-138.

Learners Entry Behaviour: Students are familiar with addition of numbers

Behavioural Objectives: At the end of the lecture student should be able to:

- Solve problems on the factorization of expression
- Solve problems on the factorization of the difference of two squares

Procedure:

Introduction

Factorization

To write an expression as the product of its factors which usually involves the introduction of brackets is all about factorizing an expression or factorization. The nature of expression to be factorized determines the process or ways of factorization. They involve:

- By taking out common factors
- Grouping items of the expressions
- Quadratic expressions
- Perfect square

- Difference of two squares

1. By taking our common factors

Worked example 4

Complete the bracket in the statement.

- $8r - 20v = 4(\quad)$

Solution

4 is the HCF of 8r and 20v. Divide 8r and 20v by 4 to find the terms inside the bracket.

$$8r \div 4 = 2r \text{ and } 20v \div 4 = 5v$$

$$8r - 20v = 4(2r - 5v)$$

2. $2a^3 - 5a^2 - a$

Solution

The common factor is 'a'

$$2a^3 - 5a^2 - a$$

$$= a(2a^2 - 5a - 1)$$

3. $15a^3b^4c - 6a^2b^5c^2$

Solution

The HCF of the two terms is $3a^2b^4c$

$$15a^3b^4c - 6a^2b^5c^2$$

$$= 3a^2b^4c (5a - 2bc)$$

4. $5x^2 + 15x$

Where 5x is the HCF

$$= 5x(x + 3)$$

Factorization by Grouping of Terms

Worked examples

- Factorize $3x - 2dy + 3y - 2dx$

Solution

The terms $3x$ and $3y$ both have 3 in common. The terms $2dx$ and $2dy$ both have 2d in common. Group the given terms in this order

$$3x - 2dy + 3y - 2dx$$

$$= 3x + 3y - 2dx - 2dy$$

$$3(x+y) - 2d(x+y)$$

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

2. Factorize $12x^2 + 3x - 4x - 1$

The elements $12x^2$ and $3x$ have $3x$ in common. The terms $-4x$ and -1 have -1 in common.

$$12x^2 + 3x - 4x - 1$$

$$= 3x(4x + 1) - 1(4x + 1)$$

$= (4x + 1)(3x - 1)$ since the expressions $3x(4x+1)$ and $-1(4x+1)$ both have $(4x + 1)$ in common.

3. $2dx + 2dy + c(x+y)$

$$= (2dx + 2dy) + (cx + cy)$$

$$= 2d(x+y) + c(x+y)$$

$$= (x+y) (2d+c)$$

4. $5ax - 5bx - a + b = (5ax - 5bx) - (a+b)$

$$= 5x(a-b) - 1(a-b)$$

$$= (5x-1)(a-b)$$

Factorization of Quadratic Expressions

The general form of quadratic expression in $ax^2 + bx + c$ where a , b , and c are real constant $a \neq 0$. Consider this two linear expressions $(x + a)$ and $(x + b)$

i.e. $(x+a)(x+b) = x(x+b) + a(x+b)$

$$= x^2 + bx + ax + ab$$

$$= x^2 + x(b+a) + ab$$

Or

$$= x^2 + (a+b)x + ab$$

Worked Examples

Factorize

- $x^2 + 6x + 8$

1st Step: Find the two terms such that their product is $+8x^2$ and their sum is $+6x$ (the middle term)

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

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

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

- $a^2 + 8a - 20 = a^2 + 10a - 2a - 20$

$$= a(a+10) - 2(a+10)$$

$$= (a+10)(a-2)$$

- $8x^2 - 14x - 9$

1st step: $8x^2 \times (-9) = -72x^2$

2nd step: factors of $-72x^2$

$$-72x \text{ and } +x = -71x$$

$$-36x \text{ and } +2x = -34x$$

$$-18x \text{ and } +4x = -14x \text{ (stop)}$$

3rd step:

$$8x^2 - 14x - 9 = 8x^2 - 18x + 4x - 9$$

$$= 2(4x - 9) + 1(4x - 9)$$

$$= (4x-9)(2x+1)$$

- $6a^2 + 15a + 9$

3 is a common factor. First take out the common factor

$$6a^2 + 15a + 9$$

$$= 3(2a^2 + 5a + 3)$$

$$= 2a^2 \times (+3) = +6a^2$$

Factors of $+6a^2$

$$+6a \text{ and } a = +7a$$

$$+3a \text{ and } +2a = +5a \text{ (Stop)}$$

$$= 6a^2 + 15a + 9$$

$$= 3(2a^2 + 5a + 3)$$

$$= 3(2a^2 + 3a + 2a + 3)$$

$$= 3 [a(2a+3) + 1(2a+3)]$$

$$= 3(2a+3)(a+1)$$

- $x^2 + 5xy + 6y^2$

$$= x^2 + 3xy + 2xy + 6y^2$$

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

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

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

$$= 2x(x+1) + 1(x+1)$$

$$= (x+1)(2x+1)$$

- $5 - 7m - 6m^2 = 5 - 10m + 3m = 6m^2$

$$= 5(1-2m) + 3m(1-2m)$$

$$= (1-2m)(5+3m)$$

- $3u^2 + 5uv - 2v^2 = 3u^2 + 6uv - uv - 2v^2$

$$= 3u(u+2v) - v(u+2v)$$

$$= (u+2v)(3u-v)$$

- $2a^2 + 7a - 15$

1st Step: Find the two terms such that their product is $-30a^2$ and their sum is $+7a$ (the middle term)

Factors of $-30a^2$

$$-10a \text{ and } +3a = -7a$$

$$+10a \text{ and } -3a = +7a \text{ (Stop)}$$

3rd step: replace $+7a$ in the given expression with $+10a - 3a$

$$2a^2 + 7a - 15 = 2a^2 + 10a - 3a - 15$$

$$= 2a(a+5) - 3(a+5)$$

$$= (a+5)(2a-3)$$

Factorization of Difference of Two Squares

Expression of the form $a^2 - b^2$ is called difference of two squares.

$$(a+b)(a-b) = a^2 - ab + ab - b^2$$

$$= a^2 - b^2$$

$$\text{Hence } a^2 - b^2 = (a+b)(a-b)$$

Worked examples 7

Factorize the following

- $x^2 - y^2$
- $y^2 - 4$
- $36 - 9a^2$
- $25m^2 - 16m^2$
- $5a^2 - 45$
- $4y^2 - 1$
- $(a+8)^2 - (a+5)^2$

Solution

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

- $y^2 - 4 = (y)^2 - (2)^2$
 $= (y+2)(y-2)$
- $36 - 9a^2 = (6)^2 - (3a)^2$
 $= ((6+3a)(6-3a))$
- $25m^2 - 16n^2 = (5m)^2 - (4n)^2$
 $= (5m+4n)(5m-4n)$
- $5a^2 - 45 = 5(a^2-9)$
 $= 5(a^2-3^2)$
 $= 5(a+3)(a-3)$
- $4y^2 - 1 = (2y+1)(2y-1)$
- $(a+8)^2 - (a+5)^2 = \text{Let } A = a+8, B = a+5$
 $= A^2 - B^2 = (A+B)(A-B)$
 $(a+8)^2 - (a+5)^2 = (a+8+a+5)(a+8-a-5)$
 $= (a+a+8+5)(a+8-a-5)$
 $= (2a+13)(3)$
 $= 3(2a+13)$

Exercises

- $3x + 9b + 5ax + 15ab$
- $4a - 7b + 28bx - 16ax$
- $2pr - sq + 2qr - ps$
- $2c^2 - 8cm - 3cm + 12m^2$
- $12eq - 4eh - 6fq + 2fh$
- $4m^2 - n^2$
- $u^2 - 16v^3$
- $25k^2 - 16$

- $8px - 4qx + 8rx$

Assignment

- $m^2n - 3nx - 6xy + 3xy$
- $a^2n + am^3 - mn - an$
- $y^2 + 2y - 5y - 10$
- $15gh - 5gm + 6dh - 2dm$
- $4by - y + 8br - 2r$

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Algebraic Expression Lesson Note for NCE 1 EXPERIMENTAL GROUP

FIFTH WEEK

Level: 100

Course Code: GSE 122

Course Title: Basic General Mathematics II

TOPIC: Variations: Direct and Inverse

Subtopic: Direct and Inverse

Period: First Period

Time: 1 Hour

Instructional Materials: College series, Textbook, Public address system and charts.

Reference Book: Olosunde G. R. & Nnaji C. C. (2015) Algebraic Expressions II In V. I. Aleburu & S. A. Taiwo (Eds.) *Fundamentals of General Studies Education*, 1, 103-126.

Learners Entry Behaviour: Students are familiar with addition of numbers

Behavioural Objective: At the end of the lecture student should be able to:

- Solve problems on variations

Procedure:

Variation: Direct and Inverse

In algebra, unknown quantities are represented by letters, such as x and y called value. The value of one variable is often called to the values of others. Two very special relationships often.

- Y is said to be directly proportional to x if their relationship is expressed in the term $y = kx$
- Y is said to be inversely proportional to x if their relationship is expressed in the term $y = k/x$

In each case, k is a number whose value is constant, it is called constant of proportionality.

Note: In direct proportion, y gets larger as x gets larger while in an inverse proportion, as x gets larger, y gets smaller.

Example 1

Determine the value of k assuming that x and y are directly proportional and $y = 15$, when $x = 3$

Solution

Hence, $y = kx$ substituting given

$$15 = k \times 3$$

To solve, divide both sides of the equation by 3 to get $k = 5$

Example 2

Determine the value of k given that x and y are inversely proportional and $y = 15$, when $x = 3$

Solution

Inverse proportions $y = k/x$

Substituting yields $15 = k/3$

This time we multiply both sides by 3 to get $k = 45$. Once we have determined the value of k , we can use the equation to solve problems.

Exercises

The amount of money Jim earns is directly proportional to the number of hours he works. If he works 40 hours, he will earn #200. How much will be earned if he works 55 hours?

Assignment

- $5a^3 - 3a^2h$
- $4a^4 + 2a^3b - 10a^2b^2$
- $a^2 + 8a + 15$
- $m^2 + 4m - 21$
- $7 - 22x + 3x^2$

Appendix III

Scheme of work on Algebraic Expressions for NCE 1 Control and Experimental Groups

Week	Topic	Subtopic	Behavioral Objectives	Lecturers Activities	Students Activities
1 st	Algebraic Expression	Simple Algebraic Expression	Students should be able to: Define Algebra Solve problems on algebraic expressions	Lecturer explain the meaning of algebraic expression and give them simple examples on Algebraic Expression	Solve simple Algebraic Expression
2 nd	„	Word Problems	Students should be able to: Solve simple word problems on Algebra Expression, solve problems on Linear Equations	Lecturer gives examples on word problems	Solve simple word problem
3 rd	„	Ratio, Percentages, Simple and Compound Interests	Students should be able to: solve problems on ratio and percentage, solve simple and compound interest	Lecturer gives example on Ratio, percentage, simple and compound interests.	Solve problems on ratio, percentage, simple and compound interest
4 th	„	Factorization	Students should be able to: solve problems on the factorization of expression and solve problems on the factorization of	Lecturer gives example on Factorization	Solve problems on the factorization of expression and difference of two squares.

			the difference of two squares		
5 th	„	Direct and Inverse	Student should be able to: solve problems on variations	Lecturer give example on variation: direct and inverse	Solve problems on variations

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Appendix IV

Algebraic Expressions Students' Academic Achievement Test (AESAAAT)

Section A

Demographic Data

Gender: Male () Female ()

Level: NCE I () NCE II () NCE III ()

Name of Institution: FCE (SP) Oyo () FCE Iwo () FCE, Osiele, Abeokuta ()

Average Class for Basic General Mathematics II: 0-50 (), 51-100 (), 101-150 (), 151-160 (), 161-Above ()

Section B

Instructions: Attempt All Questions By Picking The Correct Answers From The Options A to D.

1. Expand $(2x+3y)(4x-y)$

- (a) $8x^2+10xy-3y^2$
- (b) $10x^2+8x+4y^2$
- (c) $4xy^2+8x+2x$
- (d) $3x+10xy+2y^2$

2. Expand $(x-5)(x+2)$

- (a) x^2-2x-5
- (b) $x^2+7x+10$
- (c) $x^2-3x-10$
- (d) x^2-10

3. Simplify the value of $7 \times 3a - (3a + 5a) \times 2$

- (a) $15a$
- (b) $10a$
- (c) $5a$
- (d) $25a$

4. Expand $(2m+n)^2$

- (a) 32
- (b) 42
- (c) 57
- (d) 62

5. Given that $(6x-y)/(x+2y)=2$, find the value of x/y

- (a) $3/8$
- (b) $5/4$
- (c) $1/2$
- (d) $3/4$

6. Simplify $\frac{4}{(a-3)} - \frac{1}{(a+2)}$

- (a) $\frac{(3a+11)}{((a-3)(a+2))}$
- (b) $\frac{(3a+14)}{((a+3)(a-2))}$
- (c) $\frac{(3a+11a)}{((a+2)(a+2))}$
- (d) $\frac{(11-3a)}{((a+3)(a+2))}$

7. Simplify $(m+2n)(-m)$

- (a) $-m^2 - 2mn$
- (b) $m + 2mn$
- (c) $mn - 2$
- (d) $2mn - mn$

8. Simplify $\frac{(a-b)}{(a+b)} - \frac{(a+b)}{(a-b)}$

- (a) $\frac{4ab}{(a^2-b^2)}$
- (b) $\frac{2ab}{(a-b^2)}$
- (c) $\frac{(-4ab)}{(a^2-b^2)}$
- (d) $\frac{2b^2-2ab}{(a^2-b^2)}$

9. Factorize this expression $8x^2 - 2xy + 12xy - 3y^2$

- (a) $(2x + 3y)(4x-y)$
- (b) $(2x-3y)(4x+y)$
- (c) $(y-4x)(2x+3y)$
- (d) $(2x-3y)(4x-y)$

10. Factorize this expression $x^2 + 13x + 40$

- (a) $(x+8)(x+5)$
- (b) $(x-10)(x-4)$
- (c) $(x+8)(x-5)$
- (d) $(x+10)(x+4)$

11. Given that $\frac{(6x-y)}{(x+2y)} = 2$, find the value of $\frac{x}{y}$

- (a) $\frac{3}{8}$
- (b) $\frac{5}{4}$
- (c) $\frac{1}{2}$
- (d) $\frac{3}{4}$

12. Solve the equation: $\frac{2(x+5)}{3} = \frac{(5x-3)}{4}$

(a) $\frac{11}{7}$

(b) $\frac{18}{23}$

(c) 7

(d) 9

13. Simplify $\frac{4}{(x+1)} - \frac{3}{(x-1)}$

(a) $\frac{(x+7)}{(x^2-1)}$

(b) $\frac{(x-1)}{(x^2-1)}$

(c) $\frac{(x-7)}{(x^2-1)}$

(d) $\frac{(x-11)}{(x^2-1)}$

14. Solve the equation $\frac{(2y-1)}{3} - \frac{(3y-1)}{4} = 1$

(a) 8

(b) 12

(c) -13

(d) 19G

15. Find the value of x which satisfies the equation $5(x-7) = 7-2x$.

(a) $x=2$

(b) $x=6$

(c) $x=6$

(d) $x=14$

16. Solve this quadratic equation $a^2 + 8a - 20 = 0$

(a) 2, -10

(b) -10, 2

(c) 5, 3

(d) -5, -3

17. Solve this quadratic equation $8x^2 - 14x - 9 = 0$

(a) $\frac{1}{2}$, $-\frac{9}{4}$

(b) $\frac{1}{2}$, $\frac{4}{9}$

(c) $\frac{9}{4}$, $-\frac{1}{2}$

(d) $-\frac{4}{9}$, $-\frac{1}{2}$

18. If $6\log_x 2 - 3\log_x 3 = 3\log_5 0.2$, Find x

- (a) $8/3$
- (b) $4/3$
- (c) $4/3$
- (d) $3/8$

19. Solve for x . if $(0.25)^{x+1} = 16$

- (a) -3
- (b) -1
- (c) 3
- (d) -2

20. Determine the value of x . if $3\sqrt[3]{4^{2x}} = 16$

- (a) $-1/3$
- (b) -1
- (c) -3
- (d) $1/3$

21. A number is multiplied by 4, the result is the same in adding $30 + 2$ times the number, find the number

- (a) 7
- (b) 8
- (c) 9
- (d) 10

22. From a certain number subtract 4, multiply the result by 3, and then add 8, if the final result is 20. Find the original number.

- (a) 16
- (b) 9
- (c) 8
- (d) 5

23. John thinks of a number and subtract 9, the result is 15, find the number

- (a) 10
- (b) 6
- (c) 24
- (d) 12

24. A man is four times as old as his son. The difference between their ages is 36 years. Find the sum of their ages.

- (a) 45 years
- (b) 48years
- (c) 60 years
- (d) 74years

25. What fraction must be subtracted from the sum of $2\frac{1}{6}$ and $2\frac{7}{12}$ to give $3\frac{1}{4}$?

- (a) $1\frac{1}{2}$
- (b) $\frac{1}{2}$
- (c) $\frac{1}{3}$
- (d) $1\frac{1}{6}$

26. The sum of two numbers is 20 if one of the numbers is 8, what is the value of the second number?

- (a) 20
- (b) 15
- (c) 8
- (d) 12

27. If you add an even number to another even number, the answer is

- (a) An even number
- (b) Odd number
- (c) Prime number
- (d) Composite number

28. The sum of four consecutive integers is 34. Find the least of these numbers

- (a) 7
- (b) 8
- (c) 5
- (d) 6

29. In how many ways can 3 seats be occupied if 5 people are willing of sit?

- (a) 5
- (b) 120
- (c) 60
- (d) 20

30. A square tile has side 30cm. how many of those tiles will cover a rectangular floor of length 7.2m and width 4.2m?

- (a) 720
- (b) 336
- (c) 420
- (d) 576

31. _____ is used when we are faced with problems by comparing like terms.

- (a) Ratio
- (b) Simple interest
- (c) Communal interest
- (d) Interest ratio

32. 20% of what number is 40?

- (a) 500
- (b) 400
- (c) 200
- (d) 100

33. A man was allowed 20% of his income as tax fee; he then paid ₦1, 200 as tax. Calculate his total income

- (a) ₦ 4000
- (b) ₦ 6000
- (c) ₦ 4200
- (d) ₦ 7000

34. Find the simple interest on Mary Jay's loan of ₦6,500, if the loan offered at a rate of 21% and is due in 3 months.

- (a) ₦413.25
- (b) ₦143.25
- (c) ₦341.25
- (d) ₦431.25

35. Find the simple interest on N5400 for 8 months at the rate of $4\frac{1}{2}\%$ per annum

- (a) ₦162
- (b) ₦126
- (c) ₦621
- (d) ₦1052

36. A number of pencils were shared out among Bisi, Sola, and Tunde in ratio of 2:3:5: respectively. If Bisi got 5, how many were shared out?

- (a) 15
- (b) 25
- (c) 30
- (d) 50

37. If a car travels 120km on 45 litres of petrol, how much petrol is needed for a journey of 600km?

- (a) 720 litres
- (b) 160 litres
- (c) 225 litres
- (d) 960 litres

38. A man earn ₦3,500 per month out of which he spends 15% on his children's education. If he spends additional ₦1,950 on food, how much does he have left?

- (a) ₦525
- (b) ₦1,025
- (c) ₦1,950
- (d) ₦2,975

39. A father decided to give 20% of his monthly income to his three children as their monthly allowance. The eldest child got 45% of the allowance and the youngest got 25%. How much was the father's monthly income if the second child got ₦3,000?

- (a) ₦50,000
- (b) ₦33,000
- (c) ₦60,000
- (d) ₦45,000

40. A man made a loss of 15% when he sold an article for ₦510. The original price of the article is?

- (a) ₦600
- (b) ₦575
- (c) ₦545
- (d) ₦722

41. Find the value of k assuming x and y are directly proportional and y=15 when x= 3

- (a) 15
- (b) 10
- (c) 0
- (d) 5

42. If $y \propto \frac{1}{x^2}$ and x = 3 when y =2. Find y when y = 3/2

- (a) 6
- (b) 10
- (c) 12
- (d) 18

43. y is directly proportional to x and y = 6 when x = 7. Find the constant of the variation

- (a) 47
- (b) 42
- (c) 54

(d) 48

44. If temperature t is directly proportional to heat h , and when $t = 200^\circ\text{C}$, $h = 50\text{J}$. Find t when $h = 60\text{J}$.

- (a) 24°C
- (b) 20°C
- (c) 34°C
- (d) 30°C

45. If x varies directly as square root of y and $x = 81$ when $y = 9$, find x when $y = \frac{16}{9}$

- (a) $\frac{81}{4}$
- (b) $\frac{9}{4}$
- (c) 36
- (d) 27

46. x varies directly as the product of u and v and inversely proportional as their sum. If $x = 3$ when $u = 3$ and $v = 1$, what is the value of x if $u = 3$ and $v = 3$?

- (a) 3
- (b) 4
- (c) 6
- (d) 9

47. Y is inversely proportional to x and $y = 4$ when $x = \frac{1}{2}$. Find x when $y = 10$.

- (a) 2
- (b) 10
- (c) $\frac{1}{5}$
- (d) $\frac{1}{10}$

48. If p varies inversely as the cube of q and q varies directly as the square of r , what is the relationship between p and r ?

- (a) p varies inversely as r^6
- (b) p varies directly as r^6
- (c) p varies directly as r^3
- (d) p varies inversely as $6\sqrt{r}$

49. If y varies directly as the square root of x and $y = 3$ when $x = 16$. Calculate y when $x = 64$.

- (a) 3
- (b) 5

- (c) 6
- (d) 12

50. If x is inversely proportional to y and $x = \frac{5}{2}$ when $y = 2$, find x if $y = 4$.

- (a) $\frac{5}{4}$
- (b) $\frac{9}{4}$
- (c) 4
- (d) 5

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Section C: Questionnaire on Students Attitude (QSA)

Section B

S/N	Items	SA	A	D	SD
1	I believe that mastering algebraic expressions is important for my academic success.				
2	I feel anxious when faced with algebraic expression problems.				
3	I avoid tasks that involve algebraic expressions.				
4	I find algebraic expressions easy to understand				
5	I enjoy solving problems that involve algebraic expressions				
6	Algebraic expressions are useful in real-life situations				
7	I prefer other mathematical topics over algebraic expressions				
8	I struggle to understand the concepts behind algebraic expressions.				
9	Practicing algebraic expressions helps improve my overall math skills				
10	I avoid tasks that involve algebraic expressions				

N.B:

SA = Strongly Agreed

A = Agreed

D = Disagreed

SD= Strongly Disagreed

Appendix





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Photograph of researcher with her students when administering test items



Lead City



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Bio-data

A. Personal Data

1. **FULL Name:** Oluwafunmike Oyenike EZEKIEL,
Address: Noc6, Olubiyi Street, Peace House, Beside Oke-Olola Community Secondary School, Oke-Olola Oyo.
E-mail Address: ezekieloluwafunmike1974@gmail.com
Phone Number: 08135455114
2. **Date and Place of Birth:** 27th April, 1974 / Bacita.
3. **Nationality:** Nigerian
4. **Name and Address of Next of Kin:** Dr. Olubiyi Johnson Ezekiel
Address: No c6, Olubiyi Street, Peace House, Beside Oke-Olola Community Secondary School, Oke-Olola Oyo

B. Educational Background

Educational Institutions Attended with Dates

- | | |
|---|-----------------|
| ❖ Lead City University, Ibadan | 2022- Till Date |
| ❖ Lead City University, Ibadan | 2019 –2021 |
| ❖ Federal College of Education (Special), Oyo | 2019- 2020 |
| ❖ Ekiti State University, Ado Ekiti, Ekiti State, Nigeria | 2006– 2013 |
| ❖ Anglican Secondary Grammar School, Ife-Odan Osun State | 2004 –2005 |
| ❖ Federal College of Education (Special), Oyo | 1995– 1998 |
| ❖ Nisuco Staff Children School, Bacita, Kwara State | 1983 - 1988 |

C. Working Experience with Date

1. Aatan Baptist Nursery and Primary School, Koso), Oyo (Teaching)- 1998 - 2007
2. Community Junior High School Oke-Olola , Oyo (Teaching) - 2014 – 2017
3. Federal College of Education (Special), Oyo (Assistant Lecturer) - 2019

D. Award and Fellowship (If any) Nil

E. Membership Academic of Professional Bodies:

- i. Member, Science Teacher's Association of Nigeria (STAN)
- ii. Member, Mathematics Association of Nigerian (MAN)
- iii. Member, Women in College of Education (WICE)
- iv. A member, Colleges of Education Academic Staff Union (COEASU), Federal College of Education (Special), Oyo, Oyo Chapter.

F. Publications:

1. Thesis/Dissertation:

(a) Ezekiel, O. O. (2021) *Mathematics students attitude and class-size as determinants of Basic General Mathematics achievement in Federal Colleges of Education Southwest, Nigeria.* Unpublished M. Ed. Mathematics Thesis in Department of Science Education, Faculty of Education, Lead City University.

2. **Books/Monographs**

Chapter Contributions in Book

(a) Ezekiel, O. O. (2018). The impact of truancy on students' academic achievement in Mathematics. In T, A. O. Oladimeji, O. F. Fatiloro & F. I. Akinsowon (Eds), *Topics In General Studies education*. (pp. 103-108). Ibadan: Graceville Publisher.

(b) Olaniyan, O. Ezekiel, O. J. & Ezekiel O. O. (2019). Relevance of Mathematics in promoting good governance: Perspective of politicians, teachers and students in Oyo Township Journal Physical Education and research, XXIII 24480-24490.

(c) Ezekiel, O. J. & Ezekiel O. O. (2020) A study of relationship between students' achievement in Mathematics and general Studies Mathematics in Federal College of Education (Special), Oyo

(d) Sabitu, K. A. & Ezekiel, O. O. (2022). Influence of cognitive ability, gender and school location on students' academic achievement in senior secondary school Mathematics in Oyo metropolis, Oyo State. In O. A. Adegbite, R. O. Olatunji & A. A. Mohammed (Eds.), *Contemporary issues in teacher education in Nigeria: A multidisciplinary approach* (pp. 197 - 204) Oyo: Adeyoung Printing Press.

(e) Ezekiel, O. J. & Ezekiel, O. O. (2022). Female enrolment and science education among students in Federal College of Education (Special), Oyo In O. A. Adegbite, R. O. Olatunji & A. A. Mohammed (Eds.), *Contemporary issues in teacher education in Nigeria: A multidisciplinary approach* (pp. 364 - 368) Oyo: Adeyoung Printing Press.

(f) Sabitu, K. A & Ezekiel, O. O. (2022). Motivation as a predictor of Mathematics teachers' achievement in Oyo State In P. I. Farayola, R. A. Foyewa, S. A. Salman, O. O. Adeoye, F. A. Ajasa, I. O. Mustapha & R. A. Raji (Eds.), *A book of reading in honour of Dr. Rasak Adetunji Adefabi*,.

(g) Sabitu, K. A., **Ezekiel, O. O.** & Lamidi T. O. (2023) Impact of locally improvised instructional materials on secondary school students academic achievement in geometry in Oyo State, Nigeria In R. A. Sanusi, O. B. Jegede, O. A. Adegbite, & S. A. Ojediran (Eds.), *Leadership and mentorship for remarkable administrative development: Reflection of Professor Kamoru Olayiwola Usmans Administration*. Oyo: Adeniran Printing Press.

(h) Ezekiel O. J. & **Ezekiel, O. O.** (2023) Science education curriculum for sustainability of national development n R. A. Sanusi, O. B. Jegede, O. A. Adegbite, & S. A. Ojediran (Eds.), *Leadership and mentorship for remarkable administrative development: Reflection of Professor Kamoru Olayiwola Usmans Administration*. Oyo: Adeniran Printing Press.

4. Scholarly articles

(a) Sabitu, K. A., Lamidi, T. O., & **Ezekiel, O. O.** (2020). An investigation into the effects of Demonstration Instruction Strategy (DIS) on senior secondary school students' Mathematics achievement in Afijio Local Government, Oyo State, Nigeria. *Research Journal in Comparative Education*, 1 (1), 29-38.

(b) Sabitu, K. A., Lamidi T. O., **Ezekiel, O. O.** & Akintobi, O. J. (2020). Impact of integrating ICT on pupils' achievement in Mathematics primary schools in Afijio Local Government Area, Oyo State, Nigeria *Journal of Mathematical Sciences & Computational Mathematics*, 2(1), 158-168

(c) Sabitu, K. A. & **Ezekiel, O. O.** (2021). The influence of parental contribution to learning of Mathematics in primary schools in Oyo Metropolis, Oyo State, Nigeria, *Journal of General Studies Education*, 3(1), 133-146.

(d) Sabitu, K. A., Lamidi, T. O; **Ezekiel, O. O.** & Oyelabi, G. (2022). Psychosocial factors of classroom environment and cognitive styles as correlates of students' academic achievement in Mathematics. *Current Research in Statistics & Mathematics*, 1(1), 01-06.

(e) Sabitu, K. A., Odebode, A. O., Lamidi, T. O. & **Ezekiel, O. O.** (2022). Effect of metacognition approach on students' academic achievement and retention in Mathematics. *International Research, Journal of Science, Technology, Education, and Management*, 2(3), 01-07.

(f) **Ezekiel, O. O.**, Yara, P. O. & Ezekiel O. J. (2022). Students' attitude as a determinant of basic general Mathematics achievement in Federal Colleges of Education Southwest, Nigeria. *IFE Journal of Theory and Research in Education*, 23:161 – 169

(g) Sabitu, K. A., **Ezekiel, O. O.** & Oyebamiji, A. O. (2022). Teachers' perception of the availability and utilization of ICT tools for teaching of Mathematics in basic schools in Atiba Local Government Area of Oyo State, Nigeria. *International Journal of General Studies Education*, 4(1), 44-54

5. Notable scholarly or Professional Accomplishments: NIL

G. Major Conferences Attended with Dates:

- (a) **Ezekiel O.O.** (2019) Mathematics as a veritable tool in the entrepreneurship educational programmes for the national development in Nigeria. A paper presented at 56th Annual National Conference of Mathematical Association of Nigeria at Rivers State University Port Harcourt, University Hall. Between 1st -6th September,
- (b) **Ezekiel O.O.** (2019) Mathematics education as a tool for national development in the 21st century. A paper presented at 2019 Biannual National Conference of Mathematical Association of Nigeria at Federal College of Education Special, Oyo, at Tim Obani Hall. Between 11th -15th November,
- (c) **Ezekiel, O. O.** (2021) *Mathematics education: A tool that ushers in the entrepreneurship education and manpower development in Nigeria* A paper presented at the 2021 Biennial National Conference and Award Presentation on Modeling Teacher Education in COVID-19 Pandemic Landscape at Tim Obani Hall, in Federal College of Education (Special), Oyo. Between 22nd - 25th June,
- (d) Odebode, A. O, **Ezekiel, O. O.** & Lamidi, T. O. (2022). *Assessment of Explicit Strategy on Academic Achievement of Students with Orthopaedic Impairment in Geometry in Oyo State* A paper presented at 58th Annual National Conference of the Mathematical Association of Nigeria (MAN), at Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. Between 28th August - 2nd September,
- (e) **Ezekiel, O. O.** (2023). *Mathematics education: A veritable tool for solving economic hardship, societal vices and insecurity in Nigeria*. A paper presented at the 1st International Conference of School of General Studies Education, Federal College of Education Special, Oyo at Department of Economics, School of Arts & Social Sciences. Between 13th–16th February.

H. Referees

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Dr A.O. Odebode

Head,

Department of Science Education,

Federal College of Education (Special), Oyo

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.....

Signature

.....

Date

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The University Compliance Certification

This is to certify that this thesis by, Oluwafunmike Oyenike EZEKIEL in the Department of Science Education, Faculty of Education, Lead City University, Ibadan, Oyo State is in full compliance with the approved University Format and Style.

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Signature

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Date

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