

**EFFECTS OF CONVERGING AND DIVERGING KOLB-LEARNING
STYLES ON PERFORMANCE IN ALGEBRA AMONG SECONDARY
SCHOOL STUDENTS IN ZARIA , KADUNA STATE, NIGERIA**

BY

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DECLARATION

I Vincent Dodo JATAU (P13EdSC8066) declared that this dissertation entitled ‘ Effects of converging and diverging Kolb – learning styles on Academic Performance among Secondary School Students in Algebra in Zaria, Kaduna State , Nigeria has been carried out by me in the Department of Science Education. No part of this dissertation was previously presented for another higher degree. All quotations and sources of information are specifically acknowledged by means of references.

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CERTIFICATION

This dissertation titled “Effect of Converging and Diverging Kolb – learning styles on academic performance among Secondary School Students in Zaria, Kaduna State, Nigeria

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DEDICATION

I dedicate this research project to my family, my wife Victoria Vincent and my children; Polycarp Vincent and Sabestina Vincent for their support and encouragement. To all beneficiaries of this study who may find it useful in terms of further studies.

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OPERATIONAL DEFINITION OF TERMS

1. **Accommodating Learning Styles:** This is the learning style in which the students receive by receiving information from other people.
2. **Algebra:** It is a branch of Mathematics in which letters are used to represent numbers.
3. **Assimilating Learning Style:** It is a type of learning in which students take instruction from the teacher.
4. **Converging Learners:** - These are learners who solve or attempt a task on their own without guidance by the teachers.
5. **Diverging Learning Style:** - This is a learning style in which the learners solve a task by brainstorming or sharing ideas by themselves.
6. **Learning:** - This is the acquisition of idea of new things either formal or informal.
7. **Learning Style:** - It is the way or manner a learner interact, perceive and react or respond to learning situations.
8. **Performance** – It is the rating of a learner by an instructor through test or examination scores for a placement of either pass or fail.

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ABBREVIATIONS

WASSCE --- West African Secondary School Certificate Examination

NECO – National Examination Council

NIED --- National Institute for Educational Development

NCE – National Certificate of Education

DV – Divergence

CV - Convergence

ELT – Experiential Learning Theory

RO – Reflective Observation

Ac – Abstract Conceptualization

CE – Concrete Experience

AE – Active Experimental

ABSTRACT

This study investigated the effects of converging and diverging Kolb – learning styles preference on the academic performance of secondary school students in Mathematics in Zaria, Kaduna state. Three objectives, three research questions and three null hypotheses were formulated. The study was on the effect of two Kolb – learning styles for teaching of Mathematics in Kaduna state. A quasi experimental control design was used involving pre and post test. A total of 2773 students was the population of the study. One Hundred and Twenty students (120) were randomly selected for the experiment using simple random sampling (volunteers) method. Algebra Concepts Performance Test (ACPT) was adopted as an instrument for data collection and Kolb – learning style inventory (KLSI). The data collected were analyzed using descriptive statistics while null hypotheses were analyzed using independent sample t – test at $P \leq 0.05$ level of significance by the aid of computer software SPSS 16.0 version. The following findings were made; (i) significant difference was observed on the performance of students exposed to converging and diverging Kolb – learning style preference. (ii) Significant difference was observed on the academic performance between male and female students exposed to KLS teaching methods. (iii) It was observed that Kolb – converging learning style was more effective than the Kolb – divergent learning style as discovered in this study. On the basis of the findings some recommendations were made. The major recommendation is that Mathematics teachers should identify students learning style preference so that students would participate actively in the learning / teaching algebraic concept for the improvement in the academic performance at the Secondary school level among others.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

A strong background in mathematics is critical for many career and job opportunities in today's increasingly technological society. However, many academically capable students prematurely restrict their educational and career options by discontinuing their mathematical training early in secondary school. This was reported by Eccles, Meece and Wigfield in Akinsola and Areelu (2014). Nokoe (2008) argued that, mathematics carries an optimal degree of consistency, certainty and credibility to guide the Sciences. The great misconception about mathematics is the notion that mathematics is about formulae and computations that need to be memorized. This is worrisome, especially as mathematics is considered as the bedrock of all scientific and technological breakthrough and advancement of all activities of human developments. It is the only language and culture common to all studies (Uzo, 2002).

Mathematics is an expanding and evolving body of knowledge as well as a way of perceiving, formulating and solving problems in many disciplines (Odili, 2011). Alechenu (2012), described mathematics as the “queen” of the sciences without which it would be difficult for people to study other sciences like physics, chemistry, and biology and computer science/information technology. Underscoring the importance of science and technology to national development, he said, “We hope our government will properly address the issue of scientific transformation of our grown dynamics and processes as a nation” (Alechenu, 2012).

Mathematics is one of the subjects that is taken very seriously in the school system, irrespective of country or level of education. It has been described as a model of thinking (Iji, 2008), which encourage learners to observe, reflect and reason logically about a

problem and in communicating ideas, making it the central intellectual discipline and a vital tool in science, commerce and technology (Imoko & Agwagah, 2006).

According to Salman (2005) mathematics is a precursor of scientific discoveries and inventions. It is the foundation for any meaningful scientific endeavour and any nation that must develop in science and technology must have a strong mathematical foundation for its youths. In terms of curriculum relevance, mathematics is compulsory at the secondary school level and a prerequisite for moving from the junior to the senior secondary school and to the tertiary level of education. However, due to the immense benefit of the subject (Mathematics) to individual and the societal development, the achievement of students at the final year secondary school examination revealed under achievement (Jaggi 2006). Therefore, the use of methods or strategy that would make mathematics easier and reduce the failure rate should be used.

According to Amoo in Areelu (2014) poor learning interest and assimilation of Mathematical ideas, concepts, principles, processes and teacher's failure to use appropriate and stimulating teaching methods are responsible for students' poor performance in Mathematics in Nigeria (Akintola 2000 & 2014). The teacher is the most important determinant of what takes place in the classroom. This is because, strategies of teaching Mathematics effectively in the classroom originates from the teacher (Akinsola & Olowojaiye, 2005; 2008). These issues of students' poor performance in Mathematics are brought about as a result of students' inactivity in the classroom which is characterized by the traditional method of teaching in our secondary schools (Akinsola & Ifamuyiwa, 2008). For effective teaching of mathematics, the use of methods and styles that would simplified mathematical concepts should be used. Therefore, this study is to determine the effectiveness of kolb learning styles preference on academic performance in algebra among senior secondary school students.

1.2 Statement of the Problem

Despite several studies carried out to enhance academic performance in Mathematics by secondary school students. The areas that are found difficult to students in both internal and external Mathematics examination in Mathematics include algebraic processes domain. National Mathematics Council of Nigeria (NMC), 2009 reported that the most disturbing problems that students have in SSCE and other examination bodies are identified mostly in algebraic processes. Algebra is an important domain in mathematics and indeed everyday life, but most problematic to learners. Irish Chief Examiners report (2010) identified algebra as an area of weakness over some past number of years. Questions related to algebra are often the lowest scoring questions on the paper or continually avoided by students. The current teaching methods such as lecture method in schools are inadequate to enhance students' performance in Algebra. With this, the challenge is to find ways to make the power of algebra available to all students and to find ways of teaching that allow students learn with understanding and generate a genuine interest on the topic. Therefore, this study investigated the effects of converging and diverging Kolb Learning Styles on the academic performance in algebra among Senior Secondary School Students in Zaria.

1.3 Objectives of the Study

The major purpose of this research work is to find out the effects of converging and diverging Kolb – learning styles on performance in Algebraic concepts among secondary school students in Zaria.

Specifically, the objectives of the study are to:

1. Examine the effectiveness of Kolb converging and diverging learning styles on the academic performance of Senior Secondary School students when taught algebraic concepts

2. Compare the effects of Kolb diverging learning style on the academic performance of Senior Secondary School male and female students when taught algebraic concepts.
3. Compare the effect of Kolb converging learning styles on the academic performance among Senior Secondary School Male and Female students in algebra.

1.4 Research Questions

1. What is the difference between the mean academic performance of Kolb – Diverging, Kolb – Converging learning styles and the lecture method among Senior Secondary School Students in Algebra?
2. How does Kolb – Diverging learning style affect the Male and Female Senior Secondary School Students Academic Performance in Algebra?
3. What is the difference between the mean performance of Male and Female Senior Secondary School Students Academic Performance in Algebra using Kolb – Converging learning style?

1.5 Null Hypotheses

This study has the following null hypotheses to be tested at $P \leq 0.05$

Ho₁ There is no significant difference between the mean performance of students taught Algebraic concepts using Kolb Diverging and Converging learning styles and those taught with lecture method.

Ho₂ There is no significant difference in the mean performance of male and female students taught algebraic concepts using Kolb Diverging learning style.

Ho₃: There is no significant difference in the mean performance of male and female students taught algebraic concepts using Kolb Converging learning Style.

1.6 Significance of the Study

This study was aimed at determining the impact of converging and diverging Kolb - learning styles on Senior Secondary School students' performance in Mathematics in Zaria, Kaduna State, Nigeria. Therefore, the study will be significant in the sense that;

The findings would afford the Mathematics teachers and pre – service teachers who will not only lay emphasis on the content and methodology of teaching Mathematics but also consider students' learning styles preference as a very important aspect of teaching

Secondary School Students would find the result from the study useful for it would serve as a mirror to examine their learning styles preference in Mathematics and other subjects which would motivate their interest as well as their academic performance in the subject.

The result of this study will be beneficial to curriculum planners by creating awareness on the importance of identifying students' learning styles preference for effective teaching and learning, so that such consideration can be made when designing the curriculum and relevant facilities that can be used in Mathematics as a subject

This study will be of great significance to the government at all levels for it will be in line with the federal Government effort to improve the teaching of Mathematics syllabus, which will make the government provide adequate and relevant facilities and equipments needed for effective teaching and learning of the subject.

1.7 Basic Assumptions

The following assumptions are made for the study that:

1. Learning style preference which can serve as interest motivator in the learning of algebraic concepts is not applied in the secondary school

2. Secondary school students in Zaria do not learn Algebraic concepts in Mathematics through their learning style preference.

1.8 Scope and Delimitation of the Study

The study was carried on public senior secondary schools in Zaria Education Zone of Kaduna State. It investigated some aspects that constitute students' poor performance in Algebra especially the method by which the teacher imparts the knowledge as he / she examines the classroom situation. The study was delimited to two Kolb - learning styles (converging and diverging) only and conventional (lecture) methods. The study covered four public senior secondary schools (two coeducational and two single schools). In each sample school, students' participation was voluntary that is those who identified their learning styles preference and activities were carried out in the afternoon so as not to disrupt their normal lessons with their classmates. The content area of the study covered some algebraic concepts which include Algebraic expressions, change of subject formulae, linear inequalities, simultaneous equation and variation.

The study did not extend to the retention ability of both converging and diverging learning styles and also retention ability of male and female students. The finding of this study did not involve the other type of learning styles; that is accommodating and assimilating learning styles of which learners learn differently from converging and diverging learning styles. Some topics in algebra were not covered because of time frame of the study. Only five topics were involved during the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The study investigated the effects of two learning styles, converging and diverging Kolb – learning styles on the academic performance in algebraic concepts at secondary school level Mathematics in Zaria, Kaduna State. This chapter contains the Theoretical / Conceptual framework and overview of related studies.

2.2 Theoretical Framework

2.3 Conceptual Framework

2.3.1 Definition and Types of Learning Styles

2.3.2 Assimilating Learning Style

2.3.3 Converging Learning Style

2.3.4 Diverging Learning Style

2.3.5 Accommodating Learning Style

2.4 Methods of Identifying Learners Learning Style.

2.5 Kolb (2005) Learning Style Inventory

2.6 Academic Performance in Mathematics

2.7 Overview of Related studies.

2.8 Implication of the Literature Reviewed For the Present Study.

2.2. Theoretical Framework

The Kolb Learning Style Inventory differs from other tests of learning styles and personality used in education by being based on a comprehensive theory of learning and development. Experiential learning theory (ELT) draws on the work of prominent twentieth century scholars who gave experience a central role in their theories of human learning and development-notably John Dewey, Kurt Lewin, Jean Piaget, William James, Carl Jung,

Paulo Freire, Carl Rogers, and others—to develop a holistic model of the experiential learning process and a multi-linear model of adult development.

The theory of Experiential Learning: Experience as the Source of Learning and Development (Kolb (1984), is built on six propositions that are shared by these scholars.

1. Learning is best conceived as a process, not in terms of outcomes. To improve learning in higher education, the primary focus should be on engaging students in a process that best enhances their learning—a process that includes feedback on the effectiveness of their learning efforts. “...education must be conceived as a continuing reconstruction of experience: ... the process and goal of education are one and the same thing (Dewey (1897).
2. All learning is relearning. Learning is best facilitated by a process that draws out the students’ beliefs and ideas about a topic so that they can be examined, tested, and integrated with new, more refined ideas.
3. Learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world. Conflict, differences and disagreement are what drive the learning process. In the process of learning, one is called upon to move back and forth between opposing modes of reflection and action, feeling and thinking.
4. Learning is a holistic process of adaptation to the world. It is not just the result of cognition but involves the integrated functioning of the total person—thinking, feeling, perceiving, and behaving.
5. Learning results from synergetic transactions between the person and the environment. In Piaget’s terms, learning occurs through equilibration of the dialectic processes of assimilating new experiences into existing concepts and accommodating existing concepts to new experience.

6. Learning is the process of creating knowledge. ELT proposes a constructivist theory of learning whereby social knowledge is created and recreated in the personal knowledge of the learner. This stands in contrast to the “transmission” model on which much current educational practice is based, where pre-existing fixed ideas are transmitted to the learner.

The Experiential Learning Cycle

Kolb's experiential learning style theory is typically represented by a four stage learning cycle in which the learner 'touches all the bases' as shown in figure 2.1.

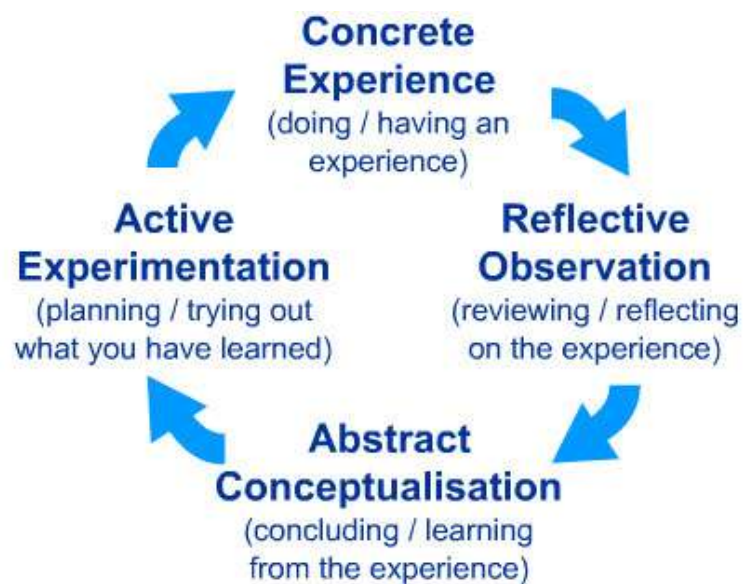


Figure 2.1

Source: Kolb – experiential learning cycle (1984)

1. **Concrete Experience** - (a new experience of situation is encountered, or a reinterpretation of existing experience).
2. **Reflective Observation** (of the new experience. Of particular importance are any inconsistencies between experience and understanding).
3. **Abstract Conceptualization** (Reflection gives rise to a new idea, or a modification of an existing abstract concept).

4. Active Experimentation (the learner applies them to the world around them to see what results).

Experimental Learning Theory (ELT) defines learning as “the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience” (Kolb 1984 in mutual 2014). The ELT model portrays two dialectically related modes of grasping experience-Concrete Experience (CE) and Abstract Conceptualization (AC)-and two dialectically related modes of transforming experience-Reflective Observation (RO) and Active Experimentation (AE).

Experiential learning is a process of constructing knowledge that involves a creative tension among the four learning styles that is responsive to contextual demands. This process is portrayed as an idealized learning cycle or spiral where the learner “touches all the bases” experiencing, reflecting, thinking, and acting-in a recursive process that is responsive to the learning situation and what is being learned. Immediate or concrete experiences are the basis for observations and reflections. These reflections are assimilated and distilled into abstract concepts from which new implications for action can be drawn. These implications can be actively tested and serve as guides in creating new experiences (Figure 1). ELT proposes that this idealized learning cycle will vary by individuals’ learning style and learning context.

2.3 Conceptual Framework

2.3.1 Definition and types of Learning Styles

Learning styles can be described as “an individual’s preferred approach to organizing and presenting information” Riding & Rayner in Brown et al (2013). It can also be described as “the way in which learners perceive, process, store, and recall attempts of learning” James & Gardner in Brown et al (2013).

Yunyan in Silas (2013) defined learning styles as the manner in which a combination of physical, psychological, emotional, sociological and environmental factors affect an individual's ability to perceive, interact with and respond to the learning environment, which is often used in special education. (Montgomery in Silas (2013) identified learning style as learners' preferred instructional technique, curriculum content, and their preferred response to Keefe in Francis (2014) stated that learning style is the composite of cognitive, affective and physiological characteristics that serve as relatively stable indicators of how learners perceive, interact with and respond to the learning environment. He also suggested that teachers need to understand the learning strategies of students in order to facilitate their learning. It has also been argued that teachers should not only possess content knowledge but should also be acquainted with their learners' attribute Gudmundsdottir, Oguamanam (2011) succinctly posits that; when a student- learning style differs from the teaching style, the way a teacher presents the subject matter may conflict with students' idea about learning thus, resulting in no learning. In spite of the different definitions, Yunyan and Montgomery in Silas (2013) classified learners into different categories in order to study the individual learning differences.

Kolb in Silas (2013) emphasized that one needs to map an individual's location on concrete-abstract and active-reflective dimensions which makes it possible to identify the learners' relative emphasis of concreteness over abstractness and active experimentation over reflection. Learners can thus be classified into one of the four Kolb's learning styles, namely; converging, diverging, assimilating, and accommodating.

2.3.2 Assimilating Learning Style Learners

Assimilating learning style learners are best at understanding a wide range of information and organizing it into concise and logical form (Honey & Mumford Kolb & Kolb and Kolb in Silas (2013). They further stated that assimilating learners are good at

assimilating disparate facts into coherent theories, yet often not interested in deducing hypothesis from the theory. Their strength lies in inductive reasoning and the ability to create theoretical models, in organizing disparate observations into an integrated explanation. They are interested in abstract ideas and concepts rather than people. They value the logical soundness of a theory more than its practical value. Kolb and Kolb (2001) further stated that their characteristic question should be „What“ and for these learners to learn better, the teacher should function as an expert.

2.3.3 Converging Learning Style Learners

According to Kolb in Silas (2013), converging learning style learners are best at finding solutions to practical task by relating it to theories and ideas learnt. These types of learners are good at solving problems and making decisions and they also tend to do best in situations where there is a single correct answer to a question. Murray (2002) state that converging learners organize knowledge by hypothetical-deductive reasoning and focused on specific problems. These types of learners are usually reluctant to express their emotion and prefer dealing with technical tasks than with social and interpersonal issues and therefore, their characteristic question is ‘‘how‘‘. To be effective, the teacher should function as coach, providing guided practice and feedback in the content being taught.

2.3.4 Diverging Learning Style Learners

Kolb and Kolb (2001) state that diverging learners are best at viewing concrete situations from different points of view and organizing many relationships into a meaningful whole picture. They prefer brainstorming situations to taking action. They are interested in people and tend to be imaginative and feeling-oriented. Daniel et al. (2002) noted that this type of learners involve themselves in new experiences, tackling problems by brainstorming and enjoy moving from one task to the next as the excitement fades and are especially good at imaginative ability and awareness of meaning and values. These

learners characteristic question of interest is ‘why’ and for them to learn better, the teacher should work as a motivator.

This approach ensured that every learner participates in the discussions of the group. Aronson, Fried, and Good (2002) described the jigsaw method as a cooperative learning approach where each member of the small group is given a problem to solve for a certain amount of time and then later the members give each other opportunities to show how they solved the problem.

In using the jigsaw method, the researcher will give out Mathematics problems to five groups, each group 3 learners. Each group will discuss and presents their group solution to the entire class.

During the group presentations, the researcher posed the ‘what if’ questions in order for every learner in the class to get the opportunity to carry out their own analysis. This approach will give room to the entire class to hear and critique different methods of solving a given problem. For example, solve the simultaneous equations

2.3.5 Accommodating Learning Style Learners

Accommodating learners learn primarily from “hands-on” experience (Kolb, 1984;s 1993). They prefer to act on feelings rather than on logical analysis. In solving problems, they rely more heavily on people for information than on their own technical analysis. Their strength lies in doing things, in carrying out plans and tasks and getting involved in new experiences. They are good at opportunity seeking, risk taking, and handling changing immediate circumstances. When the theory or plans do not fit the facts, they would discard the plan theory. Furthermore, Yunyan (2004) stated that accommodating learners’ characteristic question is “ what if ”, and for the lesson to be effective, the teacher should pose open-ended questions and then get out of the way, maximizing opportunities for the learners to discover things for themselves.

Yunyan (2004) stressed the need to consider learning styles in classroom environments. This provides teachers with a perspective to address conflicts between their teaching style and a learner's contrasting learning style by supplementing their instruction with aspects of other methods.

During the group presentations, the researcher posed the „what if“ questions in order for every learner in the class to get the opportunity to carry out their own analysis. This approach will give room to the entire class to hear and critique different methods of solving a given problem. For example, solve quadratic equations methods such as factorization, completing the square or using the formula.

2.4 Methods of Identifying Learners' Learning Styles

Matthews (1996) used the Kolb (1993) Learning Style Inventory and a learners' questionnaire that asked learners to rate their academic performance. Data was collected from nearly 6,000 high school learners throughout Southern Carolina. The results showed that learners' learning styles had a significant effects on perceived academic performance. Those learners whose styles favoured interpersonal relationships over deductive reasoning often rated themselves as academically "poor". On the contrary, the learners who showed an analytical preference in learning style rated themselves as being academically strong.

Riding and Caine (2000) correlated the learning styles of a group of 182 British Secondary School level learners to their performance on the General Certificate of secondary Education (GCSE) examination. Believing that learning style characteristics could be simplified into two forms, Global/Analytic and Visual/Imagery, Riding & Caine (2000) developed a learning style inventory to measure these dimensions and subsequently graphed the learners' performance on the GCSE examination. Riding & Caine's (2000) research revealed that learners who were in the intermediate range on both learning style continuums performed best on the GCSE examination and the two researchers theorized

that these learners had the ability to “avoid the limitations of an extreme of style and can utilize the most appropriate facilities of both dimensions as the task requires.

Murray (2002) carried out a study on adult learners whose reading abilities were below a 6th Grade level. Murray administered the Kolb (1993) Learning Style inventory to the participants and discovered that these adult learners preferred a reflective observation learning style orientation. The least preferred learning style was abstract conceptualization. These adult learners were able to view situations from different perspectives and apply their experience to evaluate information. Murray’s study also revealed that adults often have trouble in acquiring new information if the new information is not presented in a visual style. The incorporation of learning styles into the adult education classroom significantly improved the reading ability of the adult learners (Murray, 2002).

Most of the following studies (Murray, 2002; Matthews, (1996); Daniel et al., (2002) adopted the Kolb (1993) learning style inventory to determine the learners’ learning styles. This study adopted the Kolb (2005) learning style inventory in order to identify individual learner’s learning style.

2.5 Kolb (2005) Learning Style Inventory

Kolb developed the learning styles inventory from his Experiential Learning Theory model (Kolb, 1984) in which he had noted that learning was a dialectic process integrating experience of concepts, observations and action which occur in all kinds of settings and encompass all life stages.

According to Yunyan (2004) learning involves the integrated functioning of thinking, feeling, perceiving and behaving as well as communications between the person and the environment. In order to maximize one’s own personal learning, each learner ought to understand his or her learning style and seek out opportunities to learn because learning styles are not fixed traits, but can change and adapt to different situations and learning

contexts. Educationalists Garner, (2000); Coffield, Moseley, Hall and Ecclestone, Smith, (2010) questioned the validity and reliability of the learning styles inventory, the inventory also gained support from Honey & Mumford (2000); Entwistle and Walker (2000); Yunyan (2004) and McCarthy (2010) that there is a benefit in enabling learners to reflect on how they learn best and this is an important aspect of developing metacognition in young people. The supporters further noted that the inventory promotes greater interest in the subject material, enhances intrinsic learning satisfaction, increases understanding of course material, develops the desire and ability to be continuous learners, improves communication and interpersonal skills, problem solving, analytical thinking and the critical thinking of learners. They also concluded that fostering metacognition is perhaps the most important advantage that can be claimed for applying learning styles theory to learning and teaching. Entwistle and Walker (2000) and Yunyan (2004) stated that the inventory has the potential to engage learners in topics of their interest, and that it provides opportunities to explore how those subjects can be applied to real-world situations. Yunyan (2004) further stated that based on life experiences and innate characteristics, individuals may develop preferences for one or two particular phases of the learning process.

2.6 Extent to which Teachers Can Plan the Lesson Based on the Learners' Learning Styles

Heimlich and Norland (2002) noted the discrepancy between teacher's knowledge of learning styles and teacher's application of this knowledge. Heimlich & Norland proposed that teachers should consciously adapt the role of "lifelong learners" and continue to study their own teaching methods to examine if they are effectively adapting information about learners' learning styles into their classroom practice. Drawing on the conclusions of Brown (2003), teachers might change their teaching styles through effective training, thus better meeting the changing demands of learner – centered learning. According to Beihler

& Snowman (2000), there are a number of things a teacher can incorporate into the lesson plan to accommodate different types of learning styles. The teacher can use the following standard academic method of instruction, lecture and reading, covering the aural and verbal activities. Furthermore, the teacher may use small group discussion, brainstorming sessions for diverging learning style learners and may use Power point presentations, over head projectors, even drawing on chalkboard for visual (assimilating) learners. In- class exercises, tactile (converging) learners can be reached by being given independent research problems and programmed outlines to fill in as the teacher lectures.

Claxton and Murrell (2004) believe that matching learners' and teachers learners styles are most important when working with the other achieving learners'. Some intentions mis-matching may however be beneficial if handled sensitively, but care must be taken to ensure that the under achieving learners does not experience discontinuity. The above statement supports the view of Smith, Sekara and Townsend (2002) that most learners learn best when matched with teachers whose styles mimic their own.

Woolfolk (2007) states that, before teachers "accommodate all their learners", learning styles, they should remember that learners especially young ones, may not be the best judges of how they should learn. Sometimes learners particularly those who have difficulty in learning may prefer what is easy and comfortable while real learning can be hard and uncomfortable. Sometimes, learners prefer to learn in a certain way because they have no alternative. It is the only way they know how to approach the task. These learners may benefit from developing new and perhaps more effective ways of learning.

Wilson (2002) in his findings on learning styles concluded that, awareness of learning styles and skill in utilization of instructional methods will give teachers a wide array of techniques to use in promoting learners learning. Incorporating learning style theories into classroom practice motivates learners to invest time and effort in their

academic performance leading to a feeling that school is a valuable resource for their lives, and decides to give education undivided attention, Woolfolk (2007). Cardellini & Felder (2004) suggested a balance between all learning styles as the key to accommodate diverse learning styles in the teaching and learning process. That is, to make sure that teachers address most of the learning dimensions rather than favouring one side at the expense of the other, Cardellini and felder (2004), and hence suggested that a balanced teaching approach should accommodate each stage of the learning process. This happens perhaps because of limited time for covering the syllabus, lack of teaching aids and uniqueness of every learner in the classroom. If the teachers give the balance to all learning styles, it might improve learners' performance.

The two groups with different learning styles were taught Algebraic topics separately. This is because the learning styles seem to be experimental while the other two (Assimilating and Accommodation) seems to be the same with the conventional lecture method. The lessons were planned and taught using the learning objectives and competences in the syllabus. The researcher prepared only one lesson plan per day and use different teaching methods for each learning style group. The researcher taught according to the envisaged effective approaches and developed the best lesson, but considered the learner-centered approach by making sure that the starting point of each lesson include the learners' existing knowledge and link the lesson to learner' experiences. Considering learner pre-knowledge may help learners to arouse their interests and to investigate further and make sense of the new concepts learnt (Njenga, 2010). The problems about substitution and solve for unknowns were contextualized particularly for the diverging learning style learners whose characteristic question is 'why'. Furthermore, the researcher explained the main purpose of the study to the selected learners for the study and encouraged them to participate in the lessons. The learning objectives informed the

participants on what they were to prepare and what they were expected to learn during the lessons. Each lesson took 40 minutes. For the first five minutes of each lesson, the researcher asked the entire group how to solve a certain problem. The converging learning style learners gave the solution to the researcher without consulting other learners while the diverging style learners first discussed with each other before giving the solution to the researcher.

Dedicated teachers have made attempts to enhance their students' academic performance Abidin et al., (2011). One of these ways according to Abidin (2011) is to identify each students learning style to determine strength for academic performance. In a study of Castro and Peck (2005) on learning styles and learning difficulties of foreign language students, they claimed that the preferred learning style of the student can be a help or a hindrance in the success of the student in the foreign language classroom. Abidin et al., (2011) implied that the student in their study possessed multiple or a combination of different learning styles, thus, they are able to learn effectively. They indicated that learning styles make an impact on the students' overall achievement. Dunn et al., (1995) argued that students who were taught by an approach compatible with their learning style did better than those whose learning styles were not matched with the teaching methodologies.

Algebra: It is a branch of Mathematics in which letters are used to denote numbers in arithmetic operations. For example, the relation $x + y = y + x$ belongs to algebra since it is true for any two numbers denoted by x and y is a commutative property. In an equation any term can be added or subtracted on both sides or divide by any constant or variable quantity Jaggi, (2006).

Just as individuals differ in height, weight, metabolism, personal interests, and other characteristics, learners also differ in how they learn the rate at which learning

occurs, and the cognitive styles they prefer for learning new material (Hamachek 1995). He further stated that teachers realize that in order to assist pupils and to capitalize on their natural inclination to understand, one must not only diagnose their learning style, but also accept their learning styles.

According to Keefe in Silas (2013) learning styles is the cognitive, affective, and physiological traits that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment. Chris in Silas (2013) defined learning styles as types of learning activities and tasks which learners prefer to experience and which they feel are more effective in promoting their own learning. The question that this study sought to address is; what effects do learning styles have on secondary school students achievements in Mathematics? James, Gardner, and Kolb (1995) states that learning styles have been acknowledged as the prime constructs that serve as relatively stable indicators of how learners respond to the learning environment. However, with variation, these stable indicators may change as the learners adapt to the learning approach, progress and respond to the problems (Montgomery, 1996).

Learning style is both a characteristic which indicates how a student learns and likes to learn, as well as instructional strategy informing the cognition, context and content of learning. Previous studies have reported that students' learning performance could be improved if proper learning style dimensions could be taken into consideration when developing any learning or instructional process(Graf, Liu & Kinshuk, 2010)

Research conducted by Yazici (2011) on the effects of learning styles on the performance of students at Istanbul Kultur University in Turkey indicated that, academic performance of students was consistent with their learning styles. The Namibian education system shifted from a traditional teacher-centered to a learner-centered education after independence, according to Angula in Silas (2013). This type of education system has led

to an increased interest in learners' individual differences. The "new" paradigm learner-centered education is based on inclusiveness, cooperative learning, and encourages diversity. According to James, Gardner, & Kolb in Silas (2013), claimed that learners consistently show positive improvements in performance when the content concepts are illustrated in their preferred learning style.

Research on the effects of learning styles on the learner academic performance has been conducted worldwide (Dunn, Beaudry & Klavas, 2001; Daniel, Price, & Merrifield, 2002; Ginthier & Caldwell, 2003 ; Yunyan, 2004), Nonetheless, the results on learning styles are not conclusive (Rautopuro & Vaisanen, 2003). They noted that the learning styles do not seem to have any effect on the performance of learners in different school subjects while other researchers (Bell, 1998; Yunyan, 2004; Sandmire & Boyce, 2004) stated that there is a significant difference between learning styles and performance in the school subjects. Hence, this study want to investigate the effect of converging and diverging Kolb learning style on the performance of secondary school students.

Most Nigerian secondary school teachers have not established how learners learn mathematics, particularly on the concepts of algebra, geometry and trigonometry. The consistently low academic performance of the Nigerian students in the West African Senior School Certificate Examination (WASSCE) noted in Asikhia (2010), Nigerian Elites Forum (2012) and Ossai (2012), were attributed to students not using a method that match their learning style. Also, teachers have not understood the diversity of their learners in a typical classroom, and they keep on embracing the same traditional teaching styles in every context. In consequence, students become bored and inattentive in class, do poorly on tests, get discouraged about the subject, the curriculum and themselves and in some worse cases drop out of school

The poor performance in Mathematics amongst others, is attributed to the instructional approaches employed by teachers as reported by National Institute for Educational Development (NIED 2010). Learning style theories have been cited as an effective means of helping teachers recognize the incredibly diverse needs learners bring into the classroom, as well as helping the learners discover how they learn best for optimum academic performance. In addition, these theories provide a framework that enable teachers to reap the very best from their learners through developing a variety of instructional methodologies to benefit all learners and more importantly helping the students learn how to learn and consequently achieve better academic results. It is therefore imperative to understand learning style preference among the learners and how they relate to academic performance so as to develop effective and successful learners.

Generally students fear and hate or dislike mathematics because they see it as abstract. This has resulted to their lack of interest which leads to poor performance in mathematics examinations, both internally and externally (Obodo, 2004). Reporting to the National Council on Education (NCE) on students' performance in the May/June Senior Secondary School Certificate Examinations (SSCE), the West African Examinations Council (WAEC, 2006), expressed worries over the low performance due to poor retention rate and interest in mathematics by Nigerian candidates.

Academic performance is defined as a display of knowledge attained or skills developed in schools subject designated by test and examination scores or marks assigned by the subject teachers (Smith, 2010). It could also be said to be as an expression used to represent students scholastic standing.

Kolb learning style is an experiential learning which deals with the process of constructing knowledge that involves a creative tension among the four learning styles that are responsive to the contextual demands. This process is an idealised learning cycle

where the learner touches all the bases-experiences, reflecting, thinking and acting in a recursive process that is responsive to the learning situations and what is being learned. Concrete experiences are the basis for observations and reflections. These reflections are assimilated and distilled into abstract concepts from which new implications for actions can be drawn.

2.7 The Concept of Academic Performance

Academic performance could be defined as a display of knowledge attained or skills developed in schools subject designated by test and examination scores or marks assigned by the subject teachers (Smith, 2010). It could also be said to be as an expression used to represent students scholastic standing.

As important as the subject (Mathematics) is, the tremendous and persistent failures of the Nigerian students in algebra had remained a major concern to mathematics learning (Sanni & Ochepe, 2002; Uloko & Imoko 2007; Abakpa & Agbo - Egwu, 2008). Learners continue to manifest weak understanding of Mathematical concepts, skills generalization among others, not only in external examinations but also in classroom exercises (Bot, 2000). This view is supported by the West Africa Examination Council Chief Examiners' Reports 2002-2011 on Senior Secondary School Certificate Examination results, which recorded very low percentage passes in Mathematics at credit level in those years. These poor performance are evident in the statistic of WAEC results of mathematics from 2009-2013 which indicated the poor performance of students in mathematics. See Table 1.1

Table 1:1 Analysis of WASSCE in Mathematics Results of May/June 2009 – 2013 in Kaduna state, Nigeria

YEAR	No. that sat For the Exam	No with credit Six and above	No with pass & below
2009	26806	1904	24902
2010	25197	3020	2177
2011	35214	4048	31166
2012	3105	7034	26081
2013	36291	4666	40957

Source: Education Resource Centre (ERC), Kaduna 2014

Table 1.1 gives the analysis of students’ performance at the Senior Secondary School Certificate Examinations in Mathematics between 2009 to 2013 in Kaduna state. The table showed poor performance of students with grades A1-C6 recorded the highest of 21.2 in 2012 and failure grade F9 reached the peak of 92.9% in 2009. The situation in Nigeria is that, academic performance in Mathematics education is still in deplorable stage both in Primary and Secondary Schools examinations. Many researchers identify inherent unfairness in school – based assessment (Grifith, 2005; Njabili, Abedi, Magesse & Kalole , 2005; Asim, 2007) which may result from teachers’ incompetence in assessment (Asim, Kalu, Idaka & Basse, 2007), as well as psycho – cultural factors among others as being responsible for this abnormality (West African Examination Council, 2001). Amoo (2002) reported that poor learning, interest and assimilation of Mathematical ideas, concepts, principles, processes and teacher’s failure to use appropriate and stimulating teaching methods (Akinsola, 2000), are responsible for students’ poor performance in Mathematics in Nigeria.

The constructs “academic achievement” and “academic performance” are often used in manners that create confusion in reference to the different levels of measurable and observable behaviour of learners. It is hardly surprising that there seems to be a lack of consensus among the researchers regarding the similarities and differences among the

constructs: academic achievement and academic performance. One of the major conceptual problems of this measurement construct, that is, academic performance and academic achievement in educational research is that on one hand they mean different things to some researchers and to others they mean the same thing.

Poopola(2010) defined Academic Achievement as an expression used to present student scholastic standing and which is a function of various factors such as method of teaching, teacher's qualification, child home background, school background, school environment, attitudes, interest among others. Achievement is defined as measurable behaviour in a standardized series of tests (Simpson & Weiner. 1989). The tests are usually constructed and standardized to measure proficiency in school subjects. The most highly valued method of determining whether a successful completion has taken place for a learner is quantitative in nature. In other words, numbers (in the context of grading and testing) are used to indicate whether a student has been successful or unsuccessful in mastering academic content and skills (Simpson & Weiner, 1989). A student who scores 90 per cent (where 90 per cent equals an A) is deemed to have achieved, where as a student who has 18 per cent is deemed not to have achieved. A student who takes a standardized test in writing and scores at a 99th percentile is regarded as an achiever, while a student who scores at a 13th percentile is seen as a non-achiever.

According to Steve (2000), academic achievement is distinguished from academic performance in that academic achievement is long-term (end) while academic performance is measurable at any point in time (continual). Steve (2000) further classified activities that occur in performance as academic performance index, for instance, students' performance based on reading, selection of one or more schools within each district, among others. According to him, satisfactory academic achievement award is given to recipient who maintains satisfactory academic performance and progress towards the attainment of high

school certificate. It means that academic achievement cannot be attained within a short period or at a slot, but performance can be attained within a short period.

2.8 Overview of Related Studies

Here, different related researchers on Kolb learning styles and students performance were revisited and compared with the on-going research work to find out the similarities and differences so as to fill in existing gap where any.

Bhatti and Bart (2013) conducted a research on the influence of learning styles scholastic achievement levels. The participants in this study were undergraduate students studying social sciences at a research university Islamabad, Pakistan. The frequencies of the participants in the four learning style categories were as follows: Convergent (n = 28), Divergent (n =49), Assimilator (n = 76 and Accommodator (n = 40). The instruments used in the study were the Kolb learning style inventory and a demographic form. The major findings of the study were that the dominant learning style was Assimilator and that learning style and gender influenced academic performance. The findings of the above study showed that there was a difference in learning styles of male and female. Females prefer to perceive new information from Concrete Experience whereas, males prefer to perceive new information through Abstract Conceptualization. Females tend to be Accommodators and/or Divergers whereas males tend to be Assimilators and or Convergents (Philbin, Meier, Huffman & Boverie, 1995).

Obiefuna and Oruwari (2015) conducted quasi experimental research to assess the effects of students' learning styles on their performance in English language in Senior Secondary Schools in Imo State. Two research questions and two hypotheses guided the study. A purposive sampling technique was used to sample the 200 students in the area of study. The study used both descriptive and inferential statistics in the data collection and analysis. Mathematics Achievement Test (MAT) was used as the main instrument for pre-

test and post-test. The research questions were answered with percentages and mean while the hypotheses were tested with ANCOVA at 0.05 level of significance. Relevant literatures were reviewed accordingly. The result of the analysis showed that the learning style preference for English language students was converging. Result revealed that when teaching methods match the students learning styles they perform better. Also, in the study of English language gender variable has no significant impact on students' learning styles and performances. The findings had implications on the teaching and learning of English studies at the Senior Secondary Schools. It was therefore recommended among others that English language teachers should identify the learning style that soothes their students and use teaching strategies that complement them

The similarities between Oruwari research work and the on-going research is that both used quasi experimental research. The two researches were conducted on senior secondary school students. The differences between the two researches is that Oruwari conducted the research at Owerri while the on-going work was carried out in Zaria Kaduna state. Oruwari's investigation was on English Language while the on-going research work is on Mathematics. The study did not compare the different learning styles in terms of effectiveness (ratio comparison)

Patemola (2013) in his study, investigated the effects of learning styles on the performance of Grade II learners in Mathematics at one of the secondary schools in the Oshana education region, Namibia. The study used both qualitative and quantitative approaches and it was carried out for four weeks. Using Kolb's (2005) Learning Style Inventory, learners' learning styles were identified and the learners were then grouped according to their learning styles as converging, diverging, assimilators and accommodators. All the four experimental groups were pre-tested to determine whether all the groups were on par prior to the study in Algebra by the researcher. Each learning style

group was placed in a different classroom and taught the same content using suitable teaching methods for each group and then post-tested. Post-test scores showed a significant difference in the performance of the Grade II learners and their learning styles. Structured interviews were also used to get views from the three Mathematics teachers about learning styles. The Mathematics teachers indicated that considering that learners learning styles were time - consuming and had led to less content being covered at the end of the day. The findings suggest that Mathematics teachers should familiarize themselves with knowledge and skills of dealing with different learners' learning styles and incorporate these in the teaching of Mathematics. The study also recommends that Mathematics teachers should provide the learners with a variety of activities in order to enhance the development of different learning styles in their learners. Similarities of Patemola research work and the ongoing research work is that both used Kolb learning styles. The two research works are investigated on senior secondary school students.

The difference is that Patemola's work was conducted in Namibia while the on-going research was conducted here in Nigeria. Patemola's work used qualitative and quantitative approached while the on -going work used descriptive and inferential statistics.

Another study conducted by (Gappi, 2013), explored on the student's preferred learning styles and their academic achievements. The specific objectives of the study were to describe the learning style preferences of the students; to find out whether learning style preferences of the students differed with age, gender and academic program; and to determine the relationship between the learning style preferences and the students' academic performance. The participants of the study consisted of all (131) freshman students who were accepted during the first trimester of the academic year 2012-2013, composing of 118 national youth and 13 young adults. The Index of Learning Styles (ILS) questionnaire was utilized to carry out the rationale of the study. Permission to use the

questionnaire was granted free of charge via internet and the results demonstrated that generally the students were fairly well balanced in all four dimensions presented in the ILS questionnaire. Results showed that there was no significant effect of gender, age and academic program on the learning style preferences of the students ($r = -0.056$). Based on the result, there was no significant statistical correlation between the academic achievement and the learning style preferences of the students. The study was conducted among first year students in college, and therefore [based on the small age-gaps] the results may not vary substantially. A different study conducted by Vaishnav and Chirayu (2013) on the analysis of learning styles prevalent among secondary school students also tried to find out the relationship and effect of different learning styles on academic achievements of students. It was conducted on three learning styles - visual, auditory and kinesthetic (VAK). A sample of 200 students of class 9th, 10th and 11th standard of Maharashtra state was randomly selected for the study. After selecting the sample the Howard Gardner's VAK learning style brain box and VAK Learning Style Inventory by Victoria Chislett and Alan Chapman was used to identify the preferred learning style of students. The correlation between academic achievement and learning style was determined using Pearson's product moment co-efficient of correlation method and also to identify the effect of learning style on academic achievement ANNOVA , F test was used. Findings of the study revealed that, kinesthetic learning style was more prevalent than visual and auditory learning styles among secondary school students. There exist positive high correlation between kinesthetic learning style and academic achievement ($r = 0.658$). The other two learning styles have positive relationship but not strong one: $r = 0.287$ for auditory learning style and $r = 0.129$ for visual learning style. The main effects of the three variables - visual, auditory and kinaesthetic are significant on academic achievement (Vaishnav & Chirayu, 2013).

2.9 Implications of Literature Reviewed for the Present Study

With the shift from an instructional to a learning paradigm, there is growing acceptance that understanding the way students learn is the key to educational improvement. To achieve a desired learning outcome, one should provide teaching interventions that are compatible with the students' learning styles. Thus, learning style is a concept that is important not only in shaping teaching practices, but also in highlighting issues that help school administrators think more deeply about their roles in facilitating student learning.

When teaching takes place in or out of the classroom, students are expected to learn. Because teaching is intended to result in learning, high school teachers can benefit from understanding and applying certain principles of learning when designing and implementing their teaching initiatives. Also, because neglect or misapplication of principles of learning could easily result in teaching that fails to achieve results, it is important that teachers become familiar with the underlying principles in learning. Previous studies have reported that students' learning performance could be improved if proper learning style dimensions could be taken into consideration when developing any learning or instructional process (Graf, Liu & Kinshuk, 2010).

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The decline in the performance of Secondary School Students is attributed to many factors. To enhance the performance, this study investigated the effects of Kolb learning styles on the performance of Secondary School Students in Zaria. The study was guided by three research questions and null hypotheses. This chapter discusses the research methodology for this study and presented under the following sub – headings;

3.2 Research Design

3.3 Population of the Study

3.4 Sample and Sampling Procedures

3.5 Instrumentation

3.5.1 Algebra Concepts Performance Test (ACPT)

3.5.2 Validation of the Instrument

3.5.3 Pilot testing

3.5.4 Reliability of the Instrument

3.6 Administration of the Treatment

3.7 Data Collection Procedure

3.8 Procedure for Data Analysis

3.2 Research Design

The researcher adopted Quasi-experimental design of pretest and post-test. This design was used because it helps in determining the academic performance of students, that is, the difference between pre – test and post – test scores. Tuchman (1988) states that the designing helps in comparing scores and means of the two groups of pre – test and post test. The design is also used in the test of the assumption of equality of two groups. All sampled students were pre- tested to determine the level of equivalent academic

performance. The experimental groups received treatment while the control groups received lecture method. Also, all the groups were subjected to post - test to determine the effect of the treatment on students' academic performance.

$$\begin{array}{l} EG_1 : \rightarrow O_1 \rightarrow X_1 \rightarrow O_2 \\ EG_2 : \rightarrow O_1 \rightarrow X_1 \rightarrow O_2 \end{array}$$

$$\begin{array}{l} CG_1 : \rightarrow O_1 \rightarrow X_0 \rightarrow O_2 \\ CG_2 : \rightarrow O_1 \rightarrow X_0 \rightarrow O_2 \end{array}$$

KEY

EG₁ = Experimental group 1

EG₂ = Experimental group 2

CG₁ = Control group 1

CG₂ = Control group 2

O₁ = Pre – test

O₂ = Post – test

X₁ = Treatment

X₂ = No treatment

3.3 Population of the Study

The population for the study comprises of Senior Secondary School one(SS1) Students in Zaria Education Zone, Kaduna State. The total number of Senior Secondary School One (SS1) students in the nineteen Senior Secondary schools (15 urban and 4 rural Schools) was (2,496) of which (1518) were males and (978) were females. The selected schools were from the same educational Zone (Zaria Zone) of which the learning and teaching environment and staffing were of the same standard).The average age of the students was 15 years. This category of students were targeted for the study because algebraic concepts are taught in SS 1 syllabus, and also the preparation for the WAEC and NECO Examinations foundation is laid in SS 1. The SS1 Students who had just transited from the

Junior Secondary Certificate Examination (JSCE). Details of the population is shown in Table 3.3

Table 3.3 - Population of the Study

S/NO	NAME OF SCHOOL	NUMBER OF STUDENTS			
		AREA	MALE	FEMALE	TOTAL
1.	Alhudahuda College	urban	198	-----	198
2.	GSS Aminu	urban	214	96	310
3.	Barewa College	“	256	-----	256
4.	GSS Chindit (Girls)	“	-----	85	85
5.	GSS Chindit (Boys)	“	134	-----	134
6.	GSS Dakace	rural	90	40	130
7.	GSS Dinya	urban	31	26	57
8.	GGSS D/Bauchi (Snr)	“	-----	211	211
9.	GGSS Kofan Gayan	“	-----	160	160
10.	GSS Likoro	rural	40	18	58
11.	GSS Magajiya	urban	90	36	126
12.	GSS Muchia	“	88	21	109
13.	GGSS Pada	“	-----	81	81
14.	GSS Tudun Jukun	“”	106	78	184
15.	GSS Tudu Saibu	rural	118	23	141
16.	GSS Yakasai	“	23	09	32
17.	GCC Zaria	urban	70	38	108
18.	GGSS Zaria	“	-----	140	140
19.	GSS Zaria (Snr)	“	253	-----	253
GRAND TOTAL			1711	1062	2,773

Source: Ministry of Education, Headquarters, Kaduna State, 2012

3.4 Sample and Sampling Procedures

Four Government public schools were randomly selected for the study through simple random sampling techniques of ‘Hats and Drawn’ method. The researcher wrote four (4) ‘YES’ and Fifteen (15) ‘NO’ on pieces of paper for one of the Mathematics teachers in each school to pick. Those who picked ‘YES’ were selected for the study. Thus, two (2) schools were selected for experiment group (1 & 2) and other two schools for control group (1 & 2).

The sample selected in this study consisted of two hundred and eighty (280) SS 1 students from the four schools who volunteered to participate in the study. Seventy (70)

students for each group of the experimental (1 & 2) and control group (1 & 2) the sample size was 10% of the population as stated by Krejcie and Morgan 1970. These samples have the characteristics of other students in the population for the study. The details of the sample are shown in Table 3.2.

Table 3.2 – Sample of the Study

S/NO	Name of school	Male	Female	Total
1	Alhuda – Huda	70	---	70
2	GGSS, Kofan gayan	--	70	70
3	GSS Bogari	35	35	70
4	GSS Aminu (Senior)	35	35	70
Total		140	140	280

3.5 Instrumentation

The following instruments were developed by the researcher for data collection.

1. Algebraic concepts performance test (ACPT) was used for pre – test and post – test.
2. Learning style Inventory (LSI) was used for the identification of the students by their learning style preference.

3.5.1 Algebra Concepts Performance Test (ACPT)

The ACPT test items were constructed for SS 1 students in the study. The ACPT test items were made of forty (40) objective questions which were based on the algebraic concepts from five topics which were taught during the study. These topics were; Algebraic Expressions, Linear Inequalities, Simultaneous Equations, Subject Formulae and Variations. The topics appear in External Examinations Questions almost every year. The ACPT test items were constructed based on SS1 syllabus and of WAEC and NECO standard to test the students' academic performance on the concepts taught. The scores of the students on the Algebraic Concepts Performance Test (ACPT) were scored using

marking scheme each correct response was scored two points with a maximum of eighty (80) marks. The scores were analyzed using descriptive statistics of means and standard deviations. To ensure an equal distribution of the test items over the units, a table of specification was prepared as a guide.

Table 3.5: A table of specification of the instrument Based on Bloom Cognitive Taxonomy

S/N	Content	Wgs	K _n	CO	Ap	An	Sy	Ev	TOTAL	%
1	Quadratic Equation	1	2	1	2	2	1	1	9	22.5
2	Algebraic substitution	1	2	1	2	1	1	1	8	20
3	Linear Inequalities	1	1	1	2	1	1	1	7	17.5
4	Simultaneous Equation	1	2	1	2	1	1	1	8	20
5	Variation	1	2	1	2	1	1	1	8	20
	TOTAL	5	9	5	10	6	5	5	40	100

Source: Researcher 2017

KEY

Knowledge (K_n): recognition or recall of specific materials

Comprehension (Co): grasping the meaning of materials

Application (AP): using information in concrete situation

Analysis (An): breaking down materials in parts

Synthesis (Sy): putting together parts to form a whole

Evaluation (Ev):judging the value of materials and methods for a given purpose

3.5.2 Learning Style Inventory (LSI)

The researcher adopted Kolb Learning Style Inventory 1995. The Inventory consists of questions about the way in which one learns. Each learning style had items which were associated with an individual in terms of best fit on the scale of 1 – 5 (Strongly Agreed, Agree, Not sure, Disagree and Strongly Disagree) this Inventory was used to identify the

Students learning styles preference. The learners were asked to complete the inventory by ticking every option based on the level of agreement. See Appendix A.

3.6 Validation of the Instrument

The test instrument that is the structure interviews and the Kolb learning style inventory were validated by two Ph.D holders, one at School of Applied Science, Nuhu Bamalli Polytechnic Zaria and one at the Department of Science Education, Faculty of Education, Ahmadu Bello University Zaria. They evaluated the instrument and content validity, for accuracy, clarity and level of phrasing of the test items. The experts observation: All questions of WAEC and NECO were above the standard of SS 1. After their useful observation, the items were reframe and sets directly from SS 1 Mathematics Textbook and syllabus.

3.7 Pilot Testing

Inventory for the learners were piloted at GSS Kugu in the same Zaria Education Zone, other than the selected school for the main study. The learners in the pilot study were from the same background from the learners of the Secondary Schools where the main study was carried out. Pilot testing was carried out before the researcher embarked upon the collection of the data. All the instruments (Kolb learning style inventory, and structured interviews) were piloted to provide information about the deficiency of the instruments. The responses were used to determine the number of weeks that were suitable for the conduct of the study, assess the clarity of the ACPT to calculate the reliability.

Pilot study greatly reduces the number of unanticipated problems because one has an opportunity to redesign parts of his study to overcome difficulties that the pilot study may reveal. This helped the researcher to restructure the interview questions for collecting the main data from the Mathematics teachers at the selected secondary school for the study. The test scores of the pilot study is found in Appendix E.

3.8 Reliability of the Instrument

A test retest method was used to test the reliability of the test items on Algebraic concept Performance Test (ACPT). Post test was administered after five weeks, the second test was given in line with Tuckman (1975) and Sambo(1995) recommendation. A Pearson Product Moment Correlation Coefficient statistics (internal consistency) was used to find the coefficient of the test items at $r=0.83$ and $r=0.85$

3.9 Data Collection Procedures

The researcher obtained a letter of introduction from the faculty to seek for permission from the Inspectorate Division of Zaria zone to carry out the study at the Secondary Schools. After getting the permission from the Zonal office, the researcher delivered the letter to the principals of the schools in order to carry out the study.

All the selected learners were given pseudo names which they used during the data collection process. In the first week of this study, all the selected learners were placed in the two learning style groups using Kolb's (2005) Learning Style Inventory (LSI). After the learners were placed in their learning style groups, the four groups wrote the pre-test on Algebra which tested the learners' knowledge on Algebra. The researcher also drew a teaching time table with four periods per day and each learning style group had one period per day. In the second week, the researcher taught Algebra to each learning style group using the preferable teaching methods for each learning style group as stated in Kolb's (2005) Learning Styles Inventory. The teaching phase took four weeks and the learning style groups wrote the post-test in the fifth week. The Mathematics teachers were interviewed during their free times to avoid interfering with their normal school work. The interview was done for three days, one teacher per day. The Mathematics teachers' responses was recorded and interpreted.

3.10 Procedure for Data Analysis

The scores of the students on the Algebraic Concepts Performance Test (ACPT) were scored using marking scheme. Each correct response was scored two (2) points with a maximum of eighty (80) marks. The scores were analyzed using descriptive statistics of means and standard deviations for research questions one (1) to three (3).

ANOVA and Scheffe's test were used for the testing of null hypothesis one (1) while t – test was used for the testing of null hypothesis two (2) and three (3) all at $\alpha \leq 0.05$ level of significance. The descriptive statistics was used because of the finding of difference of means of two variables while ANOVA and Sheffes for the comparing of three or more variables.

CHAPTER FOUR

DATA ANALYSIS, RESULT AND DISCUSSION

4.1 INTRODUCTION

This study examined the effects of converging and diverging Kolb – learning styles on performance among secondary school students in Zaria, Kaduna State, Nigeria. The study was guided by three research questions and three null hypotheses. A Quasi – experimental design pre test and post – test was adopted and a simple random sampling technique was used to determine the sampled schools and sample of the population. The sampled population were students of Senior Secondary School one (SS 1) of average age fifteen, and mixed (males and females). Two instruments were used for the collection of data. Algebraic Concept Performance Test (ACPT) and Kolb Learning Style Inventory (KLSI). This chapter is presented under the following sub – headings:

- Data analysis and results presentation
- Summary of findings
- Discussion

4.2 Data Analysis and Result Presentation

Research Question One: What is the difference between the mean academic performance of Kolb – Diverging, Kolb – Converging learning styles and the lecture method among Senior Secondary School Students in Algebra? To answer research question one, post test scores of Divergent, Convergent and control groups were tested and compared using means and standard deviation

Table 4.2.1 mean and standard deviation of post test scores of experimental convergent, divergent and control groups

Groups	N	Mean	Std. Deviation	MD
Experimental convergents	70	14.70	2.10	3.23
Control convergents	70	11.47	2.10	
Experimental divergents	70	11.43	1.85	3.23
Control divergents	70	8.20	1.56	
Total	280	11.45	2.98	

Source: Statistical package for social science (SPSS) contained in Appendix D

The result in table 4.2.1 showed that Kolb – converging Experimental group is 14.70 (SD = 2.10) which is higher than that of the Kolb – Converging Control group with 11.47 (SD = 2.10). The mean of Kolb – Diverging Experimental group is 11.43 which is higher than the Kolb – Diverging control group which is 8.20. This indicated clearly that Kolb – Converging and Diverging learning styles have more significant effect on students’ academic performance.

Null hypothesis 1: There is no significant difference in the Mean scores of Experimental Kolb – Convergent, Divergent and the Control groups in Algebra.

To test Null Hypothesis one, post – test scores of Convergent, Divergent and the control groups were compared using ANOVA at $P \leq 0.05$ level of significance.

Table 4.2.2 ANOVA Summary for the post – test results

Source	Sum of Squares	Df	Mean Square	F	P – value
Between Groups	633.767	3	211.256	57.534	.000
Within Groups	425.933	276	3.672		
Total	1059.700	279			

Significant level of $\alpha = 0.05$

The ANOVA results of the post test in Table 4.2.2 showed that F – value was 57.53 and P – value was 0.000 at significant level 0.05 and 116 degree of freedom. This showed [$P(0.00) < (\alpha = 0.05)$] and thus the null hypothesis was rejected, that is there was a

significant difference in the academic performance between the experimental and control groups in Algebra. Furthermore, the Scheffe test was carried out with the aim of finding out which pairs of means were compared and results is presented in Table 4.2.3

Table 4.2.3 Post – Hoc (Scheffe) test, Comparisons of pairs of means in the post test.

(I) FACTOR	(J) FACTOR	Mean Difference (I-J)	Sig.	Decision ($\alpha = 0.05$)
Experimental convergents	Control convergents	3.23	.000	Sig
	Experimental divergents	3.27	.000	Sig
	Control divergents	6.50	.000	Sig
Control convergents	Experimental divergents	-3.23	.000	Sig
	Control divergents	.033	1.000	Not sig
	Control divergents	-3.27	.000	Sig
Experimental divergents				

*. The mean difference is significant at the 0.05 level.

The results in Table 4.2.3 showed that there was a significant difference between the experimental convergent and control convergent performance. There was also a significant difference in the mean performance between Experimental convergent and Experimental divergent, between Experimental convergent and Control Divergent, between Control Convergent and Control Divergent and between Experimental Divergent and Control Divergent. The Scheffe test ratios for the five pairs (0.01) each less than the α – value 0.05 at 0.01 level of significance with 57.53 degree of freedom. However, the Scheffe test ratio between control convergent and Experimental Divergent (1.00) was greater than the alpha value 0.05 at 0.01 level of significance with 57.53 degree of freedom. This implies that there was no significant difference in mean performance between the pair. Hence, the five pairs were almost the same in terms of performance even though they learn differently.

Research Question 2: How does Kolb – Diverging learning style affect the Male and Female Senior Secondary School Students Academic Performance in Algebra?

To answer research question two, post test scores of male and female students exposed to Kolb – Diverging learning style were used and effectively compared.

Table 4.2.4 Means and Standard Deviation of Post – test scores of students under Kolb Diverging learning style (Experimental Group)

Variable	N	Mean	Std. Deviation	Mean difference
Male	35	10.87	1.88	
Female	35	12.00	1.69	1.13

Source: Statistical package for Social Science (SPSS) contained in Appendix D

The result in Table 4.2.4 shows that the mean of male students is 10.87 which is lower than that of the female counterpart with 12.00, the mean difference is 1.13. This clearly shows that the female students academically performed better than their male counterpart in Algebra when exposed to Kolb – Diverging learning style.

Null hypothesis 2: There is no significant difference in the mean scores of Male and Female students on academic performance of Senior Secondary School Students in Algebra in Zaria Education Zone.

To test Null hypothesis two, post – test scores of male and female students exposed to Kolb – Diverging style were compared using a t – test statistics at 5% level of significance.

TABLE 4.2.5 Independent t-test for Male and Female Divergent Experimental Group

GENDER	N	Mean	Std. Deviation	Df	t-value	p-value	Decision
Male	35	10.87	1.88				
Female	35	12.00	1.69	28	1.734	0.094	Retain Ho

Significant level at 0.05

The result in Table 4.2.5, the result of the t – test analysis used to test null hypothesis two, the t – value was 1.73 which is higher than the p – value 0.09 at 5% level of significance ($\alpha = 0.05$). Therefore, it showed that Kolb – Diverging learning style has

significant effect on the academic performance of female students than the male counterparts. Therefore, the null hypothesis is retained.

Research Question Three: What is the difference between the mean performance of Male and Female Senior Secondary School Students Academic Performance in Algebra using Kolb – Converging learning style?

To answer research question two, post test scores of male and female students exposed to Kolb – Converging learning style were used and effectively compared.

Table 4.2.6 Means and Standard Deviation of Post – test scores of students by gender under Converging learning style (Experimental Group)

GENDER	N	Mean	Std. Deviation	MD
Male	35	15.33	1.80	
				1.26
Female	35	14.07	2.25	

Source: Statistical package for Social Science (SPSS) contained in Appendix D

Table 4.2.6 shows that the mean of male students is 15.33 which is higher than that of the female counterpart with 14.07, the mean difference is 1.26. This clearly shows that the male students academically performed better than their female counterpart in Algebra when exposed to Kolb – Converging learning style. This finding answered Research Question 3.

Null hypothesis 3: There is no significant difference in the mean scores of Male and Female on academic performance of Senior Secondary School Students in Algebra in Zaria Education Zone.

To test Null hypothesis two, post – test scores of male and female students exposed to Kolb – Converging style were compared using a t – test statistics at 5% level of significance.

Table 4.2.7 Independent t-test for Male and Female Convergent Experimental Group

GENDER	N	Mean	Std. Deviation	Df	t-value	p-value	Decision
Male	35	15.33	1.80	28	1.702	0.100	Retain Ho
Female	35	14.07	2.25				

Significant level at 0.05

The result in Table 4.2.7, the result of the t – test analysis used to test null hypothesis three, the t – value was 1.70 which is higher than the p – value 0.10 at 5% level of significance ($\alpha = 0.05$). Therefore, it showed that Kolb – Converging learning style has significant effect on the academic performance of female students than the male counterparts. Therefore, the null hypothesis is retained.

4.3 Summary of findings.

1. There is a significant difference in the mean performance of students taught algebraic concepts using Kolb – diverging learning style
2. There is significant difference in the mean performance of students taught algebraic concept using Kolb – converging learning style.
3. There is no significant difference in the mean performance of students taught algebraic concepts using Kolb – converging learning style and those students taught using diverging learning style in experimental groups.
4. There is a significant difference in the mean performance between male and female students taught algebraic concepts using Kolb converging and diverging learning styles.

4.4 Discussion

The purpose of this study was to investigate the effects of Kolb – learning style preference on the performance in Algebraic concepts among Senior Secondary School (SSS 1) Mathematics students in Zaria Education Zone, Kaduna State. To achieve this

purpose, the students in the experimental group 1 and 2 were taught Algebraic concept using Kolb diverging and Converging learning styles preference and the students in the control group 1 and 2 were taught the same concepts but using conventional lecture method. The four groups were pre – tested and post tested where their performance were compared according to the variables being measured. The data generated from the administration of the instruction of the Algebraic Concepts Performance Test (ACPT) were analyzed according to the demand of the hypothesis and the analyses were carried out using SPSS statistical package 16.0 version. The findings were summarized in section 4.4 and are consequently discussed in this section.

The results in Table 4.2.1 show that there was a significant difference between the experimental convergent and control convergent performance. There was also a significant difference in the mean performance between Experimental convergent and Experimental divergent, between Experimental convergent and Control Divergent, between Control Convergent and Control Divergent and between Experimental Divergent and Control Divergent. This implies that there was no significant difference in mean performance between the pair. Hence, the five pairs were almost the same in terms of performance even though they learn differently.

This finding is in conformity with that of Obiefuna and Oruwari (2015) who reported that there is a significant difference in the adjusted English Language means scores of students in the experimental group and control group in KLS. Experimental group had higher performance than the control group. Igbongidi (2016) also in her study reported that marketing students achieved higher when exposed to KCLS teaching method than those taught using the lecture method.

There is no significant difference between the mean performance scores of the students taught algebraic concept using KDLS and those taught using lecture method.

Table 4.2.2 proved that there was a significant difference between the mean performance of students exposed to KDLS and those in the control group. This finding is in line with Kamkwis et al (2016) who reported that converging learners when taught according to their learning style obtained high marks performed high mean scores than the lecture method when using inquiry teaching methods when students are presented with questions to answer or problems to solve in algebra.

There is no significant difference in the mean performance of students taught algebraic concept using KCLS and those taught using KDLS. Table 4.3b confirmed that there was a significant difference in the mean scores of the KCLS and KDLS experimental group in algebraic concept. The result showed that KCLS is more effective than the KDLS. This result is in line with Silas (2013) Namibia who reported that converging learners obtained high marks when their preferred learning styles were considered than the diverging learners. This also is in line with the findings of Ogunbiyi (2012) who found similar result that the use of effective teaching methods increases students academic performance in Geography.

Table 4.2.3 showed that there was a significant difference between the mean performance of Male and female students exposed to Kolb learning styles. The difference is in favour of the Male. The result of this study is contrary to the findings of Bhatti (2013) Pakistan who reported in his study that females performed better than the male counterpart when exposed to learning styles preference. Though, according to the researcher the findings may be due to superiority of the females in terms of linguistic skills, better work habits, better study skills and better class attendance. Also in his study on the effects of learning styles on Scholastic reported that female students had higher mean score than the male counterparts. This finding is contrary to the finding of this study. The study of Duman (2010) on the effects of Brain – Based learning on the academic achievement of students

with different learning styles reported that within – group comparison of the academic achievements of the students with different learning styles found no significant differences among the academic achievements of the students in the same group but with different learning style. This may mean that learning style differences do not lead to significant differences in academic achievement.

CHAPTER 5:

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter was presented in the following sub – headings:

- Summary
- Conclusion
- Contribution to knowledge
- Limitations of the study
- Suggestions for further study

5.2 Summary

The study was conducted to determine the effects of Kolb – converging and Divergent learning styles on the academic performance of Senior Secondary School Students in Zaria, Kaduna State, Nigeria. The findings of this study were summarized as follows;

- Students performed better in the learning of Algebraic concept when exposed to Kolb – learning style preference in teaching. This revealed that Kolb – learning style significantly improve the academic performance of Senior Secondary School One (1) students.
- The result revealed that male and female students performed better in the learning of algebraic concepts when exposed to Kolb – converging and diverging learning styles. This indicated that converging and diverging Kolb – learning styles were gender friendly.
- The result revealed that both converging and diverging learners performed better when they are grouped based on their learning styles preference. This indicated that

the learning of Algebraic concepts significantly improve the performance of the students in each group.

- Students participated actively during the lesson when taught using the two different learning styles in teaching than the students taught using the conventional lecture method.

5.3 Conclusions

Based on the findings of this study, the following conclusions were made:

- (i) grouping of students into learning style preference in the teaching of Mathematics enhances the academic performance than those taught using conventional lecture method.
- (ii) The grouping of students into their learning styles preference in the teaching of Mathematics helped both males and females Students to perform better in mathematics; This was because the teaching strategy create room for students participation and is learners centered approach.

5.4 Contributions to Knowledge

Based on the findings of this research work, the following conclusions were made;

- [a] Grouping of students into their learning style preference enhance positive attitudinal change of secondary school students in algebraic concepts in Mathematics
- [b] Converging and Diverging learning styles increases the academic performance of Secondary School students in Mathematics
- [c] These instructional strategies promote acquisition of algebraic concepts in Mathematics among male and female students.
- [d] Students exposed to converging and diverging learning styles preference develop interest in solving algebraic concepts which led to intrinsic motivation.
- [e] Both urban and rural students benefitted well when taught algebraic concepts using their learning styles preference.

5.5 Recommendations

The following recommendations are made based on the findings of this study.

1. Mathematics teachers should familiarize themselves with knowledge and skills of dealing with different learner learning styles and incorporate these in the teaching of Mathematics.
2. Learning styles should be used both to teach and reinforce Mathematics concepts. For example, the Mathematics teacher could use a linguistic approach such as a story about Trigonometry and then have learners write words that reflect the concept in Mathematics in order to enhance learners' understanding.
3. The students should be assigned on how to identify their individual learning styles so as to enable them challenge problems when presented to them wither in classroom situation or outside the classroom
4. The Government should provide adequate learning facilities that would accommodate different learning style groups in school setting
5. Professional bodies like Mathematics Association of Nigeria (MAN), National Union of teachers' (NUT), Science Teachers' Association of Nigeria (STAN) and Research Centre's like National Teachers' Institute (NTI) should incorporate Kolb – learning style preference in their curriculum at the Senior Secondary School level to enable both students and teachers identify learning style preference and students active participation in Mathematics lessons.

5.6 Limitations of the study

The following limitations were observed during the study;

[a] The topics covered during the field work were taught in the afternoon after school hours so as not to disrupt the normal school lessons. This afternoon classes made the lessons boring because they were tired already.

[b] There were no enough infrastructure in these schools for the students to sit comfortably most especially the diverging learners who sit in group to brainstorm. Most of the students were congested on single bench and table.

5.7 Suggested Areas for Further Research

1. Further research on the use of learning styles in teaching could be carried out at all levels of Secondary School so as to provide an investigation on the effectiveness of learning styles in the teaching of Mathematics
2. Similar study should be conducted in some Educational zones in Kaduna State using the same tools in order to confirm and compare the findings with Zaria Education Zone.
3. Another research should be conducted on the effectiveness of Kolb – learning styles in the teaching of Mathematics in different topics like coordinate geometry and trigonometry.

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APPENDIX A

STUDENTS' QUESTIONNAIRE1

The Learning Style Inventory will be used in identifying students' learning styles preference (Divergent band Convergent). The permission to use the inventory would be formally sought for and a letter appended.

Student Name _____ **Admission Number** _____ **Date** _____

To better understand how you prefer to learn and process information, place a check in the appropriate space after each statement below, and then use the scoring directions at the bottom of the page to evaluate your responses. Use what you learn from your scores to better develop learning strategies that are best suited to your particular learning style.

This 24- item survey is not timed. Respond to each statement as honestly as possible.

		SA	A	U	D	SD
1.	I can remember best about a subject by listening to a lecture that includes information, explanations and discussions,					
2.	I prefer to see information written on a chalkboard and supplemented by visual aids and assigned readings					
3.	I like to write things down or take notes for a visual review,					
4.	I prefer to use posters, models or actual practice and other activities in class,					
5.	I require explanations of diagrams, graphs or visual directions,					
6.	I enjoy working with my hands or using tools,					
7.	I am skillful with and enjoy developing and making graphs and charts					
8.	I can tell if sounds match when presented with pairs of					

	sounds					
9.	I can remember best by writing things down several times					
10.	I can easily understand and follow directions on maps					
11.	I do best at academic subjects by listening to lectures and tapes					
12.	I play with coins or keys in my pocket					
13.	I learn to spell better by repeating the words out loud than by writing the words on paper					
14.	I can understand a news article better by reading it in the paper than by listening to radio					
15.	I chew gum, or snack while studying					
16.	I feel the best way to remember something is to picture it in your head					
17.	I learn the spelling of words by —finger spelling them					
18.	I would rather listen to a good lecture or speech than read about the same material in a text book					
19.	I am good at working and solving jigsaw puzzles and mazes					
20.	I grip objects in my hands during learning periods					
21.	I prefer listening to the news on the radio rather than reading the newspaper					
22.	I prefer obtaining information about an interesting subject by reading about it					
23.	I feel very comfortable touching others, hugging, handshaking, etc.					
24.	I follow oral directions better than written ones.					

APPENDIX B

LESSON PLAN 1A (CONVERGING EXP GROUP)

Subject: Mathematics

Class: Senior Secondary One (1)

Topic: Algebraic expressions:

Objectives: By the end of the lesson, learners should be able to use letters to express generalized numbers and express basic processes algebraically.

Teaching resources: geometrical shapes packages (Numbers of balls)

Content

Convergings' activities

Introduction

- Teacher gives a package of shapes to each group and asks them to group the shapes in the way it suites them and asks the learners to explain more on their classifications.

- Teacher further asks learners on the learner's grouping and hence

Group the shapes and explain more on their classification.

Note down the topic.

Group the shapes and explain more on their classification.

Note down the topic.

Group the shapes and explain more on their classification.

Note down the topic.

Group the shapes and explain more on their classification.

Note down the topic.

Introduces the topic for a day.

Teaching-Learning Phase

□ □ Teacher asks learners to use letters to represent each shape with a letter and note down how many of each shape do they have.

Example: 2 circles = $2c$, 3 squares = $3s$

□ □ Teacher asks to add up all the like shapes in the whole class as well as the unlike terms.

Like terms can be added but unlike terms can not.

□ □ Example: 1. $2c + 2c = 4c$, 2. $2c + 3b = 2c + 3b$

Learners use the jigsaw method to answer the question.

Learners add up the like shapes and note down how many they are.

Teacher works on the board together with learners.

Teacher asks a learner to come and solve the problem on the board with the help of others.

Learners add up the like shapes and note down how many they are.

Learners work on the activities individually.

Learners add up the like shapes and note down how many they are.

Assessment: Simplify as far as possible

1. $3x + 6y - 2x + y$

2. $6 - 3a + 2 - 4a$

3. $5p - 2q + 3r + 2p + 5q + 4s$

Learners work using jigsaw method

Solve problems individually.

Group discussions and presentation.

Learners work on the activities individually.

Conclusion:

- highlights the lesson main points.

e.g Like terms can be added and subtracted but unlike terms can not.

- Give feedback to the activity.

Teacher invites questions from the learners.

Homework: read multiplication and division of terms.

Listen and take notes

Listen and take notes

LESSON PLAN 1B (DIVERGING EXP GROUP)

Subject: Mathematics

Class: Senior Secondary One (1)

Topic: Algebraic expressions:

Objectives: By the end of the lesson, learners should be able to use letters to express generalized numbers and express basic processes algebraically.

Teaching resources: geometrical shapes packages (Numbers of balls)

Content

Divergings' activities

Introduction

- Teacher gives a package of shapes to each group and asks them to group the shapes in the way it suites them and asks the learners to explain more on their classifications.

- Teacher further asks learners on the learner's grouping and hence

Group the shapes and explain more on their classification.

Note down the topic.

Group the shapes and explain more on their classification.

Note down the topic.

Group the shapes and explain more on their classification.

Note down the topic.

Group the shapes and explain more on their classification.

Note down the topic.

Introduces the topic for a day.

Teaching-Learning Phase

□ □ Teacher asks learners to use letters to represent each shape with a letter and note down how many of each shape do they have.

Example: 2 circles = 2c, 3 squares = 3s

□ □ Teacher asks to add up all the like shapes in the whole class as well as the unlike terms.

Like terms can be added but unlike terms can not.

□ □ Example: 1. $2c + 2c = 4c$, 2. $2c + 3b = 2c + 3b$

Learners use the jigsaw method to answer the question.

Learners add up the like shapes and note down how many they are.

Teacher works on the board together with learners.

Teacher asks a learner to come and solve the problem on the board with the help of others.

Learners add up the like shapes and note down how many they are.

Learners work on the activities individually.

Learners add up the like shapes and note down how many they are.

Assessment: Simplify as far as possible

1. $3x + 6y - 2x + y$

2. $6 - 3a + 2 - 4a$

3. $5p - 2q + 3r + 2p + 5q + 4s$

Learners work using jigsaw method

Solve problems individually.

Group discussions and presentation.

Learners work on the activities individually.

Conclusion:

- highlights the lesson main points.

e.g Like terms can be added and subtracted but unlike terms can not.

- Give feedback to the activity.

Teacher invites questions from the learners.

Homework: read multiplication and division of terms.

Listen and take notes

Listen and take notes

LESSON PLAN 1C (CONTROL GROUP)

CLASS: Senior Secondary 1

SUBJECT: Mathematics

TOPIC: Algebraic Expression

B/ OBJECTIVES: At the end of the topic, the students should be able to;

- (i) Explain algebraic expression
- (ii) Express algebraic expression using letters
- (iii) Use letters and figures to formulate algebraic equations

REF. BOOK: New General Mathematics for Senior Secondary School 1 By J.B. Channon and others

PREVIOUS KNOWLEDGE: The students have been taught the use of letters to represent numbers at the junior secondary school

INTRODUCTION: The teacher introduces the topic to be taught by asking the students questions based on the previous knowledge.

Examples (i) If $a + a + a = 12$, what is the value of a ?

(ii) $18 - x = 10\frac{1}{2}$, what is x ?

PRESENTATION:

Step I: The teacher explains to the students what algebraic expressions are

Step II: The teacher teaches the students how to use letters to formulate or express as algebraic expressions.

Step III: The teacher explains / teaches the students how to use letters and figures to express as algebraic equations.

Step IV: The teacher in every lesson gives the students' time to ask questions on where they do not understand if any.

EVALUATION: The teacher in every lesson gives the students an exercise to express by themselves to test their level of understanding on the topic taught.

CONCLUSION: The teacher after marking, express the given exercises on the chalkboard for the students to take correction if any.

STUDENTS ACTIIVITY:

Express each of the following in algebraic form

(1) A number multiplied by four is added to two – third of another number.

(2) A father is three times as old as the son. Nine years ago, the father was four tikmes as old as the son.

(3) A man bought x mangoes at N5.00 and $3x$ oranges at N6.00. He collected some balance from N30.00.

LESSON PLAN 2A (CONVERGING EXP GROUP)

Subject: Mathematics

Class: Senior Secondary One (1)

Topic: Substitution

Objectives: By the end of the lesson, learners should be able to substitute numbers for words and letters in formulae.

Teaching resources:

Content

Convergings' activities

Introduction

- Teacher gives a scenario: „suppose you have a cow that you wish to exchange for goats.

How many goats will you ask?“

- Teacher relates the scenario to substitution and hence introduces the topic.

Give their views on the scenario.

Note down the topic.

Give their views on the scenario.

Note down the topic.

Give their views on the scenario.

Note down the topic.

Give their views on the scenario.

Note down the topic.

Teaching-Learning Phase

Examples solved:

If $a = 1$, $b = 2$, $c = 3$, and $d =$. Evaluate,

1. $2a^2d^3/b^2cd$

2. $\sqrt{c^2d^2}/2b^2$

Teacher gives an example first and then groups learners to use the jigsaw method.

Teacher explains using the lecturing method.

Learners work individually

Teacher uses the think-pair method teacher the learners and gives a pair work

Teacher demonstrates an example based on real life situations on the board

on the activities and asks the learners to work on the activities individually.

Assessment:

1. If P varies directly as r^2 and $P = 3.2$ when $r = 4$, find the value of P when $r = 6.5$.

Learners work using jigsaw method.

Solve problems individually.

Group discussions..

Learners work on the activities individually.

Conclusion:- asks learners where substitution used in our everyday life.

e.g. Currency exchange,, buying and selling.

- Give feedback to the activity.

- Give learners a chance to ask questions if any.

Next topic: Construction of linear equation.

Listen and take notes

LESSON PLAN 2B (DIVERGING EXP GROUP)

Subject: Mathematics

Class: Senior Secondary One (1)

Topic: Substitution

Objectives: By the end of the lesson, learners should be able to substitute numbers for words and letters in formulae.

Teaching resources:

Content

Divergings' activities

Introduction

- Teacher gives a scenario: „suppose you have a cow that you wish to exchange for goats.

How many goats will you ask?“

- Teacher relates the scenario to substitution and hence introduces the topic.

Give their views on the scenario.

Note down the topic.

Give their views on the scenario.

Note down the topic.

Give their views on the scenario.

Note down the topic.

Give their views on the scenario.

Note down the topic.

Teaching-Learning Phase

Examples solved:

If $a = 1$, $b = 2$, $c = 3$, and $d =$. Evaluate,

1. $2a^2d^3/b^2cd$

2. $\sqrt{c^2d^2}/2b^2$

Teacher gives an example first and then groups learners to use the jigsaw method.

Teacher explains using the lecturing method.

Learners work individually

Teacher uses the think-pair method teacher the learners and gives a pair work

Teacher demonstrates an example based on real life situations on the board

on the activities and asks the learners to work on the activities individually.

Assessment:

1. If P varies directly as r^2 and $P = 3.2$ when $r = 4$, find the value of P when $r = 6.5$.

Learners work using jigsaw method.

Solve problems individually.

Group discussions..

Learners work on the activities individually.

Conclusion:- asks learners where substitution used in our everyday life.

e.g. Currency exchange,, buying and selling.

- Give feedback to the activity.

- Give learners a chance to ask questions if any.

Next topic: Construction of linear equation.

Listen and take notes

LESSON PLAN 2C (CONTROL GROUP)

CLASS: Senior Secondary One (1)

SUBJECT: Mathematics

TOPIC: Substitution

REFERENCE BOOK: New General Mathematics For Senior Secondary School One

B/ OBJECTIVES: At the end of the topic, the students should be able to:

- (i) Explain what is meant by substitution
- (ii) Make a letter the subject of the formula
- (iii) Find the value of any given subject using substitution method

PREVIOUS KNOWLEDGE: The students have been taught expression of statements in algebraic form (algebraic expressions and equations)

INTRODUCTION: The teacher introduces the topic to be taught by revising the previous topic learned through questioning the students based on the previous knowledge.

Examples: (i) Express the statement below in algebraic form

(ii) A father is three times as old as the son. Nine years ago the father was four times as old as the son.

PRESENTATION:

STEP I: The teacher explains to the students what is meant by substitution using examples on the chalkboard

STEP II: The teacher teaches the students how to make a letter the subject of any given formulae

STEP III: The teacher teaches the students how to find the value of the subject by substituting the values of each of the formulae

STEP IV: The teacher in every lesson gives the students' time to ask question(s) on where they do not understand if any.

EVALUATION: The teacher in every lesson gives the students an exercise to make the subject of the formulae or to find the value of a given subject by substituting the values of each of the formulae.

CONCLUSION: The teacher then makes or finds the given exercises on the chalkboard for the students to take correction if any.

LESSON PLAN 3A (CONVERGING EXP GROUP)

Subject: Mathematics

Class: Senior Secondary One (1)

Topic: linear inequalities

Objectives: By the end of the lesson, learners should be able to explain what is meant by inequality, express word problems leading to linear inequalities and solve word problems leading to linear inequalities

Teaching resources:

Content

Convergings' activities

Introduction

- Teacher gives a scenario: suppose the cost of two pens and three rulers is less than six naira, express this in inequality?

- Teacher relates the scenario to inequality and hence introduces the topic.

Give their views on the scenario.

Note down the topic.

Give their views on the scenario.

Note down the topic.

Give their views on the scenario.

Note down the topic.

Give their views on the scenario.

Note down the topic.

Teaching-Learning Phase

Examples solved:

1. If $2x + 3 \leq 5$, find the value of x .
2. Solve the inequality $5x + 6y \geq 4$

3. Ade bought x biros at N8.00 each and $(x + 4)$ rulers at N20.00 each. He spent less than N200.00. Form an inequality for the statement.

Teacher gives an example first and then groups learners to use the jigsaw method.

Teacher explains using the lecturing method.

Learners work individually

Teacher uses the think-pair method teacher the learners and gives a pair work

Teacher demonstrates an example based on real life situations on the board on the activities and asks the learners to work on the activities individually.

Assessment:

1. Solve the inequalities $\frac{1}{2}(4x - 7) - \frac{1}{3}(1 - 4x) \geq 6$

Learners work using jigsaw method.

Solve problems individually.

Group discussions..

Learners work on the activities individually.

Conclusion:- asks learners where inequality is used in our everyday life.

e.g. buying and selling.

- Give feedback to the activity.
- Give learners a chance to ask questions if any.

Next topic: Simultaneous equations.

Listen and take notes

Listen and take not

LESSON PLAN 3B (DIVERGING EXP GROUP)

Subject: Mathematics

Class: Senior Secondary One (1)

Topic: linear inequalities

Objectives: By the end of the lesson, learners should be able to explain what is meant by inequality, express word problems leading to linear inequalities and solve word problems leading to linear inequalities

Teaching resources:

Content

Divergings' activities

Introduction

- Teacher gives a scenario: suppose the cost of two pens and three rulers is less than six naira, express this in inequality?

- Teacher relates the scenario to inequality and hence introduces the topic.

Give their views on the scenario.

Note down the topic.

Give their views on the scenario.

Note down the topic.

Give their views on the scenario.

Note down the topic.

Give their views on the scenario.

Note down the topic.

Teaching-Learning Phase

Examples solved:

4. If $2x + 3 \leq 5$, find the value of x.

5. Solve the inequality $5x + 6y \geq 4$

6. Ade bought x biros at N8.00 each and $(x + 4)$ rulers at N20.00 each. He spent less than N200.00. Form an inequality for the statement.

Teacher gives an example first and then groups learners to use the jigsaw method.

Teacher explains using the lecturing method.

Learners work individually

Teacher uses the think-pair method teacher the learners and gives a pair work

Teacher demonstrates an example based on real life situations on the board on the activities and asks the learners to work on the activities individually.

Assessment:

2. Solve the inequalities $\frac{1}{2}(4x - 7) - \frac{1}{3}(1 - 4x) \geq 6$

Learners work using jigsaw method.

Solve problems individually.

Group discussions..

Learners work on the activities individually.

Conclusion:- asks learners where inequality is used in our everyday life.

e.g. buying and selling.

- Give feedback to the activity.

- Give learners a chance to ask questions if any.

Next topic: Simultaneous equations.

Listen and take notes

Listen and take note

LESSON PLAN 3C (CONTROL GROUP)

CLASS: Senior Secondary One (1)

SUBJECT: Mathematics

TOPIC: LINEAR INEQUALITIES

REFERENCE BOOK: New General Mathematics for Senior Secondary School One

B/ OBJECTIVES: At the end of the topic, the students should be able to:

- (i) Explain what is meant by inequality
- (ii) Express word problems leading to linear inequalities
- (iii) Solve word problems leading to linear inequalities

PREVIOUS KNOWLEDGE: The students have been taught linear inequalities in the Junior Class

INTRODUCTION: The teacher introduces the topic to be taught by revising the previous Topic learned through questioning the students based on the previous knowledge.

Examples: (i) What do you understand by the term 'Inequality'? (ii) $2x$ is greater than or equal to six. Write an inequality statement for this expression

PRESENTATION:

STEP I: The teacher explains to the students what is meant by inequality using examples on the chalkboard

STEP II: The teacher teaches the students how to express word problems leading to linear inequalities from statement to figures with the use of inequality signs

STEP III: The teacher teaches the students how to solve word problems in linear inequality.

STEP IV: The teacher in every lesson gives the students' time to ask question(s) on where they do not understand if any.

EVALUATION: The teacher in every lesson gives the students an exercise to express inequality statements using figures or to solve word problems on leading inequalities.

CONCLUSION: The teacher then makes or finds the given exercises on the chalkboard for the students to take correction if any.

LESSON PLAN 4A (CONVERGING EXP GROUP)

Subject: Mathematics

Class: Senior Secondary One (1)

Topic: Simultaneous Equation

Objectives: By the end of the lesson, learners should be able to solve simultaneous equations

Content

Convergings' activities

Introduction

Teacher asks learners the questions on the previous lesson.

Teacher solves some simultaneous equations on the chalk board and asks learners to solve.

Examples; Solve the following simultaneous equations;

1. $3x + 2y = 10$

$x + 2y = 2$

2. $2x = 10 - y$ ----- I

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

Learners discuss the problem and give the answer.

Teacher explains how to solve and learners listen.

Learners discuss and give the feedback.

Each learner writes their answer on their note.

Teaching-Learning Phase

Examples: Solve the following simultaneous equations

1. $0.5m + 0.2n = 5$

$0.6m + 0.4n = 8.4$

2. $x^2 - y^2 = 40$

$x + y = 10$

Teacher gives an example first and then groups learners to use their learning preference method.

Teacher explains using the lecturing method.

Learners work individually on the activities.

Teacher writes the question on the chalkboard and asks learners to express using their individual preferred learning styles.

Teacher demonstrates an example on the chalkboard and then asks learners to solve a given problem individually.

Assessment: worksheet

Solve the following

$$(1) \frac{y}{2} - \frac{x}{3} = \frac{1}{6}$$

$$\frac{x}{2} - \frac{y}{6} = 5$$

$$(2) 3x - \frac{y}{3} = 3\frac{1}{2}$$

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

Learners work in jigsaw method.

Solve problems individually.

Group discussions.

Learners work on the activities individually.

Conclusion:

- Gives the feedback to the activity.
- motivates learners to ask questions.

Listen and take notes.

Present their findings and ask questions.

Notes down the main lesson points and ask questions based on real life situations.

LESSON PLAN 4B (DIVERGING EXP GROUP)

Subject: Mathematics

Class: Senior Secondary One (1)

Topic: Simultaneous Equation

Objectives: By the end of the lesson, learners should be able to solve simultaneous equations

Content

Divergings' activities

Introduction

Teacher asks learners the questions on the previous lesson.

Teacher solves some simultaneous equations on the chalk board and asks learners to solve.

Examples; Solve the following simultaneous equations;

1. $3x + 2y = 10$

$$x + 2y = 2$$

2. $2x = 10 - y$

$$3x - 2y = 1$$

Learners discuss the problem and give the answer.

Teacher explains how to solve and learners listen.

Learners discuss and give the feedback.

Each learner writes their answer on their note.

Teaching-Learning Phase

Examples: Solve the following simultaneous equations

1. $0.5m + 0.2n = 5$ $0.6m + 0.4n = 8.4$

2. $x^2 - y^2 = 40$ $x + y = 10$

Teacher gives an example first and then groups learners to use their learning preference method.

Teacher explains using the lecturing method.

Learners work individually on the activities.

Teacher writes the question on the chalkboard and asks learners to express using their individual preferred learning styles.

Teacher demonstrates an example on the chalkboard and then asks learners to solve a given problem individually.

Assessment: worksheet

Solve the following

(1) $\frac{y}{2} - \frac{x}{3} = \frac{1}{6}$

$\frac{x}{2} - \frac{y}{6} = 5$

(2) $3x - \frac{y}{3} = 3\frac{1}{2}$ -----i

$\frac{x}{2} + y = 1$ -----ii

Learners work in jigsaw method.

Solve problems individually.

Group discussions.

Learners work on the activities individually.

Conclusion:

- Gives the feedback to the activity.
- motivates learners to ask questions.

Listen and take notes.

Present their findings and ask questions.

Notes down the main lesson points and ask questions based on real life situations.

LESSON PLAN 4C (CONTROL GROUP)

CLASS: Senior Secondary One (1)

SUBJECT: Mathematics

TOPIC: Simultaneous Equations

REFERENCE BOOK: New General Mathematics for Senior Secondary School One

B/ OBJECTIVES: At the end of the topic, the students should be able to:

- (i) Identify simultaneous equations
- (ii) Solve simultaneous equations using substitution method
- (iii) Solve word problems leading to simultaneous equations

PREVIOUS KNOWLEDGE: The students have been taught linear equations in the Junior Class

INTRODUCTION: The teacher introduces the topic to be taught by revising the previous Topic learned through questioning the students based on the previous knowledge.

Examples: (i) solve the equation $2x + 3 = 7$

(ii) Solve the equation $2x + 3y = 7$ ----- i $x + y = 3$ -----ii

PRESENTATION:

STEP I: The teacher explains to the students what is meant by simultaneous equation using examples on the chalkboard

STEP II: The teacher teaches the students how to solve simultaneous equations using substitution method.

STEP III: The teacher teaches the students how to solve word problems in simultaneous equations.

STEP IV: The teacher in every lesson gives the students' time to ask question(s) on where they do not understand if any.

EVALUATION: The teacher in every lesson gives the students an exercise to solve simultaneous equations or word problems leading to simultaneous equations.

CONCLUSION: The teacher then makes or finds the given exercises on the chalkboard for the students to take correction if any.

APPENDIX C (I)

STUDENT ACHIEVEMENT TEST (EXPERIMENTAL CONVERGENT GROUP)

1. One -third of a number added to four-fifths of itself is equal to 17. Find the number.
[a] 14 [b] 15 [c] 16 [d] 17
2. The sum of three consecutive numbers is 36. Find the numbers. [a] 8 [b] 9 [c] 10 [d] 11
3. A mother is three times as old as her daughter. In twelve years time she will be twice as old. How old is the mother now? [a] 12 [b] 13 [c] 15 [d] 17
4. Solve the inequalities $\frac{2x+5}{x} \leq \frac{2x}{x-3}$
[a] $X \geq -14$ [b] $X \leq 15$ [c] $X \geq -15$ [d] $X \leq -15$
5. Ade bought x biros at N8.00 each and $(x + 4)$ rulers at N20.00 each. He spent less than N200.00. Form an inequality for the statement. [a] $x \leq -4.29$ [b] $x \geq 4.29$ [c] $x < 4.29$ [d] $x > 4.29$
6. Solve the inequalities $\frac{1}{2}(4x - 7) - \frac{1}{3}(1 - 4x) \geq 6$ [a] $X > 2.95$ [b] $X \geq 2.95$ [c] $X < 2.95$ [d] $X \leq 2.95$
7. If $y = 23_{\text{five}} + 101_{\text{three}}$, find y , leaving your answer in base two. [a] 11010_{two} [b] 10010_{two} [c] 11101_{two} [d] 10101_{two}
8. A tin has radius 3cm and height 6cm. Find the total surface area of the cone. [a] 161.71 cm^3 [b] 167.09 cm^3 [c] 169.71 cm^3 [d] 171.98 cm^3
9. The volume of a cone of height 9cm is 1848cm^3 . Find its radius. (Take $\pi = \frac{22}{7}$). [a] 14cm [b] 15cm [c] 16cm [d] 17cm
10. Simplify $\frac{X}{3y-x} - \frac{y}{3x} + 1$

$$[a] y \frac{(10x + 3y)}{3x(3y + x)} \quad [b] y \frac{(9x + 3y)}{3x(3y + x)} \quad [c] y \frac{(9x + 3y)}{2x(3y + x)} \quad [d] y \frac{(10x - 3y)}{3x(3y - x)}$$

11. For what values of x is the fraction $\frac{x^2 - 3x + 2}{4x + 13}$ equals to zero?
 [a] -1 or -2 [b] 1 or -2 [c] 1 or 2 [d] -1 or 2
12. Given that $x = \frac{3a + 5}{a + 2}$, for what value of 'a' is 'x' not defined. [a] -2 [b] 2 [c] 3 [d] -3
13. Factorize the expression $a^2 + b^2 + ap - bq + bp + aq$ [a] (a+b) (a+b+p-q) [b] (a-b) (a-b+p-q) [c] (a-b) (a+b-p-q) b [d] (a+b) (a-b+p-q)
14. Find the term that must be added to $x^2 - 22x$ to make it a perfect square. [a] 9 [b] 10 [c] 11 [d] 12
15. Solve by factorization $x^2 + 7x + 10$. [a] $x = -2$ or -5 [b] $x = 2$ or -5 [c] $x = -5$ or 2 [d] $x = 2$ or 5
16. Solve $2x^2 - 4x - 3 = 0$ using the formula [a] $x = 1.29$ or 0.29 [b] $x = -1.29$ or -0.29 [c] $x = -1.29$ or 0.29 [d] $x = 1.29$ or -0.29
17. Solve the simultaneous equation
 $2x + 4y = 42$ ----- i $6x - 4y = 30$ ----- ii
 [a] $x = 6$, $y = 9$ [b] $x = 9$, $y = 6$ [c] $x = -6$, $y = 9$ [d] $x = 9$, $y = -6$
18. The cost of three apples and one berry is N22.00 while the cost of four apples and three berries is N41.00. Find the cost of seven apples [a] N25.00 [b] N30.00 [c] N35.00 [d] N40.00
19. Simplify $(2a + b)^2 - (b - 2a)^2$ [a] $6ab$ [b] $7ab$ [c] $-8ab$ [d] $8ab$
20. Solve the equation $9^{2x-3}/3^{x+2} = 1$. [a] $x = 2$ [b] $x = 3$ [c] $x = 4$ [d] $x = 5$
21. Solve the equation : $3a + 10 = a^2$ [a] $a = 5$ or $a = 2$ [b] $a = -5$, or $a = 2$ [c] $a = 10$ or $a = 0$ [d] $a = 5$ or $a = -2$

22. Simplify $\frac{2}{2+x} + \frac{2}{2-x}$ [a] $\frac{4}{4-x^2}$ [b] $\frac{8}{4-x^2}$ [c] $\frac{4x}{4-x^2}$ [d] $\frac{8-4x}{4-x^2}$
23. A bucket of water holds 10 litres of water. How many buckets of water will fill a reservoir of size 8m X 7m X 5m. (1 litre = 1000cm³). [a] 28 [b] 280 [c] 2800 [d] 28000
24. If x is a positive integer, list the values of x which satisfy the equations $3x - 4 < 6$ and $x - 1 > 0$. [a] { 1, 2, 3 } [b] { 2, 3 } [c] { 2, 3, 4 } [d] { 2, 3, 4, 5 }
25. The capacity of a water tank is 1,800 litres. If the tank is in the form of a cuboid with base 600cm by 150 cm, find the height of the tank. [a] 2cm [b] 20cm [c] 200cm [d] 2000cm
26. Solve $\frac{2x+1}{6} - \frac{3x-1}{4} = 0$ [a] 1 [b] $\frac{1}{5}$ [c] $-\frac{1}{5}$ [d] -1
27. Five bottles of Fanta and two packets of biscuits cost Gh¢ 6.00. Three bottles of Fanta and four packets of biscuits cost Gh¢ 5.00. Find the cost of a bottle of Fanta. [a] Gh¢ 0.50 [b] Gh¢ 1.00 [c] Gh¢ 1.50 [d] Gh¢ 5.00
28. Solve the following simultaneous equations : $2x + 3y = 7$, $x + 5y = 0$
[a] $x = 5, y = -1$ [b] $x = \frac{1}{5}, y = -1$ [c] $x = -\frac{1}{5}, y = 1$ [d] $x = -5, y = 1$
29. Simplify $\frac{2x^2 - 5x - 12}{4x^2 - 9}$ [a] $\frac{x+4}{2x+3}$ [b] $\frac{x+4}{2x-3}$ [c] $\frac{x-4}{2x+4}$ [d] $\frac{x-4}{2x-3}$
30. Solve the inequality $1 - 2x < -\frac{1}{3}$ [a] $x < \frac{2}{3}$ [b] $x < -\frac{2}{3}$ [c] $x > \frac{2}{3}$ [d] $x > -\frac{2}{3}$
31. Solve the simultaneous equations: $x + y = 2$ and $3x - 2y = 1$. [a] $x = 2$ and $y = 1$ [b] $x = 1, y = 1$ [c] $x = 1, y = 2$ [d] $x = -1, y = 1$
32. The volume of a cylinder is 1200cm³ and the area of its base is 150cm². Find the height of the cylinder. [a] 80.00cm [b] 8.00cm [c] 0.80 cm [d] 0.08 cm
33. I am x years old and my brother is 3 years older. How old was my brother last year? [a] (x - 4 years) [b] (x + 2) years [c] (3x - 1) years [d] (3x + 1) years
34. Simplify $\frac{4}{2x} - \frac{2+x}{x}$ [a] -1 [b] -2x [c] 2x [d] $\frac{2-x}{2x}$
35. Expand the expression $(3a - xy)(3a + xy)$ [a] $9a^2 - x^2y^2$ [b] $9a^2 + x^2y^2$ [c] $9a^2 - xy$ [d] $9a^2 + x^2y$
36. If $x + y = 12$ and $3x - y = 20$; find the value of $2x - y$. [a] 8 [b] 10 [c] 12 [d] 15

37. A man bought 220 mangoes at N5x. He sold each for 3x kobo and made a gain of N8. Find the value of x. [a] 2 [b] 5 [c] 6 [d] 10
38. Simplify $\frac{x-4}{4} - \frac{x-3}{6}$ [a] $\frac{x-18}{12}$ [b] $\frac{x-6}{12}$ [c] $\frac{x-18}{24}$ [d] $\frac{x-6}{24}$
39. A student bought 3 notebooks and 1 pen for N35. After misplacing these items, she again bought 2 notebooks and 2 pens, all of the same type for N30. What is the cost of a pen? [a] N5.00 [b] N7.50 [c] N10.00 [d] N15.00
40. Find $(x - y)$ if $4x - 3y = 7$ and $3x - 2y = 5$. [a] 4 [b] 3 [c] 2 [d] -2

APPENDIX C (II)

STUDENT ACHIEVEMENT TEST (DIVERGENT GROUP)

1. One -third of a number added to four-fifths of itself is equal to 17. Find the number.
[a] 14 [b] 15 [c] 16 [d] 17
2. The sum of three consecutive numbers is 36. Find the numbers. [a] 8 [b] 9 [c] 10 [d] 11
3. A mother is three times as old as her daughter. In twelve years time she will be twice as old. How old is the mother now? [a] 12 [b] 13 [c] 15 [d] 17
4. Solve the inequalities $\frac{2x+5}{x} \leq \frac{2x}{x-3}$
[a] $X \geq -14$ [b] $X \leq 15$ [c] $X \geq -15$ [d] $X \leq -15$
5. Ade bought x biros at N8.00 each and $(x + 4)$ rulers at N20.00 each. He spent less than N200.00. Form an inequality for the statement. [a] $x \leq -4.29$ [b] $x \geq 4.29$ [c] $x < 4.29$
[d] $x > 4.29$
6. Solve the inequalities $\frac{1}{2}(4x - 7) - \frac{1}{3}(1 - 4x) \geq 6$ [a] $X > 2.95$ [b] $X \geq 2.95$ [c] $X < 2.95$
[d] $X \leq 2.95$
7. If $y = 23_{\text{five}} + 101_{\text{three}}$, find y , leaving your answer in base two. [a] 11010_{two} [b] 10010_{two}
[c] 11101_{two} [d] 10101_{two}
8. A tin has radius 3cm and height 6cm. Find the total surface area of the cone. [a] 161.71 cm^3 [b] 167.09 cm^3 [c] 169.71 cm^3 [d] 171.98 cm^3
9. The volume of a cone of height 9cm is 1848cm^3 . Find its radius. (Take $\pi = \frac{22}{7}$). [a] 14cm [b] 15cm [c] 16cm [d] 17cm
10. Simplify $\frac{X}{3y-x} - \frac{y}{3x} + 1$

$$[a] y \frac{(10x + 3y)}{3x(3y + x)} \quad [b] y \frac{(9x + 3y)}{3x(3y + x)} \quad [c] y \frac{(9x + 3y)}{2x(3y + x)} \quad [d] y \frac{(10x - 3y)}{3x(3y - x)}$$

11. For what values of x is the fraction $\frac{x^2 - 3x + 2}{4x + 13}$ equals to zero?
 [a] -1 or -2 [b] 1 or -2 [c] 1 or 2 [d] -1 or 2
12. Given that $x = \frac{3a + 5}{a + 2}$, for what value of 'a' is 'x' not defined. [a] -2 [b] 2 [c] 3 [d] -3
13. Factorize the expression $a^2 + b^2 + ap - bq + bp + aq$ [a] (a+b) (a+b+p-q) [b] (a-b) (a-b+p-q) [c] (a-b) (a+b-p-q) b [d] (a+b) (a-b+p-q)
14. Find the term that must be added to $x^2 - 22x$ to make it a perfect square. [a] 9 [b] 10 [c] 11 [d] 12
15. Solve by factorization $x^2 + 7x + 10$. [a] $x = -2$ or -5 [b] $x = 2$ or -5 [c] $x = -5$ or 2 [d] $x = 2$ or 5
16. Solve $2x^2 - 4x - 3 = 0$ using the formula [a] $x = 1.29$ or 0.29 [b] $x = -1.29$ or -0.29 [c] $x = -1.29$ or 0.29 [d] $x = 1.29$ or -0.29
17. Solve the simultaneous equation
 $2x + 4y = 42$ ----- i $6x - 4y = 30$ ----- ii
 [a] $x = 6$, $y = 9$ [b] $x = 9$, $y = 6$ [c] $x = -6$, $y = 9$ [d] $x = 9$, $y = -6$
18. The cost of three apples and one berry is N22.00 while the cost of four apples and three berries is N41.00. Find the cost of seven apples [a] N25.00 [b] N30.00 [c] N35.00 [d] N40.00
19. Simplify $(2a + b)^2 - (b - 2a)^2$ [a] $6ab$ [b] $7ab$ [c] $-8ab$ [d] $8ab$
20. Solve the equation $9^{2x-3}/3^{x+2} = 1$. [a] $x = 2$ [b] $x = 3$ [c] $x = 4$ [d] $x = 5$
21. Solve the equation : $3a + 10 = a^2$ [a] $a = 5$ or $a = 2$ [b] $a = -5$, or $a = 2$ [c] $a = 10$ or $a = 0$ [d] $a = 5$ or $a = -2$

22. Simplify $\frac{2}{2+x} + \frac{2}{2-x}$ [a] $\frac{4}{4-x^2}$ [b] $\frac{8}{4-x^2}$ [c] $\frac{4x}{4-x^2}$ [d] $\frac{8-4x}{4-x^2}$
23. A bucket of water holds 10 litres of water. How many buckets of water will fill a reservoir of size 8m X 7m X 5m. (1 litre = 1000cm³). [a] 28 [b] 280 [c] 2800 [d] 28000
24. If x is a positive integer, list the values of x which satisfy the equations $3x - 4 < 6$ and $x - 1 > 0$. [a] { 1, 2, 3 } [b] { 2, 3 } [c] { 2, 3, 4 } [d] { 2, 3, 4, 5 }
25. The capacity of a water tank is 1,800 litres. If the tank is in the form of a cuboid with base 600cm by 150 cm, find the height of the tank. [a] 2cm [b] 20cm [c] 200cm [d] 2000cm
26. Solve $\frac{2x+1}{6} - \frac{3x-1}{4} = 0$ [a] 1 [b] $\frac{1}{5}$ [c] $-\frac{1}{5}$ [d] -1
27. Five bottles of Fanta and two packets of biscuits cost Gh¢ 6.00. Three bottles of Fanta and four packets of biscuits cost Gh¢ 5.00. Find the cost of a bottle of Fanta. [a] Gh¢ 0.50 [b] Gh¢ 1.00 [c] Gh¢ 1.50 [d] Gh¢ 5.00
28. Solve the following simultaneous equations : $2x + 3y = 7$, $x + 5y = 0$
[a] $x = 5, y = -1$ [b] $x = \frac{1}{5}, y = -1$ [c] $x = -\frac{1}{5}, y = 1$ [d] $x = -5, y = 1$
29. Simplify $\frac{2x^2 - 5x - 12}{4x^2 - 9}$ [a] $\frac{x+4}{2x+3}$ [b] $\frac{x+4}{2x-3}$ [c] $\frac{x-4}{2x+4}$ [d] $\frac{x-4}{2x-3}$
30. Solve the inequality $1 - 2x < -\frac{1}{3}$ [a] $x < \frac{2}{3}$ [b] $x < -\frac{2}{3}$ [c] $x > \frac{2}{3}$ [d] $x > -\frac{2}{3}$
31. Solve the simultaneous equations: $x + y = 2$ and $3x - 2y = 1$. [a] $x = 2$ and $y = 1$ [b] $x = 1, y = 1$ [c] $x = 1, y = 2$ [d] $x = -1, y = 1$
32. The volume of a cylinder is 1200cm³ and the area of its base is 150cm². Find the height of the cylinder. [a] 80.00cm [b] 8.00cm [c] 0.80 cm [d] 0.08 cm
33. I am x years old and my brother is 3 years older. How old was my brother last year? [a] (x - 4 years) [b] (x + 2) years [c] (3x - 1) years [d] (3x + 1) years
34. Simplify $\frac{4}{2x} - \frac{2+x}{x}$ [a] -1 [b] -2x [c] 2x [d] $\frac{2-x}{2x}$
35. Expand the expression $(3a - xy)(3a + xy)$ [a] $9a^2 - x^2y^2$ [b] $9a^2 + x^2y^2$ [c] $9a^2 - xy$ [d] $9a^2 + x^2y$
36. If $x + y = 12$ and $3x - y = 20$; find the value of $2x - y$. [a] 8 [b] 10 [c] 12 [d] 15

37. A man bought 220 mangoes at N5x. He sold each for 3x kobo and made a gain of N8. Find the value of x. [a] 2 [b] 5 [c] 6 [d] 10
38. Simplify $\frac{x-4}{4} - \frac{x-3}{6}$ [a] $\frac{x-18}{12}$ [b] $\frac{x-6}{12}$ [c] $\frac{x-18}{24}$ [d] $\frac{x-6}{24}$
39. A student bought 3 notebooks and 1 pen for N35. After misplacing these items, she again bought 2 notebooks and 2 pens, all of the same type for N30. What is the cost of a pen? [a] N5.00 [b] N7.50 [c] N10.00 [d] N15.00
40. Find $(x - y)$ if $4x - 3y = 7$ and $3x - 2y = 5$. [a] 4 [b] 3 [c] 2 [d] -2

APPENDIX C (III)

STUDENT ACHIEVEMENT TEST (CONTROL GROUP)

1. One -third of a number added to four-fifths of itself is equal to 17. Find the number.
[a] 14 [b] 15 [c] 16 [d] 17
2. The sum of three consecutive numbers is 36. Find the numbers. [a] 8 [b] 9 [c] 10 [d] 11
3. A mother is three times as old as her daughter. In twelve years time she will be twice as old. How old is the mother now? [a] 12 [b] 13 [c] 15 [d] 17
4. Solve the inequalities $\frac{2x+5}{x} \leq \frac{2x}{x-3}$
[a] $X \geq -14$ [b] $X \leq 15$ [c] $X \geq -15$ [d] $X \leq -15$
5. Ade bought x biros at N8.00 each and $(x + 4)$ rulers at N20.00 each. He spent less than N200.00. Form an inequality for the statement. [a] $x \leq -4.29$ [b] $x \geq 4.29$ [c] $x < 4.29$ [d] $x > 4.29$
6. Solve the inequalities $\frac{1}{2}(4x - 7) - \frac{1}{3}(1 - 4x) \geq 6$ [a] $X > 2.95$ [b] $X \geq 2.95$ [c] $X < 2.95$ [d] $X \leq 2.95$
7. If $y = 23_{\text{five}} + 101_{\text{three}}$, find y , leaving your answer in base two. [a] 11010_{two} [b] 10010_{two} [c] 11101_{two} [d] 10101_{two}
8. A tin has radius 3cm and height 6cm. Find the total surface area of the cone. [a] 161.71 cm^3 [b] 167.09 cm^3 [c] 169.71 cm^3 [d] 171.98 cm^3
9. The volume of a cone of height 9cm is 1848 cm^3 . Find its radius. (Take $\pi = \frac{22}{7}$). [a] 14cm [b] 15cm [c] 16cm [d] 17cm
10. Simplify $\frac{X}{3y-x} - \frac{y}{3x} + 1$

$$[a] y \frac{(10x + 3y)}{3x(3y + x)} \quad [b] y \frac{(9x + 3y)}{3x(3y + x)} \quad [c] y \frac{(9x + 3y)}{2x(3y + x)} \quad [d] y \frac{(10x - 3y)}{3x(3y - x)}$$

11. For what values of x is the fraction $\frac{x^2 - 3x + 2}{4x + 13}$ equals to zero?
 [a] -1 or -2 [b] 1 or -2 [c] 1 or 2 [d] -1 or 2
12. Given that $x = \frac{3a + 5}{a + 2}$, for what value of 'a' is 'x' not defined. [a] -2 [b] 2 [c] 3 [d] -3
13. Factorize the expression $a^2 + b^2 + ap - bq + bp + aq$ [a] (a+b) (a+b+p-q) [b] (a-b) (a-b+p-q) [c] (a-b) (a+b-p-q) b [d] (a+b) (a-b+p-q)
14. Find the term that must be added to $x^2 - 22x$ to make it a perfect square. [a] 9 [b] 10 [c] 11 [d] 12
15. Solve by factorization $x^2 + 7x + 10$. [a] $x = -2$ or -5 [b] $x = 2$ or -5 [c] $x = -5$ or 2 [d] $x = 2$ or 5
16. Solve $2x^2 - 4x - 3 = 0$ using the formula [a] $x = 1.29$ or 0.29 [b] $x = -1.29$ or -0.29 [c] $x = -1.29$ or 0.29 [d] $x = 1.29$ or -0.29
17. Solve the simultaneous equation
 $2x + 4y = 42$ ----- i $6x - 4y = 30$ ----- ii
 [a] $x = 6$, $y = 9$ [b] $x = 9$, $y = 6$ [c] $x = -6$, $y = 9$ [d] $x = 9$, $y = -6$
18. The cost of three apples and one berry is N22.00 while the cost of four apples and three berries is N41.00. Find the cost of seven apples [a] N25.00 [b] N30.00 [c] N35.00 [d] N40.00
19. Simplify $(2a + b)^2 - (b - 2a)^2$ [a] $6ab$ [b] $7ab$ [c] $-8ab$ [d] $8ab$
20. Solve the equation $9^{2x-3}/3^{x+2} = 1$. [a] $x = 2$ [b] $x = 3$ [c] $x = 4$ [d] $x = 5$
21. Solve the equation : $3a + 10 = a^2$ [a] $a = 5$ or $a = 2$ [b] $a = -5$, or $a = 2$ [c] $a = 10$ or $a = 0$ [d] $a = 5$ or $a = -2$

22. Simplify $\frac{2}{2+x} + \frac{2}{2-x}$ [a] $\frac{4}{4-x^2}$ [b] $\frac{8}{4-x^2}$ [c] $\frac{4x}{4-x^2}$ [d] $\frac{8-4x}{4-x^2}$
23. A bucket of water holds 10 litres of water. How many buckets of water will fill a reservoir of size 8m X 7m X 5m. (1 litre = 1000cm³). [a] 28 [b] 280 [c] 2800 [d] 28000
24. If x is a positive integer, list the values of x which satisfy the equations $3x - 4 < 6$ and $x - 1 > 0$. [a] { 1, 2, 3 } [b] { 2, 3 } [c] { 2, 3, 4 } [d] { 2, 3, 4, 5 }
25. The capacity of a water tank is 1,800 litres. If the tank is in the form of a cuboid with base 600cm by 150 cm, find the height of the tank. [a] 2cm [b] 20cm [c] 200cm [d] 2000cm
26. Solve $\frac{2x+1}{6} - \frac{3x-1}{4} = 0$ [a] 1 [b] $\frac{1}{5}$ [c] $-\frac{1}{5}$ [d] - 1
27. Five bottles of Fanta and two packets of biscuits cost Gh¢ 6.00. Three bottles of Fanta and four packets of biscuits cost Gh¢ 5.00. Find the cost of a bottle of Fanta. [a] Gh¢ 0.50 [b] Gh¢ 1.00 [c] Gh¢ 1.50 [d] Gh¢ 5.00
28. Solve the following simultaneous equations : $2x + 3y = 7$, $x + 5y = 0$
[a] $x = 5, y = - 1$ [b] $x = \frac{1}{5}, y = - 1$ [c] $x = -\frac{1}{5}, y = 1$ [d] $x = -5, y = 1$
29. Simplify $\frac{2x^2-5x-12}{4x^2-9}$ [a] $\frac{x+4}{2x+3}$ [b] $\frac{x+4}{2x-3}$ [c] $\frac{x-4}{2x+4}$ [d] $\frac{x-4}{2x-3}$
30. Solve the inequality $1 - 2x < -\frac{1}{3}$ [a] $x < \frac{2}{3}$ [b] $x < -\frac{2}{3}$ [c] $x > \frac{2}{3}$ [d] $x > -\frac{2}{3}$
31. Solve the simultaneous equations: $x + y = 2$ and $3x - 2y = 1$. [a] $x = 2$ and $y = 1$ [b] $x = 1, y = 1$ [c] $x = 1, y = 2$ [d] $x = -1, y = 1$
32. The volume of a cylinder is 1200cm³ and the area of its base is 150cm². Find the height of the cylinder. [a] 80.00cm [b] 8.00cm [c] 0.80 cm [d] 0.08 cm
33. I am x years old and my brother is 3 years older. How old was my brother last year?
[a] (x - 4 years) [b] (x + 2) years [c] (3x - 1) years [d] (3x + 1) years
34. Simplify $\frac{4}{2x} - \frac{2+x}{x}$ [a] - 1 [b] - 2x [c] 2x [d] $\frac{2-x}{2x}$
35. Expand the expression $(3a - xy)(3a + xy)$ [a] $9a^2 - x^2y^2$ [b] $9a^2 + x^2y^2$ [c] $9a^2 - xy$ [d] $9a^2 + x^2y$
36. If $x + y = 12$ and $3x - y = 20$; find the value of $2x - y$. [a] 8 [b] 10 [c] 12 [d] 15

37. A man bought 220 mangoes at N5x. He sold each for 3x kobo and made a gain of N8. Find the value of x. [a] 2 [b] 5 [c] 6 [d] 10

38. Simplify $\frac{x-4}{4} - \frac{x-3}{6}$ [a] $\frac{x-18}{12}$ [b] $\frac{x-6}{12}$ [c] $\frac{x-18}{24}$ [d] $\frac{x-6}{24}$

39. A student bought 3 notebooks and 1 pen for N35. After misplacing these items, she again bought 2 notebooks and 2 pens, all of the same type for N30. What is the cost of a pen? [a] N5.00 [b] N7.50 [c] N10.00 [d] N15.00

40. Find $(x - y)$ if $4x - 3y = 7$ and $3x - 2y = 5$. [a] 4 [b] 3 [c] 2 [d] -2

APPENDIX D (I) (MARKING SCHEME CONVERGENT GROUP)

MARKING SCHEME

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

APPENDIX D (II) (MARKING SCHEME DIVERGENT GROUP)

MARKING SCHEME

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

APPENDIX D (III) (MARKING SCHEME CONTROL GROUP)

MARKING SCHEME

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

APPENDIX E

Post test scores for Pilot Testing

S/NO	CONVERGING	DIVERGING	CONTROL
1.	10	08	04
2.	05	10	09
3.	09	05	05
4.	11	06	05
5.	06	06	09
6.	10	12	10
7.	06	10	03
8.	08	10	07
9.	08	08	05
10.	11	10	08
11.	12	09	07
12.	13	05	09
13.	09	05	06
14.	14	06	06
15.	10	09	05
16.	06	10	07
17.	07	10	06
18.	10	06	06
19.	10	08	10
20.	08	11	09
21.	11	12	11
22.	14	13	08
23.	09	10	04
24.	10	13	05
25.	12	06	07
26.	09	09	08
27.	09	10	04
28.	07	09	07
29.	10	12	09
30.	06	09	06

APPENDIX F

Post test scores for divergent

Post test scores for convergent

EXGP	CONTGP	EXGP	CONTGP
12	11	12	11
15	09	15	09
16	12	16	12
18	10	18	10
17	14	17	14
14	09	14	09
13	11	13	11
17	12	17	12
15	06	15	16
17	12	17	12
14	08	14	08
15	14	15	14
18	10	18	10
15	10	15	10
14	09	14	09
10	12	10	12
15	13	15	13
16	14	16	14
14	12	14	12
18	13	18	13
12	14	12	14
15	08	15	08
11	13	11	13
13	11	13	11
15	09	15	09
16	12	16	12
17	14	17	14
12	13	12	13
14	10	14	10
13	09	13	09

Post test scores for divergent

post test scores for convergent

Male	Female	Male	Female
10	13	13	15
09	09	17	13
10	10	14	10
12	13	16	15
09	12	12	16
11	11	18	17
14	14	15	14
12	13	15	16
08	14	14	12
11	09	17	18
08	11	15	14
12	13	18	12
11	14	15	13
14	12	17	10
12	12	14	15

APPENDIX F

Post Hoc (Sheffe) test, Comparisons of pairs of means in the post test.

(I) FACTOR	(J) FACTOR	Mean Difference		Decision ($\alpha = 0.05$)
		(I - J)	Sig.	
EXPERIMENTAL CONVERGENTS	CONTROL CONVERGENTS	3.23	.000	Sig.
	EXPERIMENTAL DIVERGENTS	3.27	.000	Sig.
	CONTROL DIVERGENTS	6.50	.000	Sig.
CONTROL CONVERGENTS	EXPERIMENTAL DIVERGENTS	-3.23*	.000	Sig.
	CONTROL DIVERGENTS	.033	1.000	Not Sig.
	CONTROL DIVERGENTS			
Experimental Divergent		-3.27	.000	Sig.

*. The mean difference is significant at the 0.05 level.

Source: Statistical Package for Social Sciences (SPSS)

Descriptive Statistics for Convergent, Divergent, Control and Experimental Groups

Groups	N	Mean	Std. Deviation	MD
EXPERIMENTAL DIVERGENTS	30	14.70	2.10	Sig. 3.23
CONTROL DIVERGENTS	30	11.47	2.10	
EXPERIMENTAL DIVERGENTS	30	11.43	1.85	
CONTROL DIVERGENTS	30	8.20	1.56	
Total	120	11.45	2.98	

Statistical Package for Social Science (SPSS)

Anova Summary for the post – test results

Source	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	633.767	3	211.256	57.534	.000
Within Groups	425.933	116	3.672		
Total	1059.700	119			

Gender Statistics for Divergent Experimental Group

GENDER	N	Mean	Std. Deviation
MALE	15	10.87	1.88
FEMALE	15	12.00	1.69

Independent t-test for Male and Female Divergent Experimental Group

GENDER	N	Mean	Std. Deviation	Df	t-value	p-value	Decision
MALE	15	10.87	1.88	28	1.734	0.094	Retain Ho
FEMALE	15	12.00	1.69				

Source: Statistical Package for Social Sciences (SPSS)

Gender Statistics for Convergent Experimental Group

GENDER	N	Mean	Std. Deviation
MALE	15	15.33	1.80
FEMALE	15	14.07	2.25

Independent t-test for Male and Female Convergent Experimental Group

GENDER	N	Mean	Std. Deviation	Df	t-value	p-value	Decision
MALE	15	15.33	1.80	28	1.702	0.100	Retain Ho
FEMALE	15	14.07	2.25				

Source: Statistical Package for Social Sciences (SPSS)