EFFECTS OF MNEMONIC AND PRIOR KNOWLEDGE-BASED INSTRUCTIONAL STRATEGIES ON SENIOR SECONDARY SCHOOL STUDENTS' LEARNING OUTCOMES IN MATHEMATICS IN IBADAN

BY

Ezekiel Olukola ODEYEMI
(Matric No: 120186)
NCE (Ilesa), B.Sc. Ed. (Mathematics) Nsukka,
M.Ed. (Mathematics) Ibadan,

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ABSTRACT

Mathematics is the bedrock of scientific, technological and national development. Despite the importance of Mathematics, poor performance of students in the subject still persists at the secondary school level. The problem has been attributed to several factors which include non-utilisation of instructional strategies that make use of student's prior knowledge and memory such as the Mnemonic and Prior knowledge-based instructional strategies. Studies have shown that these strategies enhanced students' learning outcomes in subjects like Arts and Social sciences, but there is paucity of research on their effects on Mathematics. Therefore, this study determined the effects of Mnemonic-based instructional strategy (MBIS) and Prior knowledge-based instructional strategy (PKBIS) on students' achievement in and attitude to Mathematics in senior secondary schools in Ibadan. The moderating effects of numerical ability and gender were also examined.

The study adopted the pretest-posttest, control group, quasi experimental design with 3x2x3 factorial matrix. Two hundred and eighty-eight average students from two public senior secondary schools purposively selected from each of Ibadan North, Ibadan North East, and Ibadan South East local government areas. The participants were randomly assigned to MBIS, PKBIS and Modified lecture method (MLM). The treatments lasted for eight weeks. Instruments used were: Students' Mathematics Achievement Test (r =0.75), Students' Mathematics Attitudinal Scale (r=0.8), Numerical Ability Test (r=0.77). Three operational guides on mnemonic-based instructional strategy, prior knowledge-based instructional strategy and modified lecture method were also used. Seven null hypotheses were tested at 0.05 levels of significance. Data were analysed using Analysis of Covariance and Scheffe post hoc pair-wise comparison test.

The treatments were significant on students' achievement in Mathematics ($F_{(3, 284)}$ = 8.96, $\eta 2$= 0.03). The MBIS treatment group had higher achievement mean score ($\bar{x}$=16.91) than the PKBIS ($\bar{x}$=13.07) and control group ($\bar{x}$=12.10). There was significant main effect of treatments on students' attitude to Mathematics ($F_{(3,284)}$ =3.93), $\eta 2$ =0.03). The treatments in the control group had higher attitude mean score ($\bar{x}$=71.39) than MBIS ($\bar{x}$=69.01) and PKBIS ($\bar{x}$=68.46) groups. Numerical ability had significant effect on students' achievement in Mathematics ($F_{(3,284)}$ =28.86, $\eta 2$=0.18), but was not significant on students' attitude to Mathematics. Gender had significant effect on students' achievement ($F_{(2,269)}$ = 26.55, η^2= .09) in and attitude ($F_{(2,269)}$ = 4.29, η^2= .02) to Mathematics. Males performed better than females in achievement test, however, female had better attitude. The two-way and three-way interaction effects were not significant.

Mnemonic and Prior knowledge-based instructional strategies improved students' achievement in and attitude to Mathematics regardless of gender, however, the former was more effective. Therefore, teachers should create mnemonics that would link the old and new information in students' memory, assess their knowledge at the start of instruction to make teaching and learning of Mathematics meaningful. Hence, the two strategies should be regularly used for teaching Mathematics at the secondary school level.

Keywords: Mnemonic-based instructional strategy, Prior-knowledge-based instructional strategy, Students' learning outcomes, Senior secondary school Mathematics.

Word count 484

CERTIFICATION

I certify that this work was carried out by **Ezekiel Olukola ODEYEMI** in the Department of Teacher Education, Faculty of Education, University of Ibadan, Ibadan.

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SUPERVISOR
Prof. M. K. Akinsola,
NCE (Abeokuta), B.Sc. Hons. (Lagos),
M.Ed & Ph.D (Maths. Ed.) Ibadan
Department of Teacher Education
University of Ibadan

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Mathematics is perhaps one of the most dreaded subjects at all levels of education, especially secondary schools where the subject is made compulsory. It has been described as the bedrock of national development and a subject without which a nation cannot move forward scientifically and technologically (Emunefe and Oyetunde, 2009). It is the wheel on which science subjects move and the prime instrument for understanding and exploring our scientific, economic and social world (Amoo and Rahman, 2004). Mathematics is a subject that holds other subjects together, as there is a lot of Mathematics in Physics, Chemistry and Geography (Ale, 2011). Tsue and Anyor (2006) see Mathematics as the language of science and technology. Mathematics concepts and methods provide scientists with insight into natural phenomena; while its symbols are used in expressing the physical laws of nature. Therefore, to move the nation forward scientifically and technologically, Mathematics is very important. It has been observed that no nation can make any meaningful progress in this information technology age, particularly in economic development without technology whose foundation are science and Mathematics (Bajah, 2000). In the same vein, Adewumi (2005) avers that, without Mathematics, there is no science, without science there could be no modern technology. In other words, Mathematics is the precursor and queen of science.

The importance of Mathematics cuts across all aspects of human endeavour, starting from indirect use at home to actual applications to solve scientific and technological problems. Interestingly, applicants seeking the best employment opportunity would need a good knowledge of mathematics (Adewale and Amoo, 2004). It serves as a precision and indispensable tool used by engineers and scientists in their search for a clear understanding of the physical world. It is also used by many professionals (Nasir, 2001). It is mostly considered as a tool in that it contains the skills for solving problems, organising, simplifying and interpreting data, and performing calculations that are necessary in fields such as science, business and industry. Mathematics is seen as the key to a productive and fulfilling live (Adedayo, 2007). It is regarded as a key to performing many diversified functions in life. It is the key to positive cognitive development, successful daily living, scientific development, modernisation, successful career, productive employment, good citizenship and good living. The application of Mathematics to everyday living cannot be exhausted, from counting possessions to measuring property boundaries, predicting the seasons, computing taxes and profits, navigating ships and exploration, building houses and bridges, drawing maps, developing weapons and planning warfare (Kolawole and Olutayo, 2005). Therefore, it could be summarised that Mathematics is an undisputed agent of a nation's development.

Moreover, the importance of Mathematics is not limited to science and technology only. Even in arts and social sciences, the contribution of Mathematics is recognized. According to Ekaguere (2009), it is clear that economics, if it is to be a science at all must be a mathematical science'. Also, the relationship between arts and Mathematics has been emphasised and recognized by the National Council of Teachers of Mathematics (Ilori, 2003). The council states that in arts, such Mathematics concepts of symmetry, sequence and proportion provides a convenient construct. It is on the basis of this that The National Policy of Education (FME, 2004) places Mathematics as one of the core and compulsory subjects in the curricula of primary up to senior secondary schools. The importance accorded Mathematics in these curricula reflects accurately the recognition of the vital role it plays in contemporary society. In fact the national objectives of primary and secondary education in relation to Mathematics education attest to its importance:

- To lay a solid foundation for the concepts of numeracy and scientific thinking
- To give the child opportunities for developing manipulative skills that will enable him to function effectively in the society within the limit of his capacity
- To provide the basic tools for further advancement as well as prepare students for trades and craft within the localities.
- To build on the foundation of primary level so that the child can make a useful living professionally, economically, politically and socially.
- To create interest in Mathematics and to provide a solid foundation for everyday life.
- To develop computation skills and ability to recognize problem and to solve them with related mathematical knowledge (John, 2008: 134).

Thus, Mathematics is a desirable tool in virtually all spheres of human endeavour, be it science, engineering, industry, technology and even the Arts (Oyedeji, 2000).

Despite the importance and contributions of Mathematics to every facet of human development, the subject is still faced with the problem of poor performance by students at secondary school level. The analysis of WAEC results of Senior Secondary School Certificate Examinations in Mathematics from 2002 to 2011 are given in table 1 below:

Table 1.1: Statistics of Entries and Results of West African Examinations Council in Mathematics 'O' Level at the May/June Senior Secondary School Certificate Examinations for Nigeria (2002 – 2011).

Year	No. of Candidates	A1-C6 High Quality Passes	% High Quality Passes	D7-E8 Poor Quality Passes	% Poor Quality Passes	F9 Failure	% Failure
2002	908,235	309409	34.06	308369	33.95	290457	31.98
2003	926,212	341928	36.92	331348	35.77	252736	27.31
2004	832,689	287484	34.52	245071	29.43	300134	36.04
2005	1,054,853	402982	38.20	276000	26.16	375871	35.63
2006	1,181,515	482123	40.81	366801	31.04	332591	28.15
2007	1,249,028	583921	46.75	333740	26.72	331367	26.53
2008	1,292,890	726,398	56.18	302,266	23.38	264226	20.44
2009	1,373,009	634,382	46.20	344,635	25.10	393992	28.70
2010	1,306,535	548,065	42.00	363,920	27.90	355,382	27.20
2011	1,508,965	608,866	40.40	474,664	31.50	421,412	27.90

Source: West African Examinations Council, 2012

Table I gives analysis of students' performance at the May/June Senior Secondary School Certificate Examinations Ordinary Level between 2002 and 2011. The table shows that quality passes (A1- C6) between 2002 and 2011 ranged from 34.06% and 56.18%, while pass rates (D7 – E8) ranged between 23.38% and 35.77%. The failure rate (F9) ranged between 20.44% and 36.04%. There were noticeable improvements from 2006, with the highest result in quality passes in 2008 (56.18%) and later declined to 40.4% in 2011.

Several factors have been identified to be responsible for this. Prominent among these factors are: poor attitude of students to Mathematics (Amoo and Rahman, 2004), the use of traditional or conventional teaching method (Alio 2000; Ayanniyi, 2005), non-utilisation of available resources (Akinsola, 2000), lack of interest on the part of teaching staff (Amoo, 2001), lack of Mathematics laboratory (Obodo, 2008), population explosion of student enrolments without commensurate Mathematics teachers to handle them (Amoo, 2002) and lack of mathematics teachers professional training (Iheanacho, 2007).

Betiku (2002) ascribes the dismal performance of students in Mathematics to the cluster of variables, which include: government-related variables; curriculum-related variables; examination-bodies related variables; teacher-related variables; student-related variables; home-related and text book-related variables. Besides these variables some specific variables have been identified by Amazigo (2000) such as poor primary school background in Mathematics, lack of interest on the part of the students, lack of incentives for the teachers, incompetent teachers in the primary schools, large classes, perception that Mathematics is difficult, and fear of the subject.

Apart from the results of various research efforts to unearth the causes of the incessant and ever- increasing dismal performance of students in both internal and external examinations, many stakeholders in the education industry have also spoken on the issue. According to the West African Examinations Council's Report (WAEC, 2010) the unimpressive performance of students could be attributed to poor language skills and expression, insufficient preparation, misinterpretation of questions, inadequate technical competence and poor hand writing.

Ajisegiri (2010) notes that:

> *If the quality of education at the primary level is poor it will be foolish to expect that the standard at the secondary level will be high because it is the primary school that feeds the secondary. In the same vein, if the standard at the secondary level is poor, we should also expect that the quality at tertiary level will be poor. So, in ensuring that we have a high quality of education in the country, it is incumbent on the government to see that the standard is high at all levels (p.4)*

Attitude is the affective disposition of a person or group of persons towards a subject based on the belief that such a person or group of persons has about the subject (Oguntade, 2000). It denotes the sum total of a man's inclinations, feelings, prejudices or biases, preconceived notions, ideas, fears, threats and conviction about any topic or subject (Akinsola and Ifamuyiwa, 2008). According to *Encyclopedia of Education*, attitude is the pre-disposition to respond in a certain way to a person, an object, an event, a situation or an idea. Generally, students' attitude determines, to a larger extent, their success in any subject (Akinsola and Olowojaiye, 2008). To address the persistent poor performance of students in Mathematics, efforts must be made to improve students' attitude towards the learning of the subject. Attitude which is either positive or negative is very crucial to the academic achievement of students in Mathematics. Therefore, it is imperative to ensure that there is a positive change in students' attitude towards learning of Mathematics (Ifamuyiwa and Akinsola, 2008). The positive attitude reinforces affection, which enhances student's performance in Mathematics. Conversely, the negative attitude causes hatred, disaffection and depression towards Mathematics with the resultant effect being poor performance in the subject. Attitude to a certain subject or situation could be formed, developed, adopted, modified or even changed due to circumstances (Yara, 2009. In the same vein, attitude towards Mathematics is just a positive or negative disposition towards Mathematics (Zan and Martino, 2007). Also, Greenwald, McGhee and Schwarts (2002) see attitude towards Mathematics as how an individual feels about Mathematics. Thus, the perceived importance of Mathematics is one of the essential attitudes towards Mathematics

Various researches have shown that students who have positive attitude to a subject will perform better than those with negative attitude (Oguntade, 2000, Ayanniyi, 2005 and Maduabuchi, 2008). It has been revealed that students need to have positive attitude towards problem-solving to be successful and overcome risks (O'Connel, 2000). It has also been observed that the attitude of students can be influenced by the attitude of the teacher and his method of instruction (Adesoji, 2008). The teacher's method of Mathematics teaching and his or her personality greatly accounts for the students' positive or negative attitude towards Mathematics (Akinsola, 2002; Yara, 2009). Thus, the attitude of a learner towards science and Mathematics would determine the extent of the learner's attractiveness or repulsiveness to science and Mathematics (Ogunkola, 2002). Therefore, if a person is not favourably disposed to Mathematics or any other subjects, his or her attitude towards the subject may be negative. Thus, positive attitude will lead to persistence and better achievement (Odogwu, 2002). To ensure high achievement in Mathematics, positive components of Mathematics, such as likeness, usefulness and relevance of Mathematics to other subjects and everyday living, should be reinforced during instruction. The study therefore examined the influence of methods of instruction on students' attitude to Mathematics.

One other variable that may be responsible for the poor performance of students in Mathematics is the use of conventional teaching method (otherwise known as Lecture Method). This method, though prevalent in Nigerian secondary schools, has been shown to be ineffective and has not been yielding the desired results (Akinsola, 2000). It is teacher-centred; the teacher dominates the class, leaving learners uninvolved and passive. This method of teaching is not interactive and may render the set objectives unachievable (Aremu, 2010). Also, Ayodele (2007) asserts that the Conventional Teaching Method fails to respect individual differences and learning characteristic. According to Berns and Erickson (2001), the traditional approach to education where students receive direct instruction and then practise specific skills is not good enough for critical thinking. Therefore, there is need to search for more alternative methods of instruction in Mathematics that will be effective in helping learners to understand and retain what is learnt, improve their attitude and enhance their performance.

John (2008) observes that the instructional strategy that must be used in the classroom should be learner-friendly, activity-based, practical, innovative and meaningful, if students are to achieve maximally. Such instructional strategies are meant to engage, motivate, arouse and sustain the interest of the learners. Several efforts have been made to evolve tested and student-friendly instructional strategies. These include: Peer Tutoring (Onabanjo, 2000), Heuristic Problem-solving and Programmed Instructional Strategies (Popoola, 2002), Behavioural Objective and Study question-based Instructional Strategies (Olowojaye, 2004), and Self and Cooperative Instructional Strategies (Akinsola and Ifamuyiwa, 2008). Although most of these instructional strategies produced positive results, however, there is need to find more strategies that would improve students' memory and make teaching and learning of Mathematics student-centred. Also, the end product of any teaching activity is improvement in students' performance in any examination, which is based on questions that mostly require recall of specific facts. This recall can only be enhanced by improving students' memory and making learning of new materials meaningfully connected with previous experience. Based on this, the study examined another set of instructional strategies called Mnemonic and Prior Knowledge-based, which are cheaper with respect to time and cost of implementation, and may improve students' performance in virtually all forms of examinations.

Mnemonic is a systematic procedure for enhancing memory. According to Babara (2005), Mnemonic instruction is a set of strategies designed to help students improve their memory of new information. Its particular use is in developing better ways to take in (encode) information so that it will be much easier to remember (Mastropieri and Scruggs, 1992). The particular task in developing mnemonics strategies is to find a way to relate new information to information students have already locked in long-term memory. Mnemonic instruction links new information to prior knowledge through the use of visual or acrostic cues. Visual cues are pictures or graphics teachers create that link the old and new information in the student's memory. For example, a mnemonic to remember the definition of the word "carline" (meaning witch) might be a drawing of a witch driving a car. Acrostic cues, on the other hand, involve words arrangement in which the first letter of the words correspond to the first letter of the information students are expected to remember.

There are three major types of mnemonics, keyword, pegword and letter strategies. The keyword strategy is based on linking new information to keywords students had already encoded in their memory. Conversely, pegword strategy on the other hand uses rhyming words to represent numbers. For example, the pegword for "one" is "bun", "two" is "shoe", and "three" is "tree". Pegwords can be used to remember information involving numbers and have proven useful in teaching students to remember numbered information (Scruggs and Mastropieri, 1992). Letter strategy on the other hand involves the use of acronyms and acrostics. Acronyms are words whose individual letters can represent elements in the lists of information, such as BODMAS, which means Bracket, Of, Division, Multiplication, Addition, and Subtraction that represent the order of operation in mathematics. Acrostics are sentences whose first letters represent information to be remembered such as "Best of Dare Martins and Sola" (BODMAS) to remember the same order of operation in Mathematics.

All three types of mnemonic strategies can be used effectively in teaching mathematics. Mnemonics are helpful in teaching mathematics facts, order of operations, measurement, geometry, problem-solving techniques, and other areas of mathematics. Several aspects of Mathematics can be taught using mnemonics. For instance, PEMDAS (Parentheses, Exponents, Multiplication, Division, Addition and Subtraction) can be used for general arithmetic which involves order of operations; MADS can be used for Indices and Logarithms; SOHCAHTOA and All Students Take Crackers for Trigonometry which cover such aspects as Trigonometric Ratios, Sine and Cosine Rules, Angles of Elevation and Depression, Bearing, Mensuration and Longitude and Latitude; FOIL (first, outer, in, and last) for expansion of algebraic expressions;

DIRT for distance formula; and I am Pretty for Simple Interest. Also STAR and SOLVE can be used for word problems involving equations and WISE for problems involving substitutions like Variations, and Arithmetic and Geometric Progressions, among others.

Mnemonics can be teacher-created or student-created. To create mnemonics, Access Center (2006) observes that the following steps may be followed:

1. List all the steps needed to complete the mathematical process in the correct order
2. Take an initial letter to help remember the steps for each process (example, for Addition use A, Subtraction use S, etc).
3. If the initials spell a word, you can use that (example, FOIL (First, Outer, Inner, Last) helps remember how to factor or you can make up a saying for the initial such as All Students Take Crackers to help remember which trigonometry functions are positive in the four quadrants.

Also, according to Mercer and Mercer (1997) Mnemonics can be developed with the following steps:

1. Form a word (that incorporates important parts of skills).
2. Insert extra letters to form a mnemonic word if needed.
3. Re-arrange letters to form a mnemonic word (when order is not important).
4. Shape a sentence to form a mnemonic where necessary (example, All Students Take Crackers).
5. Try combination of the first four steps to create a Mnemonic.

Mnemonic-based instructional strategies have proven to be effective with students at a wide range of ability levels (gifted, normally achieving, and those with mild and moderate disabilities) and at all grade levels (Wood and Frank, 2000). It can be used in language arts (that is, vocabulary, spelling, and letter recognition), Mathematics, sciences, social studies, foreign language, and other academic studies (The Acess Center, 2006). It is also important because it appears to be an effective strategy for increasing students' comprehension test scores. On the average, students who have been trained in mnemonic instruction outperform students without training on comprehension examinations (Mastropieri and Scruggs (1991). The reason comprehension scores are higher for students using mnemonic strategies are that the strategy increased their ability to recall the factual information needed to answer comprehension question. Through the use of mnemonic-based strategy, it is more likely that the students will be able to remember factual information, answer questions, and demonstrate comprehension. It has also been observed that mnemonic instruction provides a visual and verbal prompt for students who may have difficulty retaining information (Babara, 2005). Therefore, as children learn, they are building a web of knowledge. So, for students with memory challenges or processing disorder, mnemonic devices become a tool to build threads from new to old ideas (The Access Center, 2006) to mention a few. One bigger advantage of Mnemonic instruction is that it is an inexpensive strategy that helps average children gain access to general education curriculum. No specific level of teaching experience is required to learn or use this strategy. The mnemonic instructional strategy involves no additional costs for purchase of material or technology. On the basis of the above and coupled with its advantages, it is expected that, using the mnemonic-based instructional strategy in teaching Mathematics may enhance students' memory of basic mathematical facts and ensure quick recovery of important information that may improve their academic performance.

The knowledge that students bring to the lesson is one of the most important factors influencing their learning. Since effective teaching is that which makes learning possible it is of great importance that teachers understand the level of the students' prior knowledge and target their teaching accordingly. Prior Knowledge is all knowledge learners have when entering a learning environment that is potentially relevant for acquiring new knowledge (Biemans, Deel and Simons, 2001). Also, Dochy and Alexander (1995) describe prior knowledge as the whole of a person's knowledge including explicit and tacit knowledge, meta-cognitive and conceptual knowledge. The students' prior knowledge provides an indication of the alternative conceptions as well as the scientific conceptions possessed by the students (Hewson and Hewson, 2008). In the construction of knowledge, learners use prior knowledge to incorporate meaning into newly acquired material. In this way, prior knowledge influences how learners interpret new information and decide what aspects of this information are relevant and irrelevant. Although teachers using the conventional teaching method may mediate the activation of Prior Knowledge in students as one of their instructional tactics, teachers using prior knowledge-based strategy specifically teach students about their prior knowledge and how they can intentionally use it to facilitate learning and performance. In a nutshell, they teach what prior knowledge is, how it is used to facilitate learning and performance, and when and how they can use it (Ellis, 1993).

To achieve expected result when using prior knowledge-based instructional strategy, Hewson and Hewson (2008) opine that teachers should assess students' knowledge at the start of instruction, probing for underlying assumptions and beliefs, challenge students' common misconceptions by providing examples that prove otherwise, and tailor instructions and explanations to accommodate individuals' prior knowledge and experience when possible. This may be done by providing analogical examples that bridge students' prior knowledge with the new concepts they are to learn. However, prior knowledge can make it difficult to understand or learn new information (Dochy et al, 1995). Difficulty is especially likely if pre-existing information is inaccurate or incomplete, such as when students generalise inappropriately from everyday experiences or from what they learn in the popular media (Chinn and Brewer, 1993). Remarkably, prior beliefs may be highly resistant to change, even in the context of formal course work (Fisher, Wandersee, and Moody, 2000). To counter the effect of inaccurate pre-existing information, it is necessary to activate prior knowledge which is critical and essential to the content to be discussed. Active review, rather than passive ones, should be conducted at the commencement of the lesson, during the lesson, and when concluding the lesson. By this, students are continuously recycling important information, which relates to both current and past topics (Susan, 2009).

Most importantly, prior knowledge acts as a lens through which we view and absorb new information. It can be applied in all subject areas, be it science, arts or social science. It is a composite of who we are, based on what we have learned from both our academic and everyday experiences (Kujawa and Huske, 1995). Assessment of the prior knowledge can provide valuable information to determine the appropriate guidance needed by learners. Students learn and remember new information best when it is linked to relevant prior knowledge. Teachers who link classroom activities and instruction to prior knowledge build on their students' familiarity with a topic and enable students to connect the curriculum content to their own culture and experience (Beyer, 1991). Prior knowledge influences how the teacher and the students interact with the learning materials as both individuals and a group. It is the proper entry point for instruction, which should build on what is already known, and a major factor in comprehension-that is, making sense of our learning experiences (Kujawa and Huske, 1995).

It has also been revealed that one of the key factors influencing learning outcomes is the relevant knowledge that a student has about a particular subject prior to a learning event (Biggs, 2003). According to Kopcha (2005), students with high prior knowledge have a tendency to achieve better and have more positive attitude when they are the type of control they prefer, whereas the opposite is true for low prior-knowledge students. It has also been reported that the variance in students' prior knowledge is one of the strongest factors influencing educational achievement, understanding of the lesson material and potential for meaningful learning (Fisher, et-al, 2000). Therefore, by capitalizing on students prior knowledge, teachers who are empathetic to their students' need and background bridge the new knowledge to the old, making learning of new mathematics concepts more manageable for students (Furner, Yahya and Duffy, 2005). Walberg and Paik (2000) assert that when teachers explain how ideas in the current lesson relate to ideas in the previous lesson and other prior learning, students can connect the old with the new which may help them to better remember and understand. Ausubel (1968) suggests that meaningful learning is more likely to take place if the learning task can be related to what the learners already know; rote learning is more likely if the learners lack the relevant prior knowledge needed to make the learning task meaningful. He then emphasises the importance of checking on the Prior Knowledge, what the learners bring to the lesson, and use this to inform teaching. Thus, evidence from research on Prior Knowledge Instructional Strategy showed that students are not blank slates on which our words are inscribed. The students bring more to the interpretation of the situation than we realize. What they learn is conditioned by what they already know. What they know can be as damaging as what they do not know (Svinicki, 2011).

Several studies have been conducted on the effect of prior knowledge instructional strategy as a means of enhancing students' academic performance with positive results. These include among others: Activating junior secondary school students prior knowledge for development of vocabulary concepts and Mathematics (Oyinloye and Popoola, 2013); Effect of cognitive entry behaviour on some difficult Mathematics concepts (Adeleke, 2007); and Effect of prior knowledge and schemata activation strategies on the inferential reading comprehension of children with and without learning disabilities (Carr and Thompson, 1996) However, few of these studies were conducted in the area of Mathematics, especially at the senior secondary school level and on specific aspect of the subject. Therefore, it is expected that if prior knowledge-based instructional strategy, is applied to more aspects of Mathematics in senior secondary schools, may ease teaching for the teachers and make learning of Mathematics meaningful for the students. Hence, there may be improvement in student performance in Mathematics.

Gender-based achievement gaps in Mathematics and science are one of the most interesting and actively debated areas in educational research. Some studies have reported a significant relationship between gender and students performance in Mathematics, especially in favour of boys (Scantlebury and Baker, 2007). It has also been reported that male students have higher level of achievement in science, technology and mathematics than their female counterpart (Ige, 2001; Raimi and Adeoye, 2002). Boys are superior in numerical aptitudes, science, reasoning and spatial relationship while girls are superior in verbal fluency, perceptual speed, memory and manual dexterity (Akinyele and Ugochulunma, 2007). It was also observed that though male and female frequently differ in performance on aptitude measure, gender of students was not a significant factor in the students' performance in Biology, Physics and Mathematics sub-test of Student's General Aptitude Test (SGAT) (Akinyele and Ugochulunwa, 2007). However, it was reported that gender did not have any significant effect on variation in achievement scores of boys and girls (Badiru, 2007; Okigbo and Oshafor, 2008).

Several reasons have been adduced for gender imbalance in education. Croxford (2002) avers that one of the reasons why young people, particularly females, opt out of science and technology is due largely to their perception. In a similar vein, Aguele (2004) asserts that the negative image of women towards Science, Technology and Mathematics (STM) education has accounted largely for the low enrolment of females in these subjects especially, in the universities. Ezeliora (2003) also noted that from birth baby girl is exposed to avoid sciences. The societal set up does not give her the opportunity to experience the environment which is a pre-requisite to science. Rather, she is kept in-doors to do the house work, while her brother is left free to move about exploring the environment. Furthermore, men dominate pictorial illustrations in Science and Mathematics textbooks while girls are virtually absent or depicted to be passive (Okeke, 2000). As a result of inconclusive reports, further research is necessary to investigate the influence of gender on students' learning outcomes in Mathematics.

Another variable that is critical to the achievement of students in Mathematics is numerical ability. Numerical ability is the capability of students to perform some arithmetical or mathematical calculations off hand or without the use of any mechanical device. It could be high, medium or low numerical ability. In most cases, the achievement of students in Mathematics is dependent on their numerical ability levels (Iroegbu, 1998). It also refers to any characteristic of a person that makes it possible for him or her to carry out some sort of activity successfully (Arowolo, 2010). It covers broad traits such as manual dexterity. Numerical ability is a clear case of theoretical construct replacing functions which are indirectly measurable through performance (Bamidele, 2000). According to Apata (2011), numerical ability is the strength of an individual to proffer numerical solutions to mathematical problems through the manipulations of numbers. Also Sangodoyin (2010) sees numerical ability as the capability of students to handle basic arithmetic, number sequences and simple Mathematics, depending on the nature of the situation. That is, the level of intellect or cognitive development of students to cope with the learning of Mathematics in the classroom.

Studies have shown that students' numerical Ability could influence learning and retention and scholastic attainment (Inyang and Ekpeyong, 2000; Adeoye and Raimi, 2005). It has also been observed that numerical ability, to a great extent, determines the imagination, language, perception, concept formation and problem-solving ability of learners (Arowolo, 2010). Ogunbiyi (2007) found that the achievement scores of high numerical ability pre-service environmental teachers were higher than those of their counterparts with low numerical ability. The finding provided further empirical support to that of Superka (2004), Stronghill (2004) and Graffit (2004), that numerical ability had significant effect on teachers' knowledge of environmental concepts and their attitude to the environment than gender.

On the basis of the above, it is necessary to further examine the moderating effect of Numerical Ability on student learning outcomes in Mathematics. Therefore, this study examined the effects of mnemonic and prior knowledge-based instructional strategies on students' achievement in and attitude towards Mathematics. It also investigated whether the moderating variables, gender and numerical ability, have effect on students' learning outcomes in Mathematics.

1.2 Statement of the Problem

The poor performance of students in Mathematics in both WAEC and NECO and even internal examinations has been of serious concern to all stakeholders in the educational sector. This has been attributed to several factors which include the use of Conventional Teaching Method that dominates Nigerian classrooms and makes teaching and learning of Mathematics uninteresting. It is teacher-centred and has not been yielding the desired result. Several efforts have been made to evolve tested and student-friendly instructional strategies. Though most of the research efforts showed positive results, there is need to find instructional strategies that will improve students' memory and make teaching and learning of Mathematics student-centred. This would possibly enhance students' ability to recall basic mathematical facts necessary to excel in all forms of examinations. Two of such strategies are mnemonic and prior knowledge-based instructional strategies. Empirical literature has documented the facilitative effects of these strategies in the teaching and learning of vocabulary, spelling and letter recognition with few on Mathematics. Therefore, this study examined the effects of mnemonic and prior-knowledge-based instructional strategies on senior secondary school students' achievement in and attitude to Mathematics in Ibadan. Also, moderating effects of gender and numerical ability on Mathematics learning outcomes were determined.

1.3 Hypotheses

The following null hypotheses were tested at 0.05 significant levels

$H0_1$ – There is no significant main effect of treatment on: (a) students' achievement in Mathematics, (b) students' attitude to Mathematics.

HO_2 - There is no significant main effect of numerical ability on: (a) students' achievement in Mathematics, (b) students' attitude to Mathematics

HO3 – There is no significant main effect of gender on: (a) students' achievement in Mathematics, (b) students' attitude to Mathematics.

HO_4 – There is no significant interaction effect of treatment and numerical ability on: (a) students' achievement in Mathematics, (b) students' attitude to Mathematics.

HO_5 – There is no significant interaction effect of treatment and gender on: (a) students' achievement in Mathematics, (b) students' attitude to Mathematics.

HO_6 – There is no significant interaction effect of numerical ability and gender on: (a) students' achievement in Mathematics, (b) students' attitude to Mathematics.

HO_7 – There is no significant interaction effect of treatment, numerical ability and gender on: (a) students' achievement in Mathematics, (b) students' attitude to Mathematics

1.4 Significance of the study

There have been continuous efforts at finding effective instructional strategies that would not only enhance teaching and learning of Mathematics but would improve significantly the academic achievement of students in the subject. Based on this, the results of this study would provide a basis for evaluating the effectiveness of Mnemonic-based and Prior knowledge-based instructional strategies on students' achievement in and attitude to Mathematics at senior secondary school level. It would also add to the existing data on effective strategies that have potency to enhance learning outcomes. To the stakeholders in educational sector, most especially the curriculum planners, the educational administrators and the governments at various levels, the results of this study would provide reliable information that would serve as a basis for policy making. Also, it would give direction to stakeholders for organizing seminars, workshops and symposia on the effective teaching strategies for teachers.

1.5 Scope of the Study

This study covered 288 Senior Secondary School II students in three local government areas of Ibadan. In all, six senior secondary schools, two from each local government area, were purposively selected for the study, while two intact classes from each of the selected schools were involved in the study. The concepts taught included: Logarithms of numbers, Arithmetic, Quadratic Equations, Trigonometry, Arithmetic and Geometric Progressions and Mensuration. The study focused on the effects of mnemonic and prior knowledge-based instructional strategies on students' learning outcomes in Mathematics. The moderating effects of gender and numerical ability on students' learning outcomes were also examined.

1.6 Operational Definitions of Terms

Instructional Strategies – These are the plans adopted in teaching Senior Secondary School Two (SS II) students Mathematics to ensure effective achievement and improved attitude towards Mathematics.

Numerical ability: This is a natural endowment of each student to perform in Mathematics categorized into high, medium and low levels.

Learning Outcomes: These are the output of achievement test and attitudes questionnaire of Senior Secondary Two (SS II) students in Mathematics after being exposed to some selected Mathematics concepts using Mnemonic-based, Prior Knowledge-based and Modified Lecture Method.

Students Achievement in Mathematics: This refers to the scores of Senior Secondary School Two (SS II) students in Mathematics test based on selected Mathematics concepts.

Students' Attitudes to Mathematics: These are the feelings, beliefs and interests displayed by the students towards Mathematics.

Prior Knowledge-based Instructional Strategy: This is a teaching plan that is based on the existing information students acquired before entering into the Mathematics class.

Mnemonic-based Instructional Strategy: This is a process of teaching that uses memory enhancing techniques to assist students recall new and already stored Mathematics information.

Modified Lecture Method: This is the teacher dominated plan of teaching by which he talks and solves Mathematics problems on the chalkboard.

CHAPTER TWO

LITERATURE REVIEW

Relevant and related literature had been reviewed on the following main variables of the study:

2.1 Theoretical Framework

2.1.1 Ausubel Cognitive and Meaningful Learning

2.1.2 Schema theory by Bartlett (1932)

2.2 Conceptual Framework

2.2.1 Concept of Mathematics

2.2.2 Development of Mathematics Education

2.2.3 The importance and role of Mathematics

2.2.4 Objectives of Mathematics Education

2.2.5 Mnemonics and Mathematics Instruction

2.2.6 What mnemonics are not

2.2.7 Reasons Why mnemonics work

2.2.8 Methods of Teaching Mnemonic

2.2.9 Strategies for Building Prior-knowledge

2.2.10 Strategies for helping students Activate prior knowledge

2.2.11 Factors influencing the effectiveness of Strategies to activate prior-knowledge

2.3 Empirical Study

2.3.1 Gender and students' learning outcomes in mathematics

2.3.2 Attitudes and Students' learning outcomes in Mathematics

2.3.3 Numerical Ability and Students' Learning Outcomes in Mathematics

2.3.4 Mnemonics and Students' Learning Outcomes

2.3.5 Prior-knowledge and Students' Learning outcomes

2.4 Appraisal of Literature

Theoretical Framework

Theories of learning abound that are applicable to every aspect of human development, educational inclusive. Among these theories, Schema theory by Bartlett (1932) and cognitive and meaningful learning theory by Ausubel (1968) which are very important and relevant to this study.

2.1.1 Ausubel Cognitive Learning and Meaningful Learning Theory

One of the theories that support the use of prior-knowledge-based instructional strategy as a means of enhancing students' academic achievement in Mathematics is cognitive and meaningful learning theory. According to Ausubel, "the most important single factor influencing learning is what the learner already knows" (Novak, 1998,). Relationships between concepts are formed when two concepts overlap on some level. As learning progresses, this network of concepts and relationships becomes increasingly complex. Ausubel compares meaningful learning to rote learning, which refers to when a student simply memorizes information without relating that information to previously learned knowledge. As a result, new information is easily forgotten and not readily applied to problem-solving situations because it was not connected with concepts already learned. However, meaningful learning requires more effort, as the learner must choose to relate new information to relevant knowledge that already exists in the learner's cognitive structure. This requires more effort initially, however after knowledge frameworks are developed, definitions and the meanings for concepts become easier to acquire. Furthermore, concepts learned meaningfully are retained much longer, sometimes for a lifetime.

Three basic requirements for meaningful learning include: a learner's relevant prior knowledge, meaningful material (often selected by the teacher) and learner choice (to use meaningful learning instead of rote learning). An important advantage of meaningful learning is that it can be applied in a wide variety of new problems or contexts. This power of transferability is necessary for creative thinking.

In Ausubel's view, to learn meaningfully, students must relate new knowledge (concepts and propositions) to what they already know. He proposed the notion of an advanced organizer as a way to help students link their ideas with new materials or concepts. Ausubel's theory of learning claims that new concepts to be learned can be incorporated into more inclusive concepts or ideas. These more inclusive concepts or ideas are advance organizers. Advance organizers can be verbal phrases (the paragraph you are about to read is about Albert Einstein), or a graphic. In any case, the advance organizer is designed to provide, what cognitive psychologists call, the "mental scaffolding: to learn new information.

Ausubel views knowledge as representing an integrated system. Ideas are linked together in an orderly fashion. The human mind follows logical rules for organizing information into respective categories. Mind, metaphorically, is like a Chinese puzzle box. All the smaller boxes, ideas and concepts, are tucked away inside of larger boxes. "Cognitive structure," Ausubel (1960) contends, "is hierarchically organized in terms of highly inclusive concepts under which are subsumed less inclusive sub-concepts and informational data". Subsumption is the central idea running through the whole of Ausubel's learning theory. The big boxes in the mental pyramid subsume the small boxes. Subsumers constitute the general categories around which we organize our thinking. Subsumption allows us to absorb new information into our cognitive structures. Teaching and learning, therefore, are largely matters of erecting cognitive structures (scaffolding) to hold new information. By placing information into its proper box, we are better able to retain it for future use. Similarly, forgetting occurs when the smaller boxes (being made of less durable cognitive stuff) fall apart and become incorporated into the larger boxes.

Ausubel (1963) emphasizes the learner's cognitive structure in the acquisition of new information. Present experience is always fitted into what the learner already knows. "Existing cognitive structure, that is an individual's organization, stability, and clarity of knowledge in a particular subject matter field at any given time, is the principal factor influencing the learning and retention of meaningful new material". A cognitive structure that is clear and well organized facilitates the learning and retention of new information. A cognitive structure that is confused and disorderly, on the other hand, inhibits learning and retention learning can be enhanced by strengthening relevant aspects of cognitive structure. Putting the mind in order is one of the principal objectives of all education. Having a clear and well organized cognitive structure, Ausubel (1968) believes, "is also in its own right the most significant independent variable influencing the learner's capacity for acquiring more new knowledge in the same field"

Ausubel's and Robinson's (1969) theory of learning assumes the existence of a Hierarchical structure of knowledge. Fields of inquiry are organized like pyramids, "with the most general ideas forming the apex, and more particular ideas and specific details subsumed under them". The most inclusive ideas--those located at the top of the pyramid--are the dominant and most enduring elements in the hierarchy. They possess a longer life span in memory than do particular facts or specific details, which fall at the base of the pyramid. "Learning occurs as potentially meaningful material enters the cognitive field and interacts with and is appropriately subsumed under a relevant and more inclusive conceptual system" (Ausubel, 1963). Thus new information is organized under higher level concepts already existing in the learner's mind.

Ausubel's (1960) learning theory is built around the concept of subsumption. (In his later writings, he came to prefer the word "assimilation.") When a new idea enters consciousness it is processed and classified under one or more of the inclusive concepts already existing in the learner's cognitive structure. (Little boxes, metaphorically, art into bigger boxes.) "New meaningful material becomes incorporated into cognitive structure in so far as it is subsumable under relevant existing concepts". Subsumers provide a basic structure around which information is organized. They are the intellectual linchpins holding the system together. "Subsumption," Ausubel (1962) inform us, "may be described as facilitation of both learning and retention".

The major concepts (subsumers) in cognitive structure act as anchoring posts for new information. The availability of anchoring ideas facilitates meaningful learning. Antecedent learning usually performs this function. "If this ideational scaffolding is clear, stable, and well organized," Ausubel and Fitzgerald (1962) assert, "it is reasonable to suppose that it provides better anchorage for new learning and retention than if it is unclear, unstable, and poorly organized". The cognitive stability provided by anchoring ideas helps to explain why meaningful learning is retained longer than rote learning. Meaningful learning is anchored; rote learning is not.

No feature of Ausubel's (1963) learning theory has stimulated more discussion or raised greater controversy than his advocacy of advance organizers. Organizers are not to be confused with introductory remarks or brief overviews, which are "typically written at the same level of abstraction, generality, and inclusiveness as the learning material". Organizers are abstract ideas presented in advance of the lesson. They represent a higher level of abstraction, generality, and inclusiveness than the new material. Ausubel (1960) believes organizers can be used to assist learners in assimilating new information. Organizers help to bridge the gap between what is already known and what is to be learned. "The learning and retention of unfamiliar but meaningful verbal material can be facilitated by the advance introduction of relevant subsuming concepts". Organizers are particularly useful when learners do not already possess the relevant concepts needed in order to integrate new information into their cognitive systems.

Ausubel and Fitzgerald (1962) believe good students--those who already possess clear and well organized cognitive structures--profit very little from the use of organizers. This is because their minds are already programmed with anchoring ideas. Slow learners, on the other hand, are the ones who benefit the most from the use of organizers. Such students require additional assistance in learning how to structure their thinking. Ausubel's (1963) research disclosed another interesting aspect of using organizers. Advance organizers are more useful when working with factual material than they are when dealing with abstractions. Organizers "facilitate the learning of factual material more than they do the learning of abstract material, since abstractions in a sense contain their own built-in organizers".

Anderson, Spiro, and Anderson (1978), for example, concede that Ausubel's general theory of subsumers contains much that is valuable for educational practice. They take exception, however, with his research on advance organizers. Referring to Ausubel's work on using organizers to teach reading comprehension, they say, "It is difficult to see why outlining subsequent material in abstract, inclusive terms should help readers". If ready possess relevant subsuming concepts, they will use them in assimilating new material. When readers do not possess such concepts, there is little reason to believe advance organizers can be used to take their place. Anderson et al. conclude by saying, "the theoretical justification for the advance organizer is quite flimsy". Ausubel (1995) believes the attention devoted to advance organizers far outweighs their relative importance in his learning theory. His views on this matter (which were shared with the author in personal correspondence) are reflected in the following quotation: Advance organizers are not the most important aspect of my work in educational psychology. They are merely a specific technique or method of presenting information more effectively, which is based on my more general subsumption or assimilation theory of learning. However, they caught the imagination as a "gimmick" for performing empirical studies of meaningful learning. More dissertations--most of them worthless because the organizers used were not genuine--have been written on organizers than on any other topic in psychology.

Ausubel's (1962) views of retention are linked to his larger theory of subsumption. Subsumers, anchoring ideas, help to facilitate learning and retention. Retention is influenced by three factors: "(a) the availability in cognitive structure of relevant subsuming concepts at an appropriate level of inclusiveness; (b) the stability and clarity of these concepts; and (c) their discriminability from the learning task". Learners who possess well organized cognitive structures tend to retain information effectively. Conversely, learners who have poorly organized cognitive systems tend to forget information rapidly, thus concludes Ausubel (1968), "it is largely by strengthening relevant aspects of cognitive structure that new learning and retention can be facilitated". One way of improving retention is to introduce appropriate subsumers prior to presenting the new lesson.

Just as subsumption explains how information is retained, so it also explains why forgetting occurs. New information is stored when it becomes anchored to a larger subsuming concept. Reciprocally, this same information is forgotten as it becomes progressively absorbed into its cognitive host. Forgetting is complete when the information can no longer be separated from its subsuming concept. Ausubel (1963) refers to this process as "obliterative subsumption." When the "obliterative stage of subsumption begins, the specific items become progressively less dissociable as entities in their own right until they are no longer available and are said to be forgotten". Forgetting is complete, says Ausubel (1968), when the new information is reduced to the least common denominator capable of representing it, namely, to the anchoring idea itself.

Educational Implications

Ausubel's (1962) makes a distinction between rote and meaningful learning, which is important for teaching higher order thinking. Rote learning occurs when the learner memorizes information in an arbitrary fashion. The knowledge or information is stored in an isolated compartment and is not integrated into the person's larger cognitive structure. "Rotely learned materials are discrete and isolated entities which have not been related to established concepts in the learner's cognitive structure". Because rote learning is not anchored to existing concepts, it is more easily forgotten. Meaningful learning, on the other hand, is part and parcel to higher order thinking. Such thinking takes place when we grasp the interrelationship between two or more ideas, old and new. "A first prerequisite for meaningful learning," Ausubel and Robinson (1969) contend, "is that the material presented to the learner be capable of being related in some `sensible' fashion". The new information must be fitted into a larger pattern or whole. "Second, the learner must possess relevant ideas to which the new idea can be related or anchored". The learner must already have appropriate subsuming concepts in his or her cognitive structure. Finally, the learner must actually attempt to relate, in some sensible way, the new ideas to those which he presently possesses. If any of these conditions are missing, the end result will be rote learning.

Verbal reception learning is not necessarily antithetical to higher order thinking, though the method has been characterized as "parrot-like recitation and rote memorization of isolated facts" (Ausubel, 1963). The problem stems from the widespread confusion "between reception and discovery learning, and between rote and meaningful learning". Reception learning is not invariably rote; likewise, discovery learning is not always meaningful. Either one--reception learning or discovery treated. If the learner merely memorizes the material (even if the conclusions have been arrived at by the discovery method), then, says Ausubel (1960), "the learning outcomes must necessarily be rote and meaningless". Reception learning or discovery learning may promote either rote or meaningful consequences. One does not inherently infer the other. Thus discovery learning, just like reception learning, may be either rote or meaningful. The whole question of rote learning versus meaningful learning depends upon whether or not the new information is integrated into the learner's cognitive structure.

The flip side to reception learning is expository teaching. Such teaching offers the educator the most direct route for laying a foundation for higher order thinking. Ausubel (1963) believes most teachers favour this method of instruction. Expository teaching is an efficient and effective way of organizing classroom learning. Even laboratory sciences--which lend themselves to the discovery method--can be taught as well by using the expository method. Though expository teaching has been criticized as being authoritarian, such criticism is unjustified. "There is nothing inherently authoritarian in presenting or explaining ideas to others as long as they are not obliged, either explicitly or implicitly, to accept them on faith". Teachers have an obligation to share their understanding with their students. To cast out the teacher's understanding because it might impose some structure on the students' thinking is an idea too foolish to require refutation. Didactic exposition has always constituted the core of any pedagogic system, and, I suspect, adds Ausubel (1963), always will, because it is the only feasible and efficient method of transmitting large bodies of knowledge.

Most integrated sets of ideas are not learned in a single presentation (Ausubel and Robinson, 1969). Formal education is a slow, incremental process. What is acquired one day provides the basis for what will be learned the next. Practice or drill is necessary in order to master most classroom learning. It is a grave error, Ausubel (1963) cautions us, to assume "all structured practice (drill) is necessarily rote, that unstructured (incidental) practice is maximally effective for school learning tasks". Teachers have been told that drill is an outdated technique. This is not necessarily true. Everything depends upon how drill is used, rotely or meaningfully. Practice is useful for acquiring many skills and concepts that do not occur frequently and repetitively enough in more natural settings. Though children may learn some things from incidental contact, most of what they acquire at school comes from deliberate, guided practice. Even though many educators have shield away from endorsing drill, "classroom teachers and athletic coaches have continued to place implicit reliance on practice as an essential condition of learning".

In conclusion, Ausubel's learning theory is either directly or indirectly complementary to an effective way to teaching higher order thinking skills. Ausubel's learning theory addresses the criteria in two ways: First, Ausubel (1960) believes a learner's present cognitive structure constitutes the principal factor influencing whether or not the learner will be able to acquire and retain particular pieces of information. "New meaningful material becomes incorporated into cognitive structure in so far as it is subsumable under relevant existing concepts". Second, Ausubel (1960) asserts that advanced organizers can be used as anchoring devices for enhancing learning. Organizers are abstract ideas presented in advance of the lesson. They represent a higher level of abstraction, generality, and inclusiveness than the new material that is to be learned. Organizers assist the learner in assimilating new information. "The learning and retention of unfamiliar but meaningful verbal material can be facilitated by the advance introduction of relevant subsuming concepts".

Ausubel and Robinson (1969) contend that knowledge is organized in a hierarchical fashion. "The most general ideas forming the apex, and more particular ideas and specific details subsumed under them". Learning occurs as potentially meaningful material enters the student's mind and interacts with appropriate subsuming concepts. Ausubel (1968) uses the concept of subsumption to explain both retention and forgetting. First, information is more effectively retained when it is fitted into a system of mutually supporting ideas. Learners who have well-organized cognitive systems tend to efficiently retain information. On the other hand, learners who have poorly organized cognitive systems tend to rapidly forget information. "It is largely by strengthening relevant aspects of cognitive structure that new learning and retention can be facilitated". Second, Ausubel (1968) uses the concept of subsumption to explain why forgetting occurs. The more completely information is absorbed into its anchoring concept, the more it tends to lose its own distinctive character. Thus, when information is "reduced to the least common denominator capable of representing it, namely, to the anchoring idea itself," it is said to be forgotten.

Though Ausubel was a psychologist and not a logician, nevertheless, his learning theory represents a very logical approach to instruction. (Unlike Carl Rogers who would set learners free to experience things on their own, Ausubel places prime responsibility on the teacher for directing the course of instruction.) Ausubel's ideas are derived from a handful of basic premises—that thinking is an orderly activity; that knowledge is arranged in a hierarchical pattern; that higher level concepts subsume lower level ones; that learning is largely a matter of fitting new information into an already existing cognitive structure; that retention and forgetting are two different aspects of the same psychological process, subsumption, all of which fit together in a logically consistent system. Teaching follows a deductive order. Instruction can be arranged in a sequence of five logical steps. Step One: The teacher ascertains if the student already possesses relevant concepts in his or her cognitive structure. Step Two: The teacher provides appropriate advance organizers, which are used to anchor the new material within established cognitive structure. Step Three: The teacher present the new material in an organized fashion, checking to make sure the student is subsuming the new information under appropriate organizers. Step Four: The teacher provides sufficient practice (drill) so that the material is thoroughly learned, becoming an integrated part of the student's cognitive system. Step Five: The teacher guides the student through a problem solving situation that utilizes higher order thinking skills. If the teacher is successful in executing all these steps, then he or she will have laid a secure foundation for the student to take the next step on his or her own, namely, implementing the powers of higher order thinking in his or her life.

This theory supports this study especially the use of prior knowledge-based instructional strategy as a way of making teaching and learning of Mathematics meaningful for students. According to this theory, the existing knowledge possessed by the students would ease learning for them and make teaching student-centred. Thus, the academic performance of students would be greatly enhanced.

2.1.2 **Schema Theory of learning**: This theory supports the use of mnemonic-based instructional strategy as a means of improving students' memory. The essence is to ease learning and enhance recall of basic mathematical facts necessary to improve students' academic achievement. The original concept of schemata is linked with that of reconstructive memory as proposed and demonstrated in a series of experiments (Bartlett 1932). He arrived at the concept from studies of memory he conducted in which subjects recalled details of stories that were not actually there. He suggested that memory takes the form of schema which provide a mental framework for understanding and remembering information. Schema theory describes how knowledge is acquired, processed and organized. The starting assumption of this theory is that "*every act of* comprehension *involves one's knowledge of the world*" (Anderson, Reynolds, Scallet and Goetz, 1977). By presenting participants with information that was unfamiliar to their cultural backgrounds and expectations and then monitoring how they recalled these different items of information, Bartlett was able to establish that individuals' existing schemata and stereotypes influence not only how they interpret "schema-foreign" new information but also how they recall the information over time. One of his most famous investigations involved asking participants to read a Native American folk tale, "The War of the Ghosts", and recall it several times up to a year later. All the participants transformed the details of the story in such a way that it reflected their cultural norms and expectations, i.e. in line with their schemata. The factors that influenced their recall were:

1. Omission of information that was considered irrelevant to a participant;
2. Transformation of some of the details, or of the order in which events, etc., were recalled; a shift of focus and emphasis in terms of what was considered the most important aspects of the tale;
3. Rationalization: details and aspects of the tale that would not make sense would be "padded out" and explained in an attempt to render them comprehensible to the individual in question;
4. Cultural shifts: the content and the style of the story were altered in order to appear more coherent and appropriate in terms of the cultural background of the participant.

Bartlett's work was crucially important in demonstrating that long-term memories are neither fixed nor immutable but are constantly being adjusted as our schemata evolve with experience. In a sense it supports the existentialist view that we construct our past and present in a constant process of narrative/discursive adjustment, and that much of what we "remember" is actually confabulated (adjusted and rationalized) narrative that allows us to think of our past as a continuous and coherent string of events, even though it is probable that large sections of our memory (both episodic and semantic) are irretrievable to our conscious memory at any given time (Barlett, 1932).

According to this theory, knowledge is a network of mental frames or cognitive constructs called *schema* (pl. *schemata*). Schemata organize knowledge stored in the long-term memory. Schema theory emphasizes importance of general knowledge and concepts that will help forming schemata. In educational process the task of teachers would be to help learners to develop new schemata and establish connections between them. Also, due to the importance of prior knowledge, teachers should make sure that students have it. "*The schemata a person already possesses are a principal determiner of what will be learned from a new text.*"The term schema is nowadays often used even outside cognitive psychology and refers to a mental framework humans use to represent and organize remembered information. According to Anderson, Rand and Anderson (1978) Schemata ("*the building blocks of cognition*") present our personal simplified view over reality derived from our experience and prior knowledge, they enable us to recall, modify our behavior, concentrate attention on key information, or try to predict most likely outcomes of events**.** According to Rumelhart (1980),

> *schemata can represent knowledge at all levels - from ideologies and cultural truths to knowledge about the meaning of a particular word, to knowledge about what patterns of excitations are associated with what letters of the alphabet. We have schemata to represent all levels of our experience, at all levels of abstraction. Finally, our schemata are our knowledge. All of our generic knowledge is embedded in schemata. (p.8)*

Schemata also expand and change in time, due to acquisition of new information, but deeply installed schemata are inert and slow in changing. This could provide an explanation to why some people live with incorrect or inconsistent beliefs rather than changing them. When new information is retrieved, if possible, it will be assimilated into existing schemata or related schemata will be changed (*accommodated*) in order to integrate the new information. For example: during schooling process a child learns about mammals and develops corresponding schema. When a child hears that a porpoise is a mammal as well, it first tries to fit it into the mammal's schema: it's warm-blooded, air-breathing, is born with hair and gives live birth. Yet it lives in water unlike most mammals and so the mammal's schema has to be accommodated to fit in the new information.

Schema theory was partly influenced by unsuccessful attempts in the area of artificial intelligence. Teaching a computer to read natural text or display other human-like behavior was rather unsuccessful since it has shown that it is impossible without quite an amount of information that was not directly included, but was inherently present in humans. Research has shown that this inherent information stored in form of schemata, for example:

1. *content schema* - prior knowledge about the topic of the text
2. *formal schema* - awareness of the structure of the text, and
3. *language schema* - knowledge of the vocabulary and relationships of the words in text

can cause easier or more difficult text comprehension (Al-Issa, 2006), depending on how developed the mentioned schemata are, and whether they are successfully activated (Carrel. 1988). According to Brown (2001), when reading a text, it alone does not carry the meaning a reader attributes to it. The meaning is formed by the information and cultural and emotional context the reader brings through his schemata more than by the text itself. Text comprehension and retention therefore depend mostly on the schemata the reader possesses, among which the content schema should be one of most important, as suggested by Al-Issa (2006).

An important step in the development of schema theory was taken by the work of Rumelhart (1980) describing our understanding of narrative and stories. Further work on the concept of schemata was conducted by Brewer and Treyens (1981) who demonstrated that the schema-driven expectation of the presence of an object was sometimes sufficient to trigger its erroneous recollection. An experiment was conducted where participants were requested to wait in a room identified as an academic's study and were later asked about the room's contents. A number of the participants recalled having seen books in the study whereas none were present. Brewer et al (1981) concluded that the participants' expectations that books are present in academics' studies were enough to prevent their accurate recollection of the scenes.

Also Minsky (1975) developed machines that would have human-like abilities. When he was trying to create solutions for some of the difficulties he encountered he came across Bartlett's work and decided that if he was ever going to get machines to act like humans he needed them to use their stored knowledge to carry out processes. To compensate for that he created what was known as the frame construct, which was a way to represent knowledge in machines. His frame construct can be seen as an extension and elaboration of the schema construct. He created the frame knowledge concept as a way to interact with new information. He proposed that fixed and broad information would be represented as the frame, but it would also be composed of slots that would accept a range of values; but if the world didn't have a value for a slot, then it would be filled by a default value (Schmidt, 1975). Because of Minsky's work, computers now have a stronger impact on psychology. Rumelhart (1980) extends Minsky's ideas, creating an explicitly psychological theory of the mental representation of complex knowledge (Wulf, 1991). Roger Schank and Robert Abelson were the ones to come up with the idea of a script, which was known as a generic knowledge of sequences of actions. This led to many new empirical studies, which found that providing relevant schema can help improve comprehension and recall on passages.

Mandler (1984) and Rumelhart (1980) have further developed the schema concept. Schema has received significant empirical support from studies in psycholinguistics. For example, the experiments of Bransford & Franks (1971) involved showing people pictures and asking them questions about what the story depicted; people would remember different details depending upon the nature of the picture. Schemata are also considered to be important components of cultural differences in cognition (e.g., Quinn & Holland, 1987). Research on novice versus expert performance (Chi, Glaser and Farr, 1988) suggests that the nature of expertise is largely due to -solving the possession of schemas that guide perception and problem.

Schema Influences Memory

Since schemata are essentially the organization of one's knowledge, memory plays a vital role in the schema theory. Humans learn many concepts each day, some which are revisited regularly and some of which are stored in the back of the mind for later use. Since all previous knowledge is not used on a day to day basis some of the information that is learned is also forgotten. For this purpose, think of forgotten information as memory loss (the information still exists, but you have to find it). Though adequate prior knowledge may exist, the memory may need to be stirred in order for it to resurface. Studies have shown that subjects who are prompted by examiners to activate relevant schemata often perform higher on comprehension activities than subjects who are required to activate their own relevant schemata (Carr & Thompson, 1996). As an educator we must be aware of this fact and be sensitive to the likely hood that even if a child has adequate prior knowledge in a subject area they may need assistance recalling information that they already know in order to apply it to new information as it is learned. Anderson attempted to answer the question of how a person's schema influences memory. He came up with three different possible answers. The first one he labelled the retrieval-plan hypothesis which involves a "top-down" search of schema in the memory. The reader is activating general schema related to the information in the text and connecting the schema to the concepts presented. The second hypothesis Anderson et-al (1978) described is the output-editing hypothesis. This involves the reader selecting or rejecting information presented based on their own schema already created in their memory. The third hypothesis Anderson created was the reconstruction hypothesis. "According to this hypothesis, the person generates inferences about what must have been in the passage based on his schema and aspects of the passage that can be recalled".

Schema theory emphasizes importance of general knowledge and concepts that will help forming schemata. In educational process the task of teachers would be to help learners to develop new schemata and establish connections between them. Also, due to the importance of prior knowledge, teachers should make sure that students have it as ”*The schemata a person already possesses are a principal determiner of what will be learned from a new text.*” (Anderson, et-al, 1978)

Schema theory has been applied in various areas like:

1. **motor learning** - schema theory was extended to *schema theory of discrete motor learning* (Schmidt,1975). Wulf (1991) has shown that developing a motor schema has resulted in better performance in children when learning a motor task.
2. **reading comprehension** - schema theory is often used to assist second language learning since it often contains reading a lot of texts in the target language. Failure to activate adequate schema when reading a text has shown to result in bad comprehension (Bransford and Marieta, 1973). Various methods have been proposed for dealing with this issue including giving students texts in their first language on certain topic about which they will later read in target language.

3. **mathematical problem solving,**. Jitemdra, et al conducted a research showing that 3rd-graders taught to using schemata to solve mathematical problems formulated in words performed better than their peers who were taught to solve them in four steps (read and understand/plan to solve/solve/look back and check*)*.

Key features of schema theory

Here are some basic principles of schema theory:

1. Schemata are abstract mental structures.
2. People build on these structures to understand the world.
3. People use schemata to organize current knowledge and provide a framework for future understanding.
4. Because they are an effective tool for understanding the world, the use of schemata makes the automatic processing an effortless task
5. People can quickly organize new perceptions into schemata and act effectively without effort.
6. When learners build schemata and make connections between ideas, learning is maximally facilitated and is optimally made more meaningful.
7. Prior knowledge is important and is a prerequisite for the understanding of new information.
8. Internal conflict may arise when new information doesn't fit with existing schemata.
9. People's schemata have a tendency to remain unchanged, even in the face of contradictory information. In other words, it is difficult to change existing schemata. People tend to live with inconsistencies rather than change a deeply rooted mental structure

The 4 Key Elements of a Schema

The key elements of a Schema are:

1. An individual can memorize and use a schema without even realizing of doing so.
2. Once a schema is developed, it tends to be stable over a long period of time.
3. Human mind uses schemata to organize, retrieve, and encode chunks of important information.
4. Schemata are accumulated over time and through different experiences

There are advantages and disadvantages to having schema affect our lives; some of the advantages about having schema in our cognitive development is that we now contain some information about how other people behave and think too. We now know the appropriate way to respond to certain situations because we formed a schema about what the procedure is. We have a reference for behavior in certain situations based on our event schema. Also it helps us explain why certain people have behaviors that are social due to our role schema.

With advantages come disadvantages; when we form schema it may restrict and distort the way we view things or remember things about information and at times may make us overlook some things we should have paid attention to. Schema is hard to change because we are attracted to information that supports our schema rather than disproves it and is inconsistent. This may pose a problem for people because it is hard to change someone's mind about an idea they have already based a large schema about.

This theory is appropriate for this study as it is based on developing the students' memory to enhance their academic performance. One of the strategies that could be adopted to improve students' memory is the use of mnemonic. This is expected to enhance students' memory which would eventually improve their learning outcomes in Mathematics.

2.2. Conceptual Framework

2.2.1 Concept of Mathematics

Mathematics has been described variously by people of diverse fields and interests. According to Oxford Advanced Leaner's Dictionary, Mathematics is seen as a science of size and numbers of which arithmetic, algebra, trigonometry and geometry are branches. Aghadinno (1995) saw Mathematics as the study of quantities and relations through the use of numbers and symbols. It is fundamental to science, technology and even society in general. Lisa (2007) described Mathematics as a sequential, logical activity. The student must be able to access the left hemisphere of the brain in order to accurately perform mathematics computation and problems. The right brain dominant statement is at a severe disadvantage as far as mathematics goes, but there are brain exercises that will show the student how to access the left hemisphere of the brain. Mathematics is also referred to as a developmental process. When a student is ready to understand a mathematical concept, it is easy. It clicks. But when a student is not ready to understand a concept, it really does not matter what you do to try to help the student. He is simply not yet ready for the concept.

Amoo and Rahman (2004) looked at Mathematics in several ways. They looked at it as a language, as a particular kind of logical structure, as a body of knowledge about number and space, as a series of methods for deriving conclusions, as the essence of our knowledge of the physical world, or merely as an amusing intellectual activity. Also, Akinsola (2005) regarded Mathematics as a language. He said Mathematics is a specialized language that we use to identify, describe and investigate the patterns and challenges of everyday living. It is a language that helps us to understand past events, and to predict and prepare for future events so that we can fully understand our world and more successfully live in it. In the same vein, Usman (1995) defined Mathematics as a language which provides an indispensable means of investigating the nature of the things particularly those which is dealt with in the fields of science, technology, engineering and industry. Thus, every field of science and technology has mathematical content though of different degrees. Therefore, there can be no real technological development without a corresponding development in Mathematics (Ezekoli, 1999).

Amoo (2002) described Mathematics as a service subject that is supposed to be taught under free atmosphere devoid of stress. In school setting, Mathematics as a subject is to develop the students to acquire some skills. It is the responsibility of the teacher to help students reduce the phobia associated with learning of mathematics through student's centred approaches. According Kline (1980) Mathematics is seen as a creative or innovative process deriving ideas and suggestions from real problems. Idealizing and formulating the relevant concepts, posing questions, intuitively deriving a possible conclusion. Hence, Mathematics is a process of organising data which through symbolisation and formulation of new concepts, stocks of information are brought into the grasp of the mind. Aminu (2005) sees Mathematics as a discipline, way of thinking and organising logical proof. It can be used to determine whether or not an assumption is true or at least probably true. Mathematics is used to solve all kinds of problems in sciences, technology and industry. As a way of reasoning, it gives insight into the power of human kind and becomes a challenge to intellectual curiosity.

Adeniran (2008) defines Mathematics as the study of numbers, quantity, shapes, physical system and relationship. It is not just about numbers only but also about general objects. Lassan and Paling (1988) saw mathematics as a creation of human mind, concerned primarily with ideas, processes and reasoning. Thus, Mathematics is much more than arithmetic, the science of number and computation, more than the algebra, the language of symbol and relations, more than numerical trigonometry, which ,measures distances and analyses oscillation. It is more that statistics, the science of interpreting data, and more than calculus the study of change, infinity and limits. However, Mathematics is all encompassing as it deals with all human endeavours. Holland (1980) defined Mathematics as a process of reasoning based solely on instruction and construction. It enables man to add to his knowledge and understanding of his environment. Mathematics was also seen as an investigation of axiomatically defined abstract structure using symbolic logic and mathematical notation. It is commonly defined as the pattern of change, space and structure. More formally, it can be considered as study of figures and numbers; but, since it is not empirical it is not a science. However, Mathematics is the engine room of science and technology and the anchor upon which science and technology revolve.

2.2.2 Development of Mathematics Education

Education is the process of learning the skills that can give one benefit and unique characteristics. Education cannot be limited to the study of science and arts only but in fact it is the process of learning the various set of behaviours, the various set of skills and the various aspects of life. According to English Dictionary, education is seen as the process of nourishing or rearing a child or young person, or animal. It is the profession of teaching, especially at a school or college or university. Also, it is the process of educating or instructing or teaching activities that impart knowledge or skills. Jeffs and Smith (2002), education is future oriented – it is about development and growth even when we are studying the past. It takes us into the conscious world, and involves activities that are intended to simulate thinking, to foster learning. However, Mathematics education is the practice of teaching and learning, as well as the field of scholarly research. Researchers in Mathematics education are primarily concerned with the tools, methods and approaches that facilitate practice. Mathematics education known as didactic of Mathematics has developed into a full fledge field of study all over the world. (Ma, 2000). In most ancient civilisations, including ancient Greece, the Roman Empire, Vedic society and ancient Egypt, elementary Mathematics was part of the education system. This shows how important Mathematics education was from earliest time. The first Mathematics textbooks to be written in English and French were published by Robert Recorde beginning with The Grounde of Artes in 1540.

In the Renaissance the academic status of Mathematics declined, because it was strongly associated with trade and commerce. Although it continued to be taught in European University, it was seen as subservient to the study of Natural, Metaphysical and Moral Philosophy. This trend was somewhat reversed in the seventeen century, with the University of Aberdeen creating a Mathematics Chair in 1613, followed by the Chair in Geometry being set up in University of Oxford in 1619 and the Lucasian Chair of Mathematics being established by the University of Cambridge in 1662. However, it was uncommon for mathematics to be taught outside of the universities. In the eighteen and nineteen centuries the industrial revolution led to an enormous increase in urban populations. Basic numeracy skills, such as the ability to tell the time, count money and carry out simple arithmetic, became essential in this new urban lifestyle. Within the new public education systems, mathematics became a central part of the curriculum from an early age.

By the twentieth century Mathematics was part of the core curriculum in all developed economies. Also, Mathematics education was established as an independent field of research. Here are some of the main events in this development:

1 In 1893 a Chair in mathematics education was created at the University of Gottingen, under the administration of Felix Klein.
2 The International Commission on Mathematics Instruction (ICMI) was founded in 1908, and Felix Klein became the first president of the organisation.
3 A new interest in mathematics education emerged in the 1960s, and the commission was revitalised.
4 In 1968, the Shell Centre for Mathematical Education was established in Nottingham.
5 The first International Congress on Mathematical Education (ICME) was held in Lyon in 1969. The second congress was in Exeter in 1972, and after that it has been held every four year.

In the twentieth century, the cultural impact of the "electric age" was also taken up by educational theory and the teaching of Mathematics. While the previous approach focused on "working with specialized 'problem' in arithmetic", the emerging structural approach to knowledge had small children meditating about number theory and 'sets',.

Ma (2000) at different times and in different cultures and countries, Mathematics education has attempted to achieve a variety of different objectives. These objectives have included:

1 The teaching of basic numeracy skills to pupils

2 The teaching of practical mathematics (arithmetic, elementary algebra, plane and solid geometry trigonometry) to most pupils, to equip them to follow a trade or craft.

3 The teaching of abstract mathematical concepts (such as set and function) at an early age.

4 The teaching of selected areas of Mathematics (such as Euclidean geometry) as an example of an axiomatic system and a model of deductive reasoning.

5 The teaching of selected areas of Mathematics (such as calculus) as an example of the intellectual achievements of the modern world.

6 The teaching of advanced Mathematics to those pupils who wish to follow a career in Science, Technology, Engineering, and Mathematics (STEM) fields.

7 The teaching of heuristics and other problem-solving strategies to solve non-routine problems.

Throughout most of history, standards for Mathematics education were set locally, by individual schools or teachers, depending on the levels of achievement that were relevant to, realistic for, and considered socially appropriate for their pupils. In modern times there has been a move towards regional or national standards, usually under the umbrella of a wider standard school curriculum. In England, for example, standards for Mathematics education are set as part of the National Curriculum for England, while Scotland maintains its own educational system. In Nigeria also, standards are set by the Federal Government through its agencies such as the Nigeria Educational Research and Development Council (NERDC) and National Mathematical Centre in collaboration with the State Ministries of Education.

Mathematics education has passed through several stages. Its developmental stages cannot be divorced from series of education reforms that have characterised our educational system pre and post independence era. During the pre-independence era, the Mathematics taught at the primary and post-primary schools was traditional Mathematics. The traditional Mathematics consists mainly of arithmetic, algebra, geometry, trigonometry, calculus and coordinate geometry. As a result of change in school curriculum (including Mathematics) across the world there was innovation between 1962 and 1965 into primary and secondary school curricula in Nigeria (Badmus, 1997). Modern Mathematics programmes were introduced into some classes of primary and secondary schools vis-a-viz the traditional mathematics courses. Topics under modern Mathematics include statistics, probability, logic, motion geometry, sets, vectors, matrices. Modern Mathematics used the idea and language of sets at an early state with the intention of classifying some concepts in Mathematics which are useful in many professions. Also, modern mathematics emphasised understanding and meaning rather than manipulative skills by utilizing up-to-date researches on the psychology of human learning.

The teaching of traditional Mathematics and modern Mathematics concurrently brought about the problem of choice among schools, teachers, students, parents, governments and the consumers of the products of schools, and the general public. Also, there was low performance of students in modern Mathematics and even the traditional Mathematics which was taught along with it in some schools. For instance, the failure rate in modern Mathematics rose from 48% in 1970 to 80% in 1976 (Badmus, 2002). There were open and incisive criticisms against modern Mathematics. Some renowned mathematicians like Professor Chike Obi described modern Mathematics as a repressive campaign mounted by the imperialist against African scientific and technological development.

As a result of series of debates on the pages of newspapers, on the merits of modern Mathematics vis-a-viz traditional Mathematics, the Federal Ministry of Education organised a national conference on the teaching of Mathematics in Nigeria, on 6th and 7th of January, 1977, in Benin City. The outcome of this meeting brought about the abolishment of the modern Mathematics and introduction of the general Mathematics to Nigeria schools (Badmus, 2002). However, in the early 1990s there was slight change in the Secondary school Mathematics curriculum with the introduction of some aspects of modern Mathematics like sets, arithmetic and geometric progressions and statistics into the school curriculum. According to Skamp in Obodo (1997), the main difference between the modern and traditional Mathematics was not in the content but in the method of teaching. It is believed that the abolishment of modern Mathematics retarded the technological growth of Nigeria. The general Mathematics has been taught in Nigeria schools from 1978 to 2006 when the Universal Basic Education (UBE) curriculum was introduced. The UBE curriculum was introduced to improve the weakness of the general Mathematics curriculum for the benefit of the Nation.

In Nigeria Mathematics education has come a long way. In traditional society before the advent of formal education, Mathematics was used mainly in taking stock of daily farming and trading activities (Augele and Usman, 2007). Most traditional societies have their number systems which were either base five or twenty. However, with the coming of the missionaries which introduced formal education to Nigeria, Mathematics education still occupied its central position. Since then Mathematics education has gone through several developments. From the era of formal Arithmetic, Algebra, Geometry and the likes through the period of traditional and modern Mathematics controversy to the present day general Mathematics. These changes have always been necessitated by the realization of the role and importance of Mathematics education in nation's scientific and technological development as well as responses to societal needs and demands (Aguele, 2004).

2.2.3 The Role and Importance of Mathematics

Mathematics is the study of quantities and relations through the use of numbers (Aghadinno, 1995). The importance attached to the subject in the school curricula is borne out of the role of Mathematics in scientific and technological development, a sine-quanon in nation building. Since Mathematics permeates the entire society, it is becoming necessary for everyone to have mathematical skills to functions intelligently and effectively in today's ever changing world. Amazigo (2000) said that a nation that neither develops a scientifically literate citizenry is doomed to remain underdeveloped no matter its natural resources. In this wise, he further reiterated that no nation can make any meaningful progress in this information technology age, particularly in economic development without technology whose foundation are science and mathematics.

Mathematics and its relationship to various disciplines have been seen from different areas of human endeavours. For instance, the importance of Mathematics in the school curriculum can be viewed from the relationship which it has with technology, science commerce, economics, politics, and even arts. For example, the relationship between Mathematics and arts has long been emphasised and recognized by the National Council of Teachers of Mathematics (Ilori, 2003). The council has stated that in the arts, such Mathematics concepts of symmetry, sequence and proportion provide a convenient construct. Furthermore, (Odogwu, 2002, Amoo, 2002) there is no other subject that has greater application than Mathematics. It is the wheel on which other subjects move. It is considered as the prime instrument for understanding and for exploring our scientific, economic and social world. Today, more than ever before, all fields of knowledge are dependent on Mathematics for solving problems, stating theories and predicting outcomes. (Amoo et al 2003) The subject Mathematics has many facets. One can look at it as a language, as a particular kind of logical structure, as a body of knowledge about numbers and space, as a series of methods for deriving conclusions, as the essence of our knowledge of the physical world, or merely as an amusing intellectual activity.

Aghadiuno (1995) opined that Mathematics has been exceedingly successful, especially when applied to science. Mathematics has some unique characteristics which science share to some degree. This is why Bishop et al (1993) said that "schools and individual learners exist within societies are in the concern to ensure the maxima effectiveness of school Mathematics teacher; we often ignore the educational influence of other aspect of living within a particular society". Therefore, Mathematics education should ensure that their Mathematics teaching is relevant to the particular society in which they found themselves.

The knowledge of Mathematics is very fundamental to effective implementation of various aspects of the UBE programme. The guidelines for the implementation show that more than 80% characteristics of Mathematics education is very essential especially in the areas of data collection, planning, monitoring and evaluation of the UBE programme and funding and management of the entire process.

The place of Mathematics in the implementation process is essential. This fact was supported by Adamu and Jiya (2006) who stated that mathematics methods and thinking are not prerogatives of scientists, engineers, and technologists only; they are used by people in making decisions. Also, contributing to the relevance of Mathematics to the UBE objective, Adeniran (2006) states that:

"In a nutshell, a thorough knowledge of Mathematics will help Nigeria to:

1. Produce citizens that can manufacture raw materials, machine and tools needed for our industries.
2. Produce enough food for local and international markets through mechanised agriculture by having good mathematics ability to make weather forecast and other agricultural calculations.
3. Invent new design; discover drugs capable of curing diseases as a pharmacy, which make use of the knowledge of chemistry and biology. All these will eventually transform the nation from a consuming one to a productive self-sufficient and self-reliant nation

Adeniran (2006) also stated that looking at the subject included in the UBE programme, knowledge of basic mathematics is inevitable. He stated further that looking at the objectives of UBE and that of Mathematics education at the secondary level; it will be observed that they are interwoven. One cannot be achieved without the help of the other.

Recognising the importance of Mathematics as an important tool for social change, Ezekwesili (the then Minister of Education) declared that in line with the government's declaration for a 9-year basic education programme, the Nigeria Educational Research and Development Council (NERDC) was directed by the National Council on Education (NCE) to restructure and re-design the primary and junior secondary schools (6 -3) Mathematics curricula to meet the targets of the National Economic Empowerment and Development Strategies (NEEDS) and the Millennium Development Goals (MDGs) by the year 2015. With the advent of the 9-year basic education, the scope of Mathematics contents of the 6-3 of the 6-3-3-4 educational system has been enlarged to take cognizance of the basic needs of all the people within the Nigerian society. The product of this enlargement is now what constitutes the 9-year basic education Mathematics curriculum. It takes care of the basic needs of nomadic, fishermen, market men and women and the needs of the school dropouts. Thus, the 9-year basic education Mathematics content is of wider scope. This reform in Mathematics curriculum content is to actualize the numerical goals. Based on this, the Federal Ministry of Education (FME, 2007) explained that the 9-year basic education Mathematics curriculum represents the total experiences to which learners must be exposed and as such, the contents, performance objectives, activities for both the teachers and learners and evaluation guides are all provided.

The Federal Ministry of Education (FME, 2007) explained that the Revised National Mathematics Curriculum for the 9-year basic education in Nigeria is focused on giving the child an opportunity to:

1 Acquire Mathematics literacy necessary to function in an organization
2 Cultivate the understanding and application of Mathematics skills and concepts necessary to thrive in the ever changing technological world.
3 Develop the essential element of problem solving, communication, reasoning and connection within their study of Mathematics.
4 Understand the major ideas of Mathematics, bearing in mind that the world has changed and is still changing since the first National Mathematics Curriculum Conference held in 1977. There is the need therefore to incorporate such changes in the areas of information

and communication technology (ICT), Population and Family Life Education, Environmental degradation, Drug Abuse, and HIV and AIDS.

2.2.4 Objectives of Mathematics Education

The National objectives of primary and secondary education as it relates to Mathematics education include:

1. To lay a solid foundation for the concepts of numeracy and scientific thinking
2. To give the child opportunities for developing manipulative skills that will enable him to function effectively in the society within the limit of his capacity
3. To provide the basic tools for further advancement as well as prepare students for trades and craft within the localities.
4. To build on the foundation of primary level so that the child can make a useful living professionally, economically, politically and socially.
5. To create interest in mathematics and to provide a solid foundation for everyday life.
6. To develop computation skills and ability to recognize problem and to solve them with related mathematical knowledge.

2.2.5 Mnemonics and Mathematics Instruction

According to the Oxford English Dictionary (2002), the word “mnemonic” (pronounced ne-MON-ik) was first used as part of the English language in 1662. The word has Greek roots – mnemonikos means “mindful”. In Greek, the word is in turn connected to Mnemosyne, the Greek god of memory, sleep, and dreams.

Access Center (2006) sees mnemonic instruction is a set of strategies designed to help students improve their memory of new information. It links new information to prior knowledge through the use of visual and acoustic cues. Atkinson and Raugh (1975) see mnemonic as a memory aid. Mnemonics are often verbal, something such as a very short poem or a special word used to help a person remember something. They are often used to remember lists. Mnemonics rely not only on repetition to remember facts, but also on associations between easy-to-remember constructs and lists of data, based on the principle that the human mind much more easily remembers data attached to spatial, personal or otherwise meaningful information than that occurring in meaningless sequences. The sequences must make sense though. If a random mnemonic is made up, it is not necessarily a memory aid. In the same vein, Gagnon and Maccini (2001) defined mnemonic as a memory and technique that associates what to be remembered with some diagrams, acronyms, rhymes etc., to easily recall the fact. It is the way of associating what you have to memorize with some words or things.

Also, Babara (2005) defines mnemonic technique is a memorizing technique which is very useful to students during their learning process. It is a proven technique that helps students recall information and memory. Memory refers to the brain processes to acquire, store, retains and later retrieve information. Goldenberg (2004) sees mnemonics as just that tool for remembering. There is information we want to remember and have trouble with; mnemonics are a great way to organize all kinds of things into a format that goes into memory in an organized, recoverable way. Also, Grace Flemming (2005) sees mnemonic device as a little phrase or rhyme used as a memory tool.

Higbee (1987) sees mnemonic in two ways: process and facts mnemonics. Facts mnemonics are the more commonly known form, and used to remember facts, typically, one mnemonic association is constructed for each item to be remembered. A considerable number of reports have been published about the use of facts mnemonic techniques to teach students with learning disability. Studies have employed the peg-word method, the keyword method and various other mnemonic techniques to help students with learning disability learn various assortments of facts. They have shown mnemonics to be very effective in facilitating learning (Mastropieri, Scruggs and Levin, 1987; Mastropieri, Scruggs and Folk 1990; Scruggs, Mastropieri, McLone, Levin and Morrison, 1987). According to Higbee (1987), process mnemonics are not entirely uncommon. Some are used on a daily basis by many people to remember rules and procedures in spelling, mathematics and science. In Japan, one type of process mnemonics, yodai, was used successfully for many years to teach students anything from how to solve quadratic equations to how to speak the English Language (Higbee, 1987).

2.2.6 What Mnemonic Strategies are Not

It is necessary at this point to mention briefly what mnemonic strategies are not. In the first instance, mnemonic strategies do not represent a “philosophy” of education. We do not use, or recommend the use of mnemonic strategies because they are compatible with someone’s particular philosophy or because they are a part of someone’s theory about what education should be. Mnemonic strategies are recommended for only one reason: Over and over again, they have been proven to be extremely effective in helping people remember things (Bulgren, Schumaker, and Deshler, 1994; Mastropieri and Scruggs, 1998).

It is also true that mnemonic strategies are not an overall teaching method or curricular approach. The focus of mnemonic strategies is so specific that they are intended to be used to enhance the recall of the components of any lesson for which memory is needed. It has been found that mnemonic strategies can be used to enhance science learning when the curriculum involves a textbook or lecture format (Scruggs and Mastropieri, 1992) or when the curriculum involves a hands-on, inquiry learning format (Mastropieri, Scruggs and Chung, 1997). Even though these approaches to science learning are very different (Mastropieri and Scruggs, 1994), mnemonic strategies can still be incorporated for the elements that require recall.

It is also important to consider that mnemonic strategies are memory strategies, and not comprehension strategies. Students who are trained mnemonically also perform better on comprehension tests of that content (Mastropieri, Scruggs and Fulk, 1990; Scruggs, Mastropieri, McLoone, Levin, and Morrison, 1987), but that is generally because they remember more information that can be applied on comprehension tests. Nevertheless, when comprehension enhancement is called for, it is important to consider using specific comprehension strategies, such as content elaboration, prior knowledge activation, manipulation, coaching and questioning, or prediction and verification (Mastropieri and Scruggs, 1997; Scruggs, Mastropieri, Sullivan and Hesser, 1993). Also, mnemonic strategies do not inhibit comprehension, and more importantly, there are many instances in school of students who have achieved adequate comprehension of a concept, but who have forgotten the facts associated with it.

Finally, it should be emphasized that mnemonic strategies do not represent an educational panacea. There are many things that students must do to succeed in school, and remembering content information is only one part of the entire picture. However, when there is academic content to be remembered, mnemonic strategies may be an important instructional component.

2.2.7 Reasons Why Mnemonics Work

Relatively, little is known about how mnemonics work. In his classic work on the subject, Paivio (1971) lists the following classical assumptions about the psychological foundations for mnemonics:

1) Perception and thought are continuous. Things that we experience as “real” (e.g. objects, places, and other people) have attributes (size, colour, etc) that are assumed to carry over to our memory of those things.

2) Memory is like a wax tablet. Each of the mental rooms can have images or facts stored in it much as one would write letters on a wax tablet. By implication, the images or facts stay there until they are deliberately erased or over written.
3) Sight is the strongest of all the senses. The most durable impressions placed on our minds are those placed by the sense of sight. As a result, information perceived through other senses is best retained if it is converted into visual images.
4) Words can be converted into symbols and vice versa. Using various sophisticated systems, even a long speech can be converted into a series of images. This can be stored using a location mnemonic and then be converted into words without loss.

Paivio (1971) then says that these assumptions about memory and the senses suggest several reasons why mnemonics may work:

1 Mnemonics organize information. Regardless of the specific of the system used, mnemonics force the user into chunking and ordering information somehow.

2 Mnemonics make use of power of association. Information that has been organized as described above may or may not have its own internally logical system of organization, but the user of mnemonics can also rely on the associations that we tend to make, for example, between places and the people we have met there, things we have done there, and thoughts we have had there.

3 Mnemonics require rehearsal. Inserting information into a complex mnemonic system requires that the user do a certain amount of rote learning, processing and reprocessing the information to make it fit into the system and refresh the images used.

4 Mnemonics provides retrieval cues. The order of a set of rooms can be matched to the order of set of fact, for example, Middleton (1887) suggested that rhetorical terms such as "in the first place" have their basis in location mnemonics from antiquity.

5 Mnemonics prevent interference between pieces of information. By storing piece in or on distinct room, mnemonics prevent confusion between similar words or concepts.

6 Mnemonics make use of novelty or distinctiveness. Though mnemonic system do not inherently require users to create bizarre or unusual mental images, we tend to recall that which is extraordinary more easily than that which is ordinary, and most writers on the subject of mnemonics have placed emphasis on the need for images that are active, exceptionally beautiful or ugly, disfigured or comical.

Mayer (2002) added the idea of dual coding. Regardless of the degree to which a mnemonic user connects or fails to connect verbal information to a system of imagery, the use of two distinct coding of the same material makes it more likely that the information will be recalled somehow. In addition, Higbee (1987) said process mnemonics works can be of the following:

1 They utilize the five principles of learning and memory: meaningfulness, organization, association, attention and visualisation.
2 They use metaphors that children are interested in. Children are more likely to attend to the relevant procedural steps being taught (Higbee, 1987). To have strategies for capturing attention is very important, especially for students with disabilities.
3 He also pointed out that process mnemonics often foster visualisation even if they are largely verbal in nature.

2.2.8 Methods of Teaching Mnemonics

There are at least three distinct methods for teaching mnemonics: keyword, peg-word, and letter strategies. These methods are briefly described below.

Keyword Strategy

The keyword strategy is based on linking new information to keywords that are already encoded to memory. A teacher might teach a new vocabulary word by first identifying a keyword that sounds similar to the word being taught and easily represented by a picture or drawing. Then the teacher generates a picture that connects the word to be learned with its definition. According to Uberti, Scruggs & Mastropieri (2003), the keyword strategy works best when the information to be learned is new to students.

Example

To teach students the definition of the new word, the teacher will ask the students to remember the keyword, envision the picture and how it relates to the definition, and finally recall the definition. If a teacher is trying to teach her students the definition of the old English word *carline*, she will first identify a good keyword. In this instance, "car" is appropriate because it is easy to represent visually and it sounds like the first part of the vocabulary word. *Carline* means "witch" so the teacher shows the students a picture of a car with a witch sitting in it. When asked to recall the definition of *carline*, students engage in a four-step process:

1. Think back to the keyword (car)
2. Think of the picture (a car)

3. Remember what else was happening in the picture (a witch was in the car)
4. Produce the definition (witch) (Uberti, et al, 2003)

Pegword Strategy

The pegword strategy uses rhyming words to represent numbers or order. The rhyming words or "peg words" provide visual images that can be associated with facts or events and can help students associate the events with the number that rhymes with the pegword. It has proven useful in teaching students to remember ordered or numbered information (Scruggs & Mastropieri, 2000). For example, "one" is typically represented by the word pegword "bun," two is represented by the pegword "shoe," and "three" is represented by the pegword "tree." Teachers can use these pegwords to help students remember historical facts.

Example

During a study of the American Revolutionary War, a teacher wanted her students to remember the three major Acts that the British Parliament passed that led to the American Revolutionary War: the Sugar Act of 1764, the Stamp Act (1765), and the Townshend Acts (1767). To help them remember the Acts and the order in which they occurred, she created the following mnemonics: for the Sugar Act of 1764, she created a picture of a bowl of sugar reminding students of the Sugar Act of 1764) being poured on a hamburger bun ("bun" is the pegword for "one," indicating the first Act that Parliament passed). For the Stamp Act, the teacher created a picture of a pair of shoes ("shoe" is the pegword for "two") with a stamp (to remind students of the Stamp Act) on it. Finally, she created a picture of a teapot with the Union Jack on it (to remind the students of the Boston Tea Party, which resulted from the Townshend Acts) and a tree coming out the top of the teapot ("tree" is the pegword for "three").

Letter Strategy

Teaching letter strategies involves the use of acronyms and acrostics. Acronyms are words whose individual letters can represent elements in lists of information, such as HOMES to represent the Great Lakes (e.g., Huron, Ontario, Michigan). Acrostics are sentences whose first letters represent to-be-remembered information, such as "My very educated mother just served us nine pizzas," to remember the nine planets in order (e.g., Mercury, Venus, Earth, Mars). (Scruggs & Mastropieri, 1994.). Teachers can use these letter strategies to help students remember lists of information.

Example A

The mnemonic "IT FITS" (King-Sears, Mercer, & Sindelar, 1992) is an acronym providing the following steps to create mnemonics for vocabulary words:

Identify the term (vocabulary word, e.g., "impecunious").

Tell the definition of the term (e.g., "having no money").

Find a keyword (e.g., "penniless imp").

Think about the definition as it relates to the keyword, and imagine the definition doing something with the keyword. For example, "an imp tried to buy something but found that his pockets contained no money."

Study what you imagined until you know the definition (Foil & Alber, 2002).

Example B

Another mnemonic device for creating keywords for new vocabulary is LINCS (Ellis, 1992). During a unit on medieval history, students must learn a new vocabulary word, "catapult." The teacher gives the following instructions:

List the parts. Write the word on a study card, and list the most important parts of the definition on the back. On the front-side of the card write the word "catapult" as the term to be defined, and on the back side of the card write "to throw or launch as if by an ancient device for hurling missiles."

Imagine the picture create a mental picture and describe it. For example, something being launched over or through a barrier.

Note a reminding word. Think of a familiar word that sounds like the vocabulary word. For example, a "cat" and a "pole" sounds similar to "pult"—write this on the bottom half of the card).

Construct a LINCing story. Make up a short story about the meaning of the word that includes the word to be remembered, for example, a cat pole-vaulting over a castle wall.

Self-Test. Test your memory forward to back; for example, look at the word "catapult" and "cat pole" on the front of the card, and say aloud the definition on the back of the card, as well as the image of a cat pole-vaulting over a castle wall. Reverse this process by looking at the back of the card to self-test the vocabulary word and keyword (Foil & Alber, 2002).

2.2.9 *Strategies for Building Prior Knowledge*

Direct instruction on background knowledge can significantly improve students' comprehension of relevant reading material (Dole,Valencia, Greer, and Wardrop, 1991; Graves, Cooke, and Laberge, 1983; McKeown, Beck, Sinatra, and Loxterman, 1992; Stevens, 1982). For example, in one study, students who received direct instruction on relevant background knowledge before reading an expository text demonstrated significantly greater reading comprehension than peers who received direct instruction on an irrelevant topic area (Stevens, 1982). Dole et al. (1991) extended these findings, showing that teaching students important background ideas for an expository *or* narrative text led to significantly greater performance on comprehension questions than did no pre-reading background knowledge instruction. By building students' background knowledge teachers might also help to counteract the detrimental effects that incoherent or poorly organized texts have on comprehension (McKeown et al., 1992). Direct instruction on background knowledge can be embedded into an approach such as previewing, where students are presented with introductory material before they read specific texts. Such introductory material may include important background information such as definitions of difficult vocabulary, translations of foreign phrases, and explanations of difficult concepts. For example, in a study by Graves et al. (1983), students were given previews of narrative texts that included a pilot synopsis, descriptive list of characters, and definitions of difficult words in the story. Thus, students were given both a framework for understanding the stories and important background information. Students not only liked the previews but made significant improvements in both story comprehension and recall. Results of an earlier study by Graves et al (1983) demonstrated a similarly beneficial impact of previews incorporating historical background for the text. As an alternative to a direct instruction approach, teachers might consider one more indirect, such as immersing students in field experiences through which they can absorb background knowledge more independently. Koldewyn (1998) investigated an approach that combined reading trade books, journal keeping, fields trips that put students in authentic experiences related to their reading, and follow-up Language Experience activities (Koldewyn, 1998). Qualitative observations in Koldewyn's report reflect positively on the technique. By building students' background knowledge teachers may also be able to indirectly influence other aspects of academic performance such as writing. For example, Dole et al, (1991) found that students felt better prepared to write a research paper when they took part beforehand in an extended course of building background knowledge.

2.2.10 Strategies for Helping Students to Activate Prior Knowledge

There is a good amount of research investigating the effectiveness of instructional strategies for activating prior knowledge as a means to support students' reading comprehension. As a whole, the research base provides good evidence to support the use of prior knowledge activation strategies; prior knowledge activation is regarded as a research-validated approach for improving children's memory and comprehension of text (Pressley, Johnson, Symons, McGoldrick, and Kurita, 1989). There are a variety of strategies for helping students to activate prior knowledge six of these approaches are discussed below:

Prior knowledge activation through reflection and recording.

One of the simplest methods for helping students activate background knowledge is to prompt them to bring to mind and state, write down, or otherwise record what they know. Asking students to answer a simple question such as "What do I already know about this topic" orally or on paper is a straightforward way to do this. The reported effectiveness of this simple strategy is quite good, with five studies (Carr et al., 1996; Peeck et al., 1982; Smith et al., 1983; Spires et al., 1998; Walraven et al., 1993) reporting some beneficial impact relative to control treatments, and just one study (Alvermann, Smith, and Readence, 1985) reporting only no benefit or a negative impact. Reading comprehension was the most frequently measured outcome in these studies, but some studies also report beneficial effects on text recall (Peeck et al., 1982; Smith et al., 1983). Activating relevant prior knowledge by expressing in some form what one already knows about a topic has been demonstrated to be more effective than activating irrelevant background knowledge (Peeck et al., 1982) or not activating any background knowledge (Carr et al., 1996; Smith et al., 1983; Spires et al., 1998) at improving text recall and/or comprehension. And Spires and Donley (1998) found that activating background knowledge through reflection and oral elaboration during text reading was a more effective strategy than taking notes on main ideas and their corresponding details. Walraven and Reitsma (1993) found equally good effectiveness when embedding instruction in prior knowledge activation within a Reciprocal Teaching approach. Strategy instruction that incorporated direct instruction in prior knowledge activation promoted student reading comprehension more effectively than the regular program of instruction. However, Reciprocal Teaching without instruction in prior knowledge activation was no less effective.

Teachers may be able to improve the effectiveness of a brainstorming approach to prior knowledge activation by helping students to organize their prior knowledge into a semantic map (Englert & Mariage, 1991). Englert et al., (1991) found that organizing prior knowledge in this way before reading led to significantly greater free written recall of the text than did brainstorming alone. A weakness in this research base is the failure to characterize the duration of the learning effects, with most studies presenting only a minimal delay between instruction and testing. Only Spires & Donley (1998) and Walraven & Reitsma (1993) looked for effects at delayed time points, but both found that reading comprehension gains were maintained for roughly 4 weeks after instruction, suggesting that restatement of prior knowledge can produce a lasting impact.

There are important subtleties to some of these findings indicating an influence by various factors on the effectiveness of this prior knowledge activation strategy. Some studies have shown, for example, that this strategy has a different impact on reading comprehension depending on the text features (Carr et al., 1996; Peeck et al., 1982); familiar vs. unfamiliar text, consistent vs. inconsistent with prior knowledge).

Prior knowledge activation through interactive discussion.

With the general approach discussed in the previous session, students, once prompted, record prior knowledge with little or no discussion or other stimulation from teacher or peers. An alternative to this is an interactive approach, where student reflection on prior knowledge is supplemented with interactive discussion. For example, Dole et al. (1991) designed an intervention where students reflected on and recorded their prior knowledge on a topic and then engaged in a group discussion of the topic, during which the teacher encouraged them to contribute knowledge to complete a semantic map. This approach was determined to be more effective at promoting reading comprehension than no pre-reading instruction. However, it was less effective than direct instruction on the information needed to understand the text. Thus, it is not clear that an interactive approach would have any advantage over direct instruction. The robustness of interactive approaches is not always very impressive. For example, findings from Schmidt and Patel (1987) suggest that topic area novices may significantly benefit from this kind of approach, whereas subject area experts may not. In this study students activated background knowledge by gathering in small groups to analyze a problem and then proposing and discussing solutions (Schmidt et al., 1987). Results of a study by Langer (1984) were inconsistent, showing no reliable advantage to participating in a pre-reading activity called the Pre Reading Plan (PREP), where students are trained to free associate on key vocabulary words, reflect on these associations, discuss their associations as a group, and then reformulate their knowledge based on the discussion. Students' performance on comprehension tests was not consistently better than that of peers who engaged in general discussion of the topic before reading or took part in no pre-reading activity. Thus, consistently solid evidence to support the use of an interactive approach to prior knowledge activation is lacking. Based on the studies we reviewed, it is not clear that the added effort involved in such an approach improves upon the results of direct instruction in background knowledge. However, it is also possible that the apparent advantage of direct instruction in background knowledge over an interactive approach derives only from its greater familiarity to students (Dole et al., 1991). This is a possibility that merits investigation. Further research is also needed to better determine the conditions under which an interactive approach is beneficial - e.g., does it differently affects students with different levels of subject area expertise. It should also be noted that there are many possibilities for designing an interactive approach, and we have touched on only a few of them.

Prior knowledge activation through answering questions.

Research by Rowe and Rayford (1987) suggests that teachers can facilitate student activation of background knowledge by having them answer questions before and/or while they read new material. They analyzed student responses to a series of 3 pre-reading purpose setting questions. Students were shown 3 purpose questions from the Metropolitan Achievement Test and asked to make predictions about the passage and end-of-passage questions that might go with each question. Students were also asked to put themselves in the test-takers position and describe what they would try to find out while reading the passage. Analysis of the students' responses suggested that students were able to activate background knowledge under these conditions, an indication that purpose questions may be helpful cues for activating background knowledge. Extending this work, studies have investigated whether activating background knowledge through question answering improves reading comprehension. It has been theorized that generating answers to questions facilitates deep processing and high level knowledge construction, which in turn facilitate learning (King, 1994; Pressley, M., Wood, E., Woloshyn,

V. E., Martin, V., King, A., and Menke, D.,1992). Experimental findings support this theory. First, King (1994) found that a guided reciprocal peer questioning and answering approach, where students were trained to study new material by asking and answering each other's self-generated questions, promoted significantly better lesson comprehension than untrained questioning. Interestingly, King's data show that questioning focused on linking prior knowledge with lesson material led to more maintained high performance than did questioning focused on making connections within the lesson material. Thus, instruction in peer questioning and explaining through connecting text to prior knowledge may be a particularly effective question answering strategy for improving comprehension.

Pflaum, Pascarella, Auer, Augustyn and Boswick (1982) investigated a somewhat different question-based method for prior knowledge activation where students were asked, before and during reading, five questions about the topic in the text (Pflaum, et al., 1982). The questions prompted students to define the topic, make associations between the topic and their background knowledge, identify the role and location of the topic matter, and comment on the topic's importance. Data suggest that this strategy may be effective for some readers and not others, depending on their reading ability. Similarly, Hansen & Pearson (1983) found that having students make associations between the text and their background knowledge and predictions about what would happen in the text, together with providing them with inferential questions to discuss after reading the text, significantly improved their comprehension as compared to students who did not engage in these activities. Effects also differed according to reading ability.

A review by Pressley et al. (1992) builds a strong case for the hypothesis that question answering approaches can increase learning. After reviewing a large number of research studies, they conclude that asking students to generate explanatory answers to questions about content to be learned can facilitate learning of the material. The reviewed approaches included guided Reciprocal peer questioning, asking students to respond to pre-questions accompanying text, elaborative interrogation where students generate elaborations in response to why questions about to-be-learned facts, and asking students to generate explanatory answers to questions as part of group learning. Pressley et al. (1992) emphasize that not all questioning interventions are effective; the most effective questioning requires deep processing of the to-be-learned material and relating it to prior knowledge.

The K-W-L strategy for activating prior knowledge.

Ogle (1986) developed a strategy for helping students' access important background information before reading nonfiction. The K-W-L strategy (accessing what I Know, determining what I Want to find out, and recalling what I did learn) combines several elements of approaches discussed above. For the first two steps of K-W-L, students and the teacher engage in oral discussion. They begin by reflecting on their knowledge about a topic, brainstorming a group list of ideas about the topic, and identifying categories of information. Next the teacher helps highlight gaps and inconsistencies in students' knowledge and students create individual lists of things that they want to learn about the topic or questions that they want answered about the topic. In the last step of the strategy, students read new material and share what they have learned. Informal evaluations indicate that the K-W-L strategy increases the retention of read material and improves students' ability to make connections among different categories of information as well as their enthusiasm for reading nonfiction (Ogle, 1986). The approach has been recommended by teaching professionals (Bean, 1995; Carr & Ogle, 1987; Fisher, Frey, & Williams, 2002), but it has not been rigorously tested.

CONTACT-2. computer-assisted activation of prior knowledge.

Biemans, Deel, and Simons, 2001 investigated a computer-assisted approach for activating conceptions during reading, called CONTACT-2. CONTACT-2 assists students in searching for preconceptions, comparing and contrasting these preconceptions with new information, and formulating, applying, and evaluating new conceptions. Students working with CONTACT-2 developed higher quality conceptions than students in a no activation group, and this advantage was still apparent at a 2-month follow-up. More recent research suggests that the *CONTACT-2* is comparing and contrasting new and existing knowledge, which most accounts for students' successful performance on lesson tests (Biemans, et al, 2001). These findings reinforce the idea that integrating new information with prior knowledge is a valuable learning strategy and suggests that a computer-assisted approach can be as successful as a teacher-directed one.

Prior knowledge activation through interpretation of topic-related pictures.

Croll, Idol-Maestas, Heal and Pearson (1986) describe a unique approach that combines building and activating prior knowledge. The approach entails training students to interpret topic-related pictures (Croll, Idol-Maestas, Heal, and Pearson, 1986). Two students trained in this strategy significantly improved reading comprehension for both pictures and text. These data suggest this to be an effective approach, but the limited sample of two students and lack of a control group make any such claims tentative and preliminary at best. Moreover, there has been no subsequent research to help validate these findings.

2.2.11 Factors Influencing the Effectiveness of Strategies to Activate Prior Knowledge

Grade level.

Students across a wide range of grade levels, spanning first to tenth grade, are represented in the studies we have discussed, although most studies sampled students toward the middle of this range, in grades five and six. Looking across these studies there is no apparent relationship between study outcome and the grade level sampled. On the contrary, our review suggests that prior knowledge activation strategies can be effective with K-8 students.

Student Characteristics.

Students bring to a text different level of topic area familiarity, and this is understandably a factor of interest when investigating the effectiveness of prior knowledge activation strategies. Two studies investigated the possibility that students' level of familiarity with the topic matter might influence the effectiveness of prior knowledge activation strategies. Carr and Thompson (1996) discovered a different pattern of results depending on the familiarity of the text topic to the student participants. When reading unfamiliar passages, students that were asked to state their prior knowledge on the text topic significantly outperformed students who were not asked to state prior knowledge. However, when reading familiar passages, only a subset of the student population, age-matched students without disabilities, benefited from prior knowledge activation. Similarly Schmidt and Patel (1987) found that novices and experts on passage subject matter responded differently to a prior knowledge activation strategy. Novices demonstrated better performance after having taken part in interactive prior knowledge activation than after having activated irrelevant prior knowledge, while experts showed no benefit. These findings both suggest that students with more limited knowledge of the topic area may more consistently benefit from prior knowledge activation strategies. Of course, readers may be familiar with a topic area – even has considerable knowledge of it – without that knowledge being accurate. A question of interest is whether or not prior knowledge activation is advantageous when students are activating false preconceptions. The consensus from the three studies we reviewed on this topic is that prior knowledge activation may in fact interfere with learning when learners are confronted with material at odds with their preconceptions. When text is inconsistent with prior knowledge, students that mobilize this prior knowledge perform significantly more poorly on tests of recall and comprehension than do peers who do not activate prior knowledge (Alvermann et al., 1985; Smith et al., 1983). Lipson (1982) commented that students tend to disregard passage information inconsistent with their prior knowledge therefore construct more accurate meaning when lacking prior knowledge versus when having inaccurate prior knowledge (Lipson, 1982). Although Peeck et al., (1982) reported a beneficial effect of activating incongruous prior knowledge; they did not randomize group assignment, raising the possibility that pre-existing differences in recall ability confound their findings.

Moreover, Pressley et al. (1992) minimizes the importance of these findings by reporting that there are more studies showing inconsistent prior knowledge to be detrimental than beneficial (Pressley et al., 1992). Weisberg (1988) claimed that students with disabilities, as a group, demonstrate a considerable over reliance on prior knowledge when text material is inconsistent with their preconceptions. This raises another issue, which is whether a student's educational group or disability status influences the effectiveness of prior knowledge activation strategies. Many of the studies in our review included students from different educational groups, most often students with different reading levels (Biemans et al., 2001 and Langer, 1984) but also students with and without learning disabilities (Carr et al., 1996; Croll et al., 1986; Pflaum et al., 1982; Walraven et al., 1993). A few of these studies analyzed the data in a way that would reveal differences in responsiveness to prior knowledge activation across educational groups (Carr et al., 1996; Langer, 1984; Pflaum et al., 1982). Their findings suggest that the effectiveness of prior knowledge activation strategies may in fact differ across different student populations. For example, Pflaum et al., (1982) found that "same age normal" students significantly benefited from prior knowledge activation, whereas "young age-matched normal" students and students with disabilities did not (instead these students showed significant improvement with sentence aids). Langer (1984) found that the Pre Reading Plan prior knowledge activation activities were not effective for below-level readers. On-level readers demonstrated the greatest and most consistent benefit and above-level readers a less consistent benefit. In contrast, Hansen and Pearson (1983) found that prior knowledge activation was effective for poor readers but not good readers. A possible explanation for these opposing findings is that the impact of prior knowledge activation on students from different educational groups depends in part on the topic familiarity (Langer, 1984). In summary, a range of data suggests that it is very important to consider learners' unique strengths, weaknesses, and preferences when selecting instructional approaches.

Text characteristics.

The studies we reviewed used both expository and narrative texts to investigate the impact of prior knowledge activation strategies on learning; however, the vast majority used only expository texts. These studies provide strong evidence that prior knowledge activation strategies are effective at improving comprehension of informational texts. Although very few studies investigated the use of these strategies when reading narratives, two studies by Carr and Thompson (1996) and Dole et al., (1991) suggest that prior knowledge reflection and recording and interactive prior knowledge activation, respectively, may be beneficial when working with this kind of text. Additional research may help to clarify any differences in effectiveness of prior knowledge activation when working with different kinds of text.

2.3 Empirical study

2.3.1 Gender and students' learning outcomes in Mathematics

Much research has been devoted to gender differences in mathematics participation, achievement and attitudes with the objective of enhancing female mathematics participation. Research in the 1970's found that males at the high-school level and beyond scored higher than females on tests of mathematics achievement (Jensen, 1997). Some suggested that this was due to innate differences in ability (Benbow and Stanley, 1980; Bock and Kolakowski, 1973), it was widely held that the "gender gap",is a by-product of fewer females enrolling in advanced mathematics courses (Beryman, 1983; Fennman and Sherman, 1977; Pallas and Alexander, 1983). The gap is narrowing; however, gender differences still occur in higher-level mathematics courses at the high-school level (AAUW, 1992). Betz and Hackett (1983) showed that male and female college students differed in their level of self-efficacy. Jensen (1997) found that although females had less positive attitudes towards mathematics, they aspire to mathematics-related careers in numbers equal to males. Such findings raise the possibility that gender could moderate relationship between achievement, attitudes and careers aspirations.

Despite research efforts and statistical data backing up the notion that girls are falling behind in mathematics and science, there still continues to be significant gender-based achievement gaps that are perpetuated by "insidious gender lessons, micro-inequities that chip away at girls' achievement and self-esteem" (Sadker and Sadker, 1994). According to the AAUW (1992), girls self-select out of mathematics, science and computer technology classes because of lower achievement rates. In college, boys are more likely to pick the upper-level mathematics and science courses, whereas girls are more likely to enrol in English and Humanities courses. Due to the fact that females are self-select out of these courses in college, careers in mathematics and science are overwhelmingly male. Campbell and Evans (1993) explained that boys are more likely to enrol in advanced mathematics and science classes than females, and this enrolment gap continues to exist into college. In high-school and college, research shows that teachers, guidance counsellors and professors may actually discourage female from taking upper-level mathematics and science classes. Further, Campbell-Evans (1993) found that females do not enrol or drop out of upper-level mathematics and science courses because they are "unaware that these courses are pre-requisite for college major and graduate degrees leading to high level professions".

Sadker et al (1994) found that boys spoke louder and more often, were more confident in their answers and that although there were very few girls taking these classes, girls were less confident in their answers and felt reluctant to speak. Pell (1996) confirmed the idea that girls' self-esteem significantly decreases in middle school and throughout high school. This drop in self-esteem may drastically affect performance in mathematics and science and cause females to have negative attitudes towards these courses. Attitudinal differences are due to an array of inequalities that exist in traditional schooling such as: unequal treatment of males and females by teachers, gender inequities in curriculum and socialization of both teachers and students that perpetuate the notion that males are stronger at mathematics and science. Girls are more anxious and less confident about their mathematics ability; they perceive the subject as cold, impersonal, and with little clear application to their lives and society (Sadker et al., 19994). Many studies alluded to the fact that a decrease in female self-esteem largely contributes to attitudinal differences that come before diminished academic achievement in mathematics and science. Unequal treatment of males and females by lecturers in college may be one of the explanations for attitudinal differences that exist amongst males and females.

Pell (1996) also found that females in college are less likely to report positive attitudes on mathematics and science for two reasons: the first, girls are less likely to take mathematics and science classes in college unless they would like to pursue a technological career; the second, girls who are enrolled in mathematics and science classes are not as likely to achieve as high as males. Also, Sax (1996) found that "the strongest predictor of women's enrolment in mathematics and science programmes was to have a pre-college interest in making a theoretical contribution to science. A major purpose for reducing the gap is to ensure that females do not exclude themselves from potential career opportunities by neglecting to enrol in mathematics and science classes in college. Campbell (1998) discovered that while the gender gap in mathematics and science careers such as finance and medicine may be decreasing, the gap between males and females in careers such as engineering and scientific research is increasing. According to Sax (1996), women consistently occupy stereotype career despite the fact that females numbers are increasing in male –dominated careers. Interestingly enough, the Women's Bureau of the United States Department of Labour in 2005 released the 20 leading occupations for employed women – the first leading occupation was secretariat position, followed by cashiers, registered nurses and elementary school teachers respectively. This is not different from the Nigerian situation.

2.3.2 Attitudes and Students' learning outcomes in Mathematics

According to Advanced Learner's Dictionary of Current English, attitude is defined as way of feeling, thinking and behaving. Also, psychologists define attitudes as any strong belief or feeling or any approval or disapproval toward people and situations. We have favourable or unfavourable attitudes towards people, politics, academic subjects etc. We favour the things we think are good and helpful, and oppose the things we think are bad and harmful (Kagan, 1984). The students' attitude towards an academic subject is a crucial factor in learning and achievement in that subject whether a student views herself or himself as a strong or weak person in a specific subject may be an important factor in her or his academic achievement. Stodolsky et al (1991) mentioned that students develop ideas, feelings and attitudes about school subjects over time and from variety of sources.

Attitude is a hypothetical construct (Tan, 2007). Triandis (1971) defines attitude as an idea charged with emotion, which predisposes a class of actions to a particular class of social actions. He identifies three main components attached to attitudes. First, a cognitive component, that is the idea which is generally some category used by humans in thinking, whereby categories are inferred from consistencies in responses to discriminably different stimuli. Second, an affective component that is the emotion, which changes the ideas. Third, a behavioural component associated with a predisposition to action. However, it is difficult to separate out these three components, as they tend to interact and merge with one another. From another perspective, Baker (1988) defines attitudes as inferred, conceptual inventions hopefully aiding the description and explanation of behaviour. Seen in this context, attitudes are learned predispositions, not inherited or genetically endowed, and are likely to be relatively stable over time. Lewis (1981) offers another important insight into the nature of attitudes. He sees attitudes as mental sets, which are a cluster of preconditions that determine the evaluation of a task, a situation, an institution, or an object before one actually faces it. Wenden (1991) sums up attitudes as learned motivations, valued beliefs, evaluation, or what one believes is acceptable.

It is generally true that attitudes of students towards learning of a subject have a significant impact on the outcome of their learning processes. It is equally important to note here that in any learning processes, attitude is not only a causal or input variable, it also needs to be thought of as output or outcome variable (Baker, 1988). Attitude conceived as an outcome of education is important because it may provide a complimentary or even alternative and more long-lasting effect than examination achievement. Thus, a positive attitude towards a subject may be a more enduring outcome than knowledge gained in passing examination.

There are many types of learning orientations that influence the learning processes of students, of which achievement orientation is a major concern for educators and policy planners. Achievement orientation is driven by achievement motivation. Achievement motivation as defined by Maehr (1974) refers, first of all, to behaviour that occurs in reference to a standard of excellence and thus can be evaluated in terms of success and failure. A second defining condition is that the individual must in some sense be responsible for the outcome. Third, there is some level of challenge and therewith some sense of uncertainty involved. Many studies have categorically shown that there is a strong relationship between attitude and achievement (Hough & Piper, 1982; Simpson & Oliver, 1990; Marjoribanks, 1976; Shauhnessy & Haladyna, 1985). Mager (cited in Foong, 1994) affirmed that the development of positive attitudes towards school subject is essential. Students with a positive attitude towards a subject are more likely to continue their learning in the area, both formally and informally, after the direct influence of the teacher has eroded. Marjoribanks (1987) highlighted the fact that in psychological models of educational performances, academic achievement is typically related to measures of ability and attitudes. Thus, by examining the students' attitudes and achievement orientations towards learning of science and mathematics in English, this study can effectively evaluate the impact and outcome of the implementation of the policy of teaching science and mathematics in English, especially from the perspectives of those who experience its effects directly – the students.

Generally, students had positive attitudes towards mathematics and science, although less so in countries where science is taught as separate subjects at the eighth grade (Mullis et al; 2000). Many studies have examined students' thinking about school and their attitude towards mathematics (Papanastatious 2002). Instruction in school settings provides important and regularly experienced context in which ideas and perceptions about subject matters as well as other cognitive and effective outcomes can be shaped. Research evidence shows that if an important person encourages student to behave in a certain way, he or she will accept it. The influence of an important person is so strong that even the individual may change his or her attitude in agreement with that of the important person's (Berkonatz, 1986). Also, a consistent pattern of attitudes towards school subjects and achievement in the respective subject has been confirmed through a large number of studies (Aiken, 1976; Keeres, 1992; Papanastasious, 2002; and Schneider, 2001).

2.3.3 Numerical Ability and Students' learning outcomes in Mathematics

Numerical ability to a great extent determines the imagination, language, perception, concept formation and problem solving ability of learners (Sangodoyin, 2010). Numerical ability tests are designed to measure the candidates' capacity to manipulate or use numbers to correctly solve problems (Ann, 2004). Such tests signify basic arithmetic prowess in an individual. According to Nunnally (2004), it is the ability to relatively solve problems in number sequencing, make accurate mathematical deductions through advanced numerical reasoning, interpret complex data presented in various graphical forms, deduce information and draw logical conclusions. All forms of school examinations in various subjects, are also broadly speaking types of achievement test of which numerical ability test is one, It can be given directly to candidates or administered as subsets of other tests.The reason is that usually their level of motivation towards learning is very low and attitude to learning is also negative. Green (1990) emphasised that students with low numerical ability need special attention in their work. The ability of a learner is a construct that many researchers have found to affect the achievement especially in science and mathematics. Arowolo (2011) found that there was a significant main effect of students' achievement and retention in Basic Science among low, medium and high numerical ability categories. The high Numerical ability student proved superior to medium and low Numerical ability categories. Some studies (Iruegbu, 1998; Adeoye, 2000; Inyang and Ekpeyong, 2000 and Adeoye and Raimi, 2005) found that students' academic ability could influence performance. In these studies, academic ability has been found to influence learning and retention, scholastic attainment of such learning and predicts achievement in Mathematics.

Ogunbiyi, (2005) found that the achievement scores of high academic ability of pre-service environmental teachers were higher than their counterparts with low academic ability. The finding provided further empirical support to that of Superka (2004), Stronghill (2004) and Graffit (2004) that academic ability had significant effect on teachers' knowledge of environment than gender. Muira et al (1996) observed that the mathematical skills and knowledge that children possess when they enter school can help or hinder later performance in mathematics. In the same vein, Stern (1993) discovered that understanding and solving of words problems demand the ability to access many different skills, such as language understanding, an understanding of the described situation, the ability to solve an equation, and the ability to carry out necessary computations to solve problems. This finding indicates that measurement of these abilities should vary with degree of accuracy, relevant secondary school performance criteria.

Adesoji (2008) reported no significant difference in the performances of students in the three ability levels after receiving the problem-solving strategy. This implies that, all the students in the different ability levels were able to solve problems based on electrolysis and its prerequisite concepts after the treatment. This was in support of Adesoji (1995, 1997) who observed that problem-solving strategies were effective in teaching students of different ability levels. Ability to solve problems in science could therefore be enhanced by introducing a good teaching strategy. Thus, it could be said that solving problems is not limited to a particular ability level. However, Allwood and Mongomery (1981) discovered that, even though deficiencies in students' problem-solving were related to motivational factors, high ability students were more able to detect problem solving errors, and this led to their being able to perform better than the low ability group.

2.3.4 Mnemonics and Students' learning outcomes in Mathematics

Mnemonic strategy instruction has been recommended as an effective method for addressing the serious and persistent learning difficulties of students characterised as learning disabled (Mastropieri, 1998; Pressley, Scruggs and Mastropieri, in Press, Scruggs, Mastropieri and Levin, 1997). According to Swanson (1999) and Forness, Kavale, Blun and Llyod (1997), the use of mnemonic strategies have helped students with disabilities significantly improve their academic achievement. In a study, college students used a mnemonic strategy to study and recall painting-to artist matching. The result showed that those students who used mnemonics substantially out performed those who did not use them on tests that required recall of artists and their painting (Carney and Levin, 2000). In the same vein, two recent studies on the use of mnemonics for social studies instruction showed not only test improvement among all students but also marked improvement among students with disabilities (Mastropieri, Sweda and Scruggs, 2000; Ubeti, Scruggs and Mastropieri, 2003).

Academic study of the use of mnemonics has shown their effectiveness. In one such experiment, subjects of different ages who applied mnemonic techniques to learn novel vocabulary outperformed control groups that applied contextual learning and free-learning styles Levin,J. R., and Nordwall, M.B. (1992). Mnemonics vary in effectiveness for several groups ranging from young children to the elderly. Mnemonic learning strategies require time and resources by educators to develop creative and effective devices. The most simple and creative mnemonic devices usually are the most effective for teaching. In the classroom, mnemonic devices must be used at the appropriate time in the instructional sequence to achieve their maximum effectiveness McAlum, H.G. and Sharon, S.S. (2010).

Mnemonics were seen to be more effective for groups of people who struggled with or had weak long-term memory, like the elderly. Five years after a mnemonic training study, a research team followed-up 112 community-dwelling older adults, 60 years of age and over. Delayed recall of a word list was assessed prior to, and immediately following mnemonic training, and at the 5-year follow-up. Overall, there was no significant difference between word recall prior to training and that exhibited at follow-up. However, pre-training performance gains scores in performance immediately post-training and use of the mnemonic predicted performance at follow-up. Individuals who self-reported using the mnemonic exhibited the highest performance overall, with scores significantly higher than at pre-training. The findings suggest that mnemonic training has long-term benefits for some older adults, particularly those who continue to employ the mnemonic (O'Hara, R. 2007).

According to Access Center (2006), using mnemonics in every subject area is a strategy that can help students memorize, and then apply information to a given circumstance. For mathematics, this is an extremely useful strategy, because it allows students to link sequencing steps for mathematics problems, by using simple phrases. This helps students compartmentalize each step, thus allowing them to break problems into smaller portions; the students are able to bring these smaller portions into the larger picture. Hence, according to Access Center (2005), the real benefit of mnemonic instruction is that it works for students of all ages. It has also been found that mnemonics work, at least for certain users in particular settings with well-defined information-storage needs (Mayer, 2003)

2.3.5 Prior-knowledge and Students' learning outcomes in Mathematics

The terms background knowledge and prior knowledge are generally used interchangeably. For example, Stevens (1980) defines background knowledge quite simply as "what one already knows about a subject." Biemans and Simons' (1996) definition of background knowledge is slightly more complex, "(background knowledge is) all knowledge learners have when entering a learning environment that is potentially relevant for acquiring new knowledge." Dochy and Alexander (1995) provide a more elaborate definition, describing prior knowledge as the whole of a person's knowledge, including explicit and tacit knowledge, meta-cognitive and conceptual knowledge. This definition is quite similar to Schallert's definition (Schallert, 1982). Thus, while scholars' definitions of these two terms are often worded differently, they typically describe the same basic concept. Prior knowledge and background knowledge are themselves parenting terms for many more specific knowledge dimensions such as conceptual knowledge and meta-cognitive knowledge. Subject matter knowledge, strategy knowledge, personal knowledge, and self-knowledge are all specialized forms of prior knowledge or background knowledge. Prior knowledge has a large influence on student performance, explaining up to 81% of the variance in post test scores (Dochy, Segers, and Buehl, 1999). And there is a well established correlation between prior knowledge and reading comprehension (Langer, 1984; Long, Winograd, and Bridget, 1989; Stevens, 1980). Irrespective of students' reading ability, high prior knowledge of a subject area or key vocabulary for a text often means higher scores on reading comprehension measures (Langer, 1984; Long et al., 1989; Stevens, 1980). In addition, high correlations have been found between prior knowledge and speed and accuracy of study behaviour (reviewed in (Dochy et al., 1999) as well as student interest in a topic. Thus, prior knowledge is associated with beneficial academic behaviours and higher academic performance. It is tempting to conclude from observations such as these that prior knowledge promotes better learning and higher performance, but different research methods are needed to establish such a causal relationship

2.4 Appraisal of Literature Review

It has been shown in the literature reviewed that one of the most important factors affecting learning is what the learner already knows. To learn meaningfully, therefore, the learners must relate new knowledge to what they already know. Rote learning is then compared with meaningful learning; the former refers to when a student simply memorizes information without relating it to previously learned material. Also, concept of mathematics, development of mathematics and role and importance of mathematics were examined. Mathematics is seen as a language, as a particular kind of logical structure, as a body of knowledge about number and space, as a series of methods of deriving conclusions and as the essence of our knowledge of the physical world. Thus, Mathematics is seen as a desirable tool in virtually all spheres of human endeavour, be it science, engineering, industry, technology and even the arts. It is a wheel on which other subjects move and a subject with greater applications.

Researchers in the field of education examined several strategies that could lead to effective teaching and learning of mathematics. These strategies tend to enhance the attitudes of students towards learning of mathematics and improve the performance of students at both internal and external examinations. Such strategies like Mastery Learning, Concept Mapping and Cooperative and Individualistic Instructions had been dealt with extensively. Also, in the literature reviewed, Mnemonics and Prior knowledge instructional strategies have been shown to have positive outcomes and effective in dealing with learning disabled students. These strategies could make teaching and learning of mathematics meaningful and ensure quick recall of basic mathematics facts which are necessary to excel in various examinations. The types of mnemonics such as Keyword, Pegword and Letter strategies and their benefits were dealt with. Also, various ways of activating prior knowledge such as interactive discussions, answering questions, k-w-l and CONTACT 2 were also discussed.

The issues of gender, numerical ability and students' attitude to mathematics were also discussed in the reviewed literature. Gender is an area that has been examined extensively, but with conflicting results. It has been shown that the performance of males surpassed that of females most especially in science and mathematics related subjects. Some researchers also concluded that the performance of both male and female students were not significantly different. In the same vein, attitude, being a disposition towards a subject or anything has been confirmed to have significant effect on student's achievement in mathematics and may lead to repulsiveness or attractiveness towards mathematics. As a result, efforts must be made to reinforce positive attitude towards learning of mathematics, to enhance student's performance. Finally, the performance of students in mathematics has been linked to their numerical ability level. It was observed that numerical ability of students could influence learning, retention and scholastic attainment.

It has been revealed in the literature reviewed that most of the studies on these two important strategies were carried out in foreign countries. Also, many of the strategies that had been dealt with are not making use of students' memory and relevant prior-knowledge which are necessary to make teaching and learning of Mathematics meaningful. More importantly, most questions students confront in their examinations require recall of basic Mathematics facts which can only be enhanced by mnemonics and prior knowledge they possess. On the basis of this, it is the intention of this study to fill the gap observed in research by examining the effect of Mnemonic and Prior knowledge-based instructional strategies on student's learning outcomes in Mathematics.

CHAPTER THREE

METHODOLOGY

This chapter deals with the research design, variables of the study, selection of participants, research instruments, validity and reliability of the instruments, procedure for the study and method of data analysis.

3.1 Research Design

This study adopted a pre-test-post-test, control group quasi-experimental design. Two experimental groups were exposed to Mnemonic-based and Prior-Knowledge-based instructional strategies respectively. The control group was exposed to Modified Lecture Method. All the three strategies were crossed with gender at two levels (male, female) and Numerical Ability at three levels (high, medium, low).

The research design is represented as follows:

E_1	0_1	X_1	0_2
E_2	0_3	X_2	0_4
C	0_5	X_3	0_6

Where

E_1 represents experimental group 1

E_2 represents experimental group 2

C represents control group

0_1, 0_3, 0_5 represent pre-test scores

0_2, 0_4, 0_6 represent post-test scores

X_1 represents Mnemonic-based instructional strategy

X_2 represents Prior-Knowledge-based instructional strategy

X_3 represents Modified Lecture Method

Table 3.1: The 3x3x2 Factorial Matrix design is shown in the table below

Strategies	Gender	Numerical Ability		
		High	Medium	Low
Mnemonic-based	Male			
	Female			
Prior Knowledge-based	Male			
	Female			
Modified Lecture Method	Male			
	Female			

3.2 Variables of the Study

The study used the following variables:

Independent Variables: These are the modes of instructions at three levels:

a) Mnemonic-based Instructional Strategy (MBIS)

b) Prior Knowledge-based Instructional Strategy (PKBIS))

c) Modified Lecture Method (MLM)

Moderator Variables:

a) Numerical Ability Levels (High, Medium, and Low)

b) Gender (Male, Female)

Dependent Variables

a) Students' Achievement in Mathematics

b) Students' Attitude to Mathematics

3.3 Selection of Participants

The target participants were all Senior Secondary Two (SS II) students of the five Local Governments within Ibadan metropolis. Three Local Governments were randomly selected and used. Two Senior Secondary Schools were purposively chosen from each of the Local Governments, making a total of six schools.

The bases for the selection of the participating schools were:

7 The schools must be Oyo State Government owned to ensure uniformity of treatment and response.

8 The schools must have been presenting students for WAEC and NECO examinations for more than 5 years.

9 The schools must be co-educational

10 There must be qualified Mathematics teachers who have been in the schools for a minimum of 3 years.

11 Willingness on the part of the schools to cooperate with the researcher.

12 The schools must be distant from each other to avoid contamination effects.

From each of the selected schools, two intact classes were used. In all, two hundred and eighty-eight (288) SS2 students, comprising 96 boys and 192 girls were used in the study.

3.4 Instrumentation

The following instruments were developed and used to elicit responses for this study:

1. Students' Mathematics Achievement Test (SMAT)
2. Students' Mathematics Attitude Scale (SMAS)
3. Numerical Ability Test (NAT)
4. Teachers' Instructional Guide for teaching Mathematics using Mnemonic-based Instructional Strategy
5. Teachers' Instructional Guide for teaching Mathematics using Prior Knowledge-based Instructional Strategy
6. Teachers' Instructional Guide using Modified Lecture Method

3.4.1 Students Mathematics Achievement Test (SMAT)

The test was designed by the researcher to measure the achievement of SSII students in Mathematics. The instrument was made up of two sections: Section A consisted of demographic data such as name of school, subject, gender, sex, and age. Section B consisted of 30 multiple items test taken from final draft of 40 items drawn from the mathematics concepts that were taught during the experiment. The instrument was designed to measure knowledge, understanding and thinking. Each multiple choice item has four options A to D. One mark was awarded for each question answered correctly and zero for every wrong answer. The maximum mark was 30.

Table 3.2: Table of Specification of Mathematics Achievement Test

S/N	Topics	Knowledge	Understanding	Thinking	Total
1	Logarithms of Numbers Less than or Greater than 1 General Arithmetic – Fractions, Decimals, percentages and Ratios	3(1,2,4)	2(5,7)	1(6)	6
2	Arithmetic and Geometric Progression	3(3,8,29)	2(16,25)	1(12)	6
3	Algebraic Process –Quadratic Equations	3(15,28,30)	2(24,26,)	2(21,27)	7
4	Trigonometry – Pythagoras rule, Ratios of angles, angles of elevation and depression	3(9, 10,14)	3(11,13,23)	1(17)	7
5	Mensuration – Arcs and Sectors of circle (this includes length of arcs, area of sectors, area of segment and perimeter of sector.	2(18, 20)	1(22)	1(19)	4
	Total	14	10	6	30

3.4.2 Validation of Mathematics Achievement Test

The instrument was given to three experienced Mathematics teachers who have been teaching the subject at Senior Secondary level for more than 5 years for face and content validities. It was thereafter presented to two Lecturers in the Department of Teacher Education including my Supervisor for their suggestions and corrections. The final draft which consisted of 40 items instrument was later administered as a trial-test to (20) twenty SSII students, that comprised 11 males and 9 females that are not from the participating schools and not within the selected local governments. The result of the trial-test was used to determine the difficulty index of each test item, which ranges from 0.35 (35%) to .73 (73%). Based on this, only thirty (30) items of moderate difficulty levels were selected from final draft of 40 items drawn for the test.

The reliability coefficient of 0.75 of the instrument was obtained using Kuder Richardson formula 20 (KR 20).

3.4.3 Students' Mathematics Attitude Scale (SMAS)

The instrument was adopted from Fenema-Sherman attitude scale. The instrument consisted of two sections, A and B. Section A contained questions on student's background information such as: name of school, age, class and sex. Section B consisted of 25 items covering such areas as: personal confidence about Mathematics, usefulness of mathematics, perception of Mathematics as male dominated subject, perception of teacher's attitudes, career aspiration and relationship of Mathematics to other subjects.

The instrument was designed based on a four point Linkert Scale of Strongly Agreed (SA), Agreed (A), Disagreed (D) and Strongly Disagreed (SD). The scores for SA, A, D and SD were 4, 3, 2, and 1 for positively worded statements and reversed for negatively worded statements respectively.

3.4.4 Validation of Students' Mathematics Attitude Scale (SMAS)

For validation, the instrument was presented to three Mathematics Educators, including my supervisor, to determine the suitability in terms of the content, clarity and relevance of the test items. The final copy of the instrument was later administered as a trial-test to 20 students, comprising males and females, of a school that was not among the participating schools and not within the selected local governments. The reliability coefficient of the instrument of 0.8 was obtained using Cronbach Alpha. The earlier validation by Martha (2004) showed the reliability coefficient Alpha of .97.

3.4.5 Numerical Ability Tests (NAT)

The instrument was adapted from the Psychometric Success Numerical Ability Test. The instrument which consisted of only one section has 37 questions with various degrees of difficulties. The validation of the instrument was done by presenting it to three Mathematics Educators, including my supervisor. Their inputs led to the reduction of the test items to 30. The final draft was later administered to 20 students (11 males and 9 females) as a trial-test. The reliability coefficient of 0.77 was obtained with Kuder Richardson 20 (KR 20). The scores obtained from the tests were converted to percentages and used to group the students into high, medium and low numerical ability. Based on these, students who scored 60% and above were considered high numerical ability, 40 – 59% medium numerical ability, while 0 – 39% low numerical ability. This formed the criterion for partitioning the students into ability groups.

3.5 Procedure for Treatment

A letter of introduction from the Department of Teacher Education University of Ibadan was obtained and presented to the Principals of the participating schools to obtain their permission to use their schools for the study. Then the following procedure was adopted for the training and administration of treatment for the study:

1. The first three (3) weeks were used for the training of Research Assistants and Mathematics Teachers that participated in the teaching. The training was done by the Researcher, who served as the resource person.
2. The fourth week was for conducting pre-tests in SMAT, SMAS and NAT. The pre-tests were conducted by the researcher with the assistance of the research assistants and the mathematics teachers of the participating schools.
3. The next eight weeks (i.e., week's five to twelve) were for the treatments in the six schools selected for the study. The treatment was carried out by the mathematics teachers on the experimental and control groups respectively.

3.4.6 Operational Guide for Mnemonic-based Instruction

The teacher using mnemonic-based instructional strategy first identified the mnemonic device used prior to teaching the content area lesson and hence followed these steps:

Step 1. The teacher introduced the topic and wrote the mnemonic he had developed for it on the board.

Step 2. The teacher explained and took students through the specific steps involved in applying the mnemonic to the topic given in step 1.

Step 3. The teacher demonstrated with examples on the board how to use the mnemonic he had developed to solve questions on the topic. He explained the steps he was taking and what pertains to the strategy.

Step 4. Students solved assessment questions using the mnemonic given in step 1, while the teacher moved round the class and offered assistance to the students as they needed it, but usually as they progressed in the assessment the teacher's help was stopped.

Step 5. At the expiration of the time allocated for the mathematics questions given in step 4, the teacher collected the student's work for marking and did correction for the students.

Step 6. Students asked questions on the topic and strategy used, and copied assignment questions which were solved at home and submitted for marking the next day.

3.4.7 Operational Guide for Prior knowledge-based Instruction

This operational guide was implemented by the teacher at the beginning, middle and end of the lesson. The following steps were followed:

Step 1. The teacher reviewed the previous topic and introduced the new topic.

Step2. Students solved assessment question on the previous topic reviewed in step 1 to activate their prior knowledge. The teacher moved round the classroom and offered assistance where necessary.

Step 3. In presenting the new topic, detailed in step 1, the teacher demonstrated how to apply the previous learning to understand the learning of the new topic with example.

Step 4. Students solved the assessment questions covering both previous and current topics using their prior knowledge. The teacher moved round the classroom and assisted where necessary.

Step 5. At the expiration of time allocated for the assessment questions given in step 4, the teacher collected the students' work for marking and did the correction.

Step 6. Students asked questions on the topic and strategy used, and copied assignment questions which were solved at home and submitted for marking the next day.

Table 3.3: Some Prior Knowledge identified for each of the concepts taught

S/N	Topics	Sub-Topics	Prior Knowledge
1	Logarithms General Arithmetic	-logarithms of nos.<1 -logarithms of nos.>1 -roots and powers of nos.<1 -fractions, decimals and percentages	-standard form -decimal -integers -roots -indices/powers -log tables -approximations (rounding off of nos.) -addition -subtraction, division
2	Mensurations	-arcs and sectors of circles -area of sector and segment of circles	-circle geometry -ratio of angles -Pythagoras rule -fractions -decimals -approximations -sine rule -cosine rule -logarithms
3	Quadratic Equations	-equations with irrational roots -use of quadratic formular -words problems leading to quadratic equations	-simple equations -factorisation -fraction -decimals -roots -approximations (rounding off of nos.)
4	Trigonometry	-angles of elevation and depression -bearing	-ratio of angles -plane geometry -pythagoras rule -fractions -decimals -approximations -sine rule -cosine rule -logarithms -roots
5	Arithmetic Progression Geometric Progression	-nth term of AP -sum of Arithmetic series -nth term of GP -sum of geometric series	-substitution -simple equation -fractions -decimals -substitution -indices and powers -decimals -fractions

3.4.8 Operational Guide for the Modified Lecture Method

The teacher using Modified Lecture Method adopted the following steps during his teaching:

1. Teacher presented the new topic to be discussed
2. Teacher explained and solved some problems on the topic of the period
3. Teacher gave students problems to solve in the class and marks
4. Teacher gave assignment questions that were solved at home and submitted for marking the following day.

4. The 13^{th} week was devoted to the administration of the instruments, that is, the post-test in respect of SMAT and SMAS of the research carried out. This was administered by the researcher, research assistant and the mathematics teachers of the respective schools.

3.6 Method of Data Analysis

Data collected were analysed using the Analysis of Covariance (ANCOVA).To determine the magnitude and direction of differences due to the groups, the estimated marginal means of post-test scores was used. Where significant main effects were found, Scheffe post-hoc pair wise comparison was used to determine the source of significance. All research hypotheses were tested at the 0.05 level of significant.

CHAPTER FOUR

RESULTS

This chapter presents the analysis of results of data gathered from the field based on the hypotheses generated in chapter one.

Ho.1a – There is no significant main effect of treatment on students' achievement in mathematics.

Table 4.1: ANCOVA table showing the significant main and interaction effects of Treatment groups, Numerical Ability and Gender on the Pre-Post Achievement Test in Mathematics.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared
Corrected Model	3326.340[a]	18	184.797	12.083	.000	.447
Intercept	3696.229	1	3696.22	241.677	.000	.473
PRETEST	137.045	1	9	8.961	.003	.032
Main Effect:			137.045			
TRTGRP	121.438	2		3.970	.020	.029
Numerical Ability	882.645	2	60.719	28.856	.000	.177
GENDER	406.091	1	441.323	26.552	.000	.090
2-way Interactions:			406.091			
TRTGRP*NA	51.410	4		.840	.501	.012
TRTGRP*GENDER	73.379	2	12.853	2.399	.093	.018
NA*GENDER	69.657	2	36.690	2.277	.105	.017
3-way Interactions:			34.829			
TRTGRP*NA*GEN	60.767	4		.993	.412	.015.
DER	4114.104	269	15.192			
Error	62774.000	288	15.294			
Total	7440.444	287				
Corrected Total						

a. R Squared = .447 (Adjusted R Squared = .410)

The result from table 4.1 shows that there is a significant main effect of treatment on students' achievement in mathematics ($F_{(3,269)}$ = 8.961, P < .05, η^2= .032). This implies that there is a significant difference between the achievements of students exposed to mnemonic and prior knowledge-based instructional strategies and the modified lecture method. Therefore, the null hypothesis is rejected. Table 4.2 presents the estimated marginal means scores of students' achievement in mathematics based on experimental and modified lecture method.

Table 4.2: Estimated marginal means of post-test achievement scores by Treatment and Control group

Treatment Groups	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
TRT I (Mnemonic-based)	16.129[a]	.613	14.923	17.335
TRT II (Prior knowledge-based)	14.327[a]	.467	13.407	15.246
Modified Lecture Method	13.763[a]	.458	12.861	14.665

a. Evaluated at covariates appeared in the model: PRE-TEST ACHIEVEMENT IN MATHS = 9.5347

From table 4.2, the mean scores of the different Treatment Groups show that Mnemonic-based instructional strategy has the highest mean score ($\bar{x}$ = 16.129), followed by Prior knowledge-based instructional strategy ($\bar{x}$ =14.327) while Modified lecture method obtained ($\bar{x}$ = 13.763). This indicates that mnemonic-based instructional strategy was more effective than prior knowledge-based instructional strategy and modified lecture method.

Table 4.3: Scheffe Post-Hoc Pairwise significant differences among the various groups of independent variables on the Achievement in Mathematics between the Treatment groups

Treatment Group	(I) Treatment Groups	(J) Treatment groups	Sig
Post test Achievement in Mathematics	Mnemonic-based	Prior-knowledge-based Modified Lecture Method	.000 .000
	Prior-knowledge-based	Mnemonic-based Modified Lecture Method	.000 .348
	Modified Lecture Method	Mnemonic Prior-knowledge	.000 .348

The table above shows that there is a significant difference between Mnemonic-based and Prior-knowledge-based instructional strategies and Modified Lecture Method respectively.

Ho.1b. – There is no significant main effect of treatment on students' attitudes to mathematics.

Table 4.4: ANCOVA table showing the significant main and interaction effects of Treatment, Numerical Ability and Gender on the Pre-Post Students' attitude to Mathematics.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Eta Squared
Corrected Model	1514.020[a]	18	81.112	1.249	.222	.077
Intercept	23658.168	1	23658.168	351.283	.000	.566
PREATT	298.230	1	298.230	4.428	.036	.016
Main Effect:						
Treatment Group	529.749	2	264.875	3.933	.021	.028
Numerical Ability	1.965	2	.982	.015	.986	.000
Gender	289.554	1	289.554	4.299	.039	.016
2-way Interactions:						
Treatment x Numerical	71.568	4	17.892	.266	.900	.004
Ability	139.936	2	69.968	1.039	.355	.008
Treatment x Gender	103.730	2	51.865	.770	.464	.006
Numerical Ability x						
Gender	72.878	4	18.219	.271	.897	.004
3-way Interactions:	18116.591	269	67.348			
TRTGRP x NA x Gender	1423560.000	288				
Error	19630.611	287				
Total						
Corrected Total						

R Squared = .077 (Adjusted R Squared = .015

The results from table 4.4 above show that there is a significant effect of treatment on students' attitude to mathematics ($F_{(3,269)} = 3.933$, $P < .05$, $\eta^2 = .028$). This implies that there is a significant difference between the attitudes of students exposed to Mnemonic-based, Prior knowledge-based and Modified Lecture Method. Hence, the null hypothesis is rejected.

To determine the magnitude of the means scores of students' attitude in each of the treatment groups, the estimated marginal means of scores is presented in table 4.5.

Table 4.5: Estimated marginal means of post-test attitude score by Treatment and Modified lecture method.

Treatment Groups	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
TRT I(Mnemonic-based)	67.521[a]	1.026	65.502	69.541
TRT II (Prior knowledge-based)	68.934[a]	.938	67.088	70.780
Modified Lecture Method	71.258[a]	.899	69..487	73.028

a. Evaluated at covariates appeared in the model: PRE-TEST ATTITUDE TO = 68.6250

From table 4.5, the mean scores of the different Treatment Groups were given with Modified Lecture Method having the highest mean score ($\bar{x}$ = 71.258), followed by Prior-knowledge-based Instructional strategy ($\bar{x}$ = 68.934) and finally Mnemonic-based Instructional strategy ($\bar{x}$ = 67.521). The implication is that the Modified Lecture Method influenced students' attitude towards mathematics than the two instructional styles.

In order to trace the source(s) of the significant effect of treatment on students' attitude to mathematics, the Scheffe post-Hoc analysis was carried out as presented in table 4.6.

Table 4.6: Scheffe Post-Hoc Pair-wise significant differences among the various groups of independent variables on the Attitude to Mathematics between the Treatment groups

Treatment Group	(II) Treatment Groups	(J) Treatment groups	Sig
Post test Attitude in Mathematics	Mnemonic-based	Prior-knowledge-based Modified Lecture Method	.904 .030
	Prior-knowledge-based	Mnemonic-based Modified Lecture Method	.904 .086
	Modified Lecture Method	Mnemonic Prior-knowledge	.030 .086

Table 4.6 above shows that there were pair wise significant differences between Mnemonic-based and Modified Lecture Method and vice-versa

Ho2a. There is no significant main effect of numerical ability on students' achievement in mathematics.

Table 4.7: Estimated marginal means of post-test achievement scores by Numerical ability

Numerical Ability	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Low	12.950[a]	.417	12.129	13.772
Medium	13.696[a]	.466	12.779	14.614
High	17.571[a]	.480	16.627	18.516

a. Evaluated at covariates appeared in the model: PRE-TEST ACHIEVEMENT IN MATHS = 9.5347

The result from table 4.1 shows that there is a significant main effect of numerical ability on students' achievement in Mathematics ($F_{(3,269)}$ = 28.856, P < .05, η^2= .177). This indicates that there is a significant difference between Low Ability, Medium Ability and High Ability on Students' Achievement in Mathematics. Hence, the hypothesis is rejected.

Table 4.7 shows that high numerical ability obtained the highest mean score ($\bar{x}$ = 17.571), Medium numerical ability ($\bar{x}$ = 13.696), and low numerical ability ($\bar{x}$ = 12.950).

Ho.2b There is no significant main effect of numerical ability on students' attitude to mathematics

Table 4.8: Estimated marginal means of post-test attitude scores by Numerical ability

Numerical Ability	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Low	69.218[a]	1.002	67.245	71.191
Medium	69.138[a]	.978	67.213	71.062
High	69.357[a]	.879	67.627	71.087

a. Evaluated at covariates appeared in the model: PRE-TEST ATTITUDE TO = 68.6250

The result from table 4.4 shows that there is no significant main effect of numerical ability on students' attitude to Mathematics ($F_{(3,269)}$ = .015, P >.05, η^2=0.000). This implies that there is no significant difference between Low Numerical Ability, Medium Numerical Ability and High Numerical Ability on Students' Attitude in Mathematics. Hence, the hypothesis is accepted.

Table 4.8 shows that high numerical ability obtained the highest mean score ($\bar{x}$ = 69.357), followed by Low Numerical Ability ($\bar{x}$ = 69.218) and Medium Numerical Ability ($\bar{x}$ = 69.138). Though the difference exists, however, the difference is not significant.

Ho.3a There is no significant main effect of gender on students' achievement in Mathematics.

Table 4.9: Estimated marginal means of post-test achievement scores by Gender

Gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Male	16.091[a]	.415	15.273	16.909
Female	13.387[a]	.321	12.755	14.020

a. Evaluated at covariates appeared in the model: PRE-TEST ACHIEVEMENT IN MATHS = 9.5347

Table 4.1 shows that there is a significant main effect of gender on students' achievement in Mathematics $F_{(2,269)}$ = 26.552, P < .05, η^2= .090). The implication is that there is a significant difference in Male and Female Students' Achievement in Mathematics. Hence, the hypothesis is rejected.

Table 4.9 further shows` magnitude of the mean score of male ($\bar{x}$ = 16.091) higher than female ($\bar{x}$ = 13.387). Though there is a difference, but the difference is not significant.

Ho.3b There is no significant main effect of gender on students' attitude to Mathematics.

Table 4.10: Estimated marginal means of post-test attitude scores by Gender

Gender	Mean	Std. Error	Lower Bound	Upper Bound
Male	68.095[a]	.872	66.379	69.812
Female	70.380[a]	.672	69.056	71.704

a. Evaluated at covariates appeared in the model: PRE-TEST ATTITUDE TO = 68.6250

The result from table 4.4 shows that there is a significant main effect of gender on students' attitude to Mathematics ($F_{(2,269)}$ = 4.299, P <.05, η^2= .016). This means that there is a significant difference in Male and Female Students' attitudes to Mathematics. Hence, the null hypothesis is rejected.

Table 4.10 also presents the mean score of female attitudes to Mathematics ($\bar{x}$ = 70.380) slightly higher than their male counterpart ($\bar{x}$ = 68.095)

Ho.4a There is no significant main interaction effect of treatment and numerical ability on students' achievement in mathematics.

The result from table 4.1 shows that in the main effect, both Treatment group and Numerical Ability were significant. The interaction effects of both Treatment group and Numerical Ability was not significant ($F_{(9,269)}$ = 0.840, P >.05, η^2=.012). Hence, the null hypothesis is accepted.

Ho.4b There is no significant main interaction effect of treatment and numerical ability on students' attitude to mathematics.

The result from table 4.4 shows that the Treatment group was significant while Numerical Ability was not. In the interaction effects of Treatment group and Numerical Ability, there was no significant difference in Attitude of Students to Mathematics ($F_{(9,269)}$ =.266, P >.05, η^2=.004). Hence, the null hypothesis is accepted.

Ho.5a There is no significant interaction effect of treatment and gender on students' achievement in Mathematics.

The result from table 4.1 shows that there is no significant interaction effect of treatment and gender on students' achievement in Mathematics ($F_{(6,269)}$ = 2.399, P > .05, η^2=.018). It further reveals that in the main effect, both the Treatment group and Gender were significant; however, the interaction effect was not significant on Students' Achievement in Mathematics. Hence, the null hypothesis is accepted.

Ho.5b There is no significant interaction effect of treatment and gender on students' attitude to Mathematics.

Table 4.4 shows that there is no significant interaction effect of treatment and gender on students' attitude to Mathematics ($F_{(6,269)}$ = 1.039, P >.05, η^2= .008). It shows that in the main effect, both the Treatment group and Gender were significant; however, the interaction effect was not significant on Students' Attitude to Mathematics. The null hypothesis is accepted.

Ho.6a There is no significant interaction effect of numerical ability and gender on students' achievement in Mathematics.

The result from table 4.1 shows that there is no significant interaction effect of numerical ability and gender on students' achievement in Mathematics ($F_{(6,269)}$ = 2.277, P >.05, η^2= .017). However, in the main effect, both the Numerical Ability and Gender were significant. In the interactions effects, there was no significant difference found on Students achievement in Mathematics. Hence, the null hypothesis is accepted.

Ho.6b There is no significant interaction effect of numerical ability and gender on students' attitude to Mathematics.

Table 4.4 shows that there is no significant interaction effect of numerical ability and gender on students' attitude to Mathematics ($F_{(6,269)}$ = .770, P > .05, η^2= .006). It further shows that in the main effect, Numerical Ability was not significant but Gender was. In the interactions effects, there was no significant difference found on Students' attitude to Mathematics. Hence, the null hypothesis is accepted.

Ho.7a There is no significant interaction effect of treatment, numerical ability and gender on students' achievement to Mathematics.

Table 4.1 shows that there is no significant interaction effect of treatment, numerical ability and gender on students' achievement in Mathematics ($F_{(18,269)}$ = .993, P >.05, η^2= .015). The table further shows that in the main effect, both the Treatment group, Numerical Ability and Gender were significant. In the 2-way interactions, there was no significant difference between the Treatment group and Numerical Ability, Treatment group and Gender and between Numerical Ability and Gender. The 3-way interaction between Treatment, Numerical Ability and Gender was also not significant. Hence, the null hypothesis is accepted.

Ho.7b There is no significant interaction effect of treatment, numerical ability and gender on students' attitude to Mathematics.

The result from table 4.4 show that there is no significant interaction effect of treatment, numerical ability and gender on students' attitude to mathematics ($F_{(18,269)}$ = .271, P > .05, η^2= .004). The result shows that in the main effect, the Treatment group and Gender were found significant while Numerical Ability was not. In the 2-way interactions, there was no significant interaction effect between Treatment and Numerical Ability, Treatment and Gender and between Numerical Ability and Gender. It further shows that the 3-way interaction between Treatment, Numerical Ability and Gender was not significant. Hence, the null hypothesis is accepted.

Summary of Findings

The summary of the research findings are presented as follows:

1. There was a significant main effect of treatment on students' achievement in and attitude to Mathematics.
2. There was a significant main effect of numerical ability on students' achievement in Mathematics, but students' numerical ability has no significant effect on students' attitude to mathematics.
3. There was a significant main effect of gender on students' achievement in and attitude to Mathematics.
4. There was no significant interaction effect of treatment and numerical ability on students' achievement in and attitude to Mathematics.
5. There was no significant interaction effect of treatment and gender on students' achievement in and attitude to Mathematics.
6. There was no significant interaction effect of numerical ability and gender on students' achievement in and attitude to Mathematics.
7. There was no significant 3-way interaction effect of treatment, numerical ability and gender on students' achievement in and attitude to Mathematics.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.0 This chapter presents the discussion of findings, conclusion and recommendations based on the analysis of the results shown in chapter four.

5.1 Discussions

5.1.1 Effect of treatment on students' achievement in Mathematics

Findings from the study revealed that there was a significant main effect of treatment on students' achievement in Mathematics. This indicated that differences exist between the achievement of students in the experimental group and modified lecture method on achievement in mathematics. From the results, Mnemonic-based Instructional Strategy was superior to both Prior knowledge-based instructional strategy and the Modified lecture method instructional strategy as it obtained the highest mean score. However, Prior knowledge-based also proved superior to Modified lecture method instructional strategy. This was in line with Scruggs & Mastropieri, (2000) who observed that the reason comprehension scores were higher for students using mnemonic-based strategy was that the strategy increased their ability to recall factual information needed to answer comprehension questions. Through the use of mnemonic-based strategy, it is more likely that the students were able to remember factual information, answer questions, and demonstrate comprehension. Also, Mastropieri, Scruggs & Fulk, (1990) reported that when asked about their preferences for instructional strategies, the majority of students preferred mnemonics instruction; they felt they learn more, and would prefer to use mnemonic instruction in other content areas. On why Prior knowledge-based was superior to Modified lecture method of instruction, Hayes and Tierney (1982) found that presenting prior knowledge information related to the topic to be learned helped the readers learn more from texts regardless of how that prior knowledge was presented or how specific or general it was. Thus, Kopcha (2005) concludes that high prior knowledge students have the tendency to achieve better when they receive the type of control they prefer, while the opposite is true for low prior knowledge students.

5.1.2. Effect of treatment on students' attitude to Mathematics.

The essence of this study was to investigate and ascertain the effects of Mnemonic and Prior knowledge-based instructional strategies on students' achievement in and attitude to Mathematics. It was also expected to reveal whether students who were exposed to these strategies would perform better and have positive attitude to Mathematics than those taught using Modified lecture method. One of the major findings of the study is that there was significant main effect of treatment on students' attitude to Mathematics. This supported the finding of Adeleke (2007) and Olaleye (2004) who reported significant relationship between treatment and students' attitude to Mathematics. This indicates that there were significant differences between attitudes of students to mathematics. Findings further showed that the students in the control group obtained the higher attitude mean scores followed by the Mnemonic and Prior-knowledge-based instructional strategies respectively. The implication was that the Modified Lecture Method influenced students' attitude towards Mathematics than the other two instructional strategies. The reason for this might be due to favourable attitude of teachers to the conventional method of instruction which might have influenced the attitude displayed by the students. Also, the time frame within which the experiment was carried may not have exerted much influence on already possessed attitude by the students. On the basis of this, the attitude of the teacher may have influenced the attitude displayed by the students. The finding was in line with the results of Adesoji (2008) and Yara (2009) who reported that the attitude of the students can be influenced by the attitude of the teacher and their methods of instruction.

5.1.3 Effects of numerical ability on students' achievement in and attitude to Mathematics

The results of the study revealed that numerical ability has significant effect on students' achievement in mathematics, with high numerical ability obtained the highest mean scores, and medium and low numerical ability follow in that order. On the other hand, numerical ability did not have significant main effects on students' attitude to mathematics. It means that student numerical ability does not determine the attitude of student to mathematics. A student with high numerical ability may not have positive attitude to mathematics. This was in line with Olowojaye (2004) whose results showed that there was no significant relationship between numerical ability and students' attitudes to mathematics. The results further showed that student numerical ability determines mathematics achievement. This implies that the higher the students' numerical ability the higher the achievement in mathematics. This coincided with the findings of Olowojaye (2004) and Arowolo (2010) who reported significant difference in mathematics achievement based on students' numerical ability.

5.1.4 Effects of gender on students' achievement in and attitude to Mathematics

Findings from the results showed that gender had significant main effects on students' achievement in and attitude to Mathematics. The result indicated that female students had higher positive attitude to mathematics than their male counterparts, however, male students performed better in achievement test. This might implies that male students found the strategies easy and were able to implement the strategies than their female counterparts. This result was in line with Raimi and Adeoye (2002), Olowojaiye (2004) who reported significant difference in favour of male students. Furthermore, the result was contrary to Badiru (2007), Okigbo and Oshafor (2008), and Ifamuyiwa and Akinsola (2008), who reported no significant difference in students' achievement in mathematics due to gender.

5.1.5 Two-way interaction effect of treatment and numerical ability on students' achievement in and attitude to Mathematics.

Finding from the results showed that the two-way interaction effect of treatment and numerical ability was not significant on students' achievement in and attitude to Mathematics. The implication was that numerical ability has no influence on students' achievement in and attitude to Mathematics. Thus, whatever the ability level of the students, what determines the achievement in and attitude of students to Mathematics is the strategy adopted by the teacher, which is the method of instruction. The finding was in agreement with Olowojaiye (2004) and Arowolo (2010) who concluded that there was no significant main effect of treatment and numerical ability on students' achievement in and attitude to Mathematics.

5.1.6 Two-way interaction effect of treatment and gender on students' achievement in and attitude to Mathematics

The two-way interaction effect of treatment and gender on students' achievement in and attitude to Mathematics was not significant. This supported the earlier findings by Oyeniran (2010) and Olowojaye (2004) that no significant relationship existed between two-way interaction effect of treatment and gender on students' achievement in and attitude to Mathematics. . This implies that gender has not influenced significantly achievement in and attitude of students to Mathematics. The results indicate that Mnemonic and Prior knowledge-based instructional strategies are better for both male and female students. Thus, what determines the achievement in and attitude of students to Mathematics is the method of instruction adopted by the teacher.

5.1.7 Two-way interaction effect of numerical ability and gender on students' achievement in and attitude to Mathematics.

The results showed that the two-way interaction effect of numerical ability and gender on students' attitude to and achievement in mathematics was not significant. This result was contrary to the findings of Olowojaiye (2004) who reported significant relationship between two-way interaction effect of numerical ability and gender on students' achievement in and attitude to Mathematics. However, it confirmed the findings of Oyeniran (2010) who observed no significant relationship between two-way interaction effect of numerical ability and gender on students' achievement in and attitude to Mathematics. This implies that numerical ability and gender have nothing to do with the achievement in and attitude of students to Mathematics. What determines the attitude and achievement of student in mathematics is the method of instruction.

5.1.8. Three-way interaction effect of treatment, numerical ability and gender on students' achievement in and attitude to Mathematics.

The results showed that the 3-way interaction effect of treatment, numerical ability and gender was not significant on students' achievement in and attitude to Mathematics. This result confirmed the earlier reports by Oyeniran (2010), Adeleke (2007) and Olowojaye (2004) which concluded that no significant relationship existed between the three-way interaction effect of treatment, numerical ability and gender on students' achievement in and attitude to Mathematics. .The implication was that the two strategies, Mnemonics and Prior Knowledge, are better irrespective of the numerical ability levels and gender of the students.

5.2 Conclusion

The findings of this study have shown that Mnemonic and Prior knowledge-based instructional strategies were more effective in improving the students' learning outcomes in Mathematics than the Modified lecture method. The results have revealed that the use of mnemonic instruction would enable students to remember factual information, answer questions and demonstrate comprehension. It would also provide a visual or verbal prompt for students who may have difficulty retaining information. As regards prior-knowledge strategy, it has been established that it can be used to incorporate meaning into newly acquired material. Also, it influences how learners interpret new information and decide what aspects of that information are relevant and irrelevant. The study also revealed that the numerical ability level of students determined to a larger extend the academic achievement of students in Mathematics.

5.3 Recommendations

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

1. Teachers should facilitate the use of Mnemonic and Prior knowledge-based instructional strategies in schools to enhance positive attitude of students towards Mathematics and improve their achievement in the subject.
2. Teachers should include varieties of mnemonics into their instructional strategies to effectively cater for the diverse abilities of students within their classrooms.
3. Teachers should conduct active review of students' relevant prior knowledge at the commencement, during and at the conclusion of the lesson to make teaching and learning of Mathematics meaningful.
4. Teachers should constantly look for current and innovative methods of teaching Mathematics that would be more effective
5. Periodic and regular training, seminars and workshops should be organized for teachers to update their knowledge on current and innovative teaching strategies at secondary school level.

5.4 Limitations of the Study

The following are some of the limitations observed in the course of this study:

1. The study covered only three Local Governments out of thirty-three (33) in the state and only six senior secondary schools, therefore, there is need to extend the study to cover more Local Governments and schools to enhance generalisation.
2. Uncooperative attitudes of some mathematics teachers in secondary schools were also noted in the course of the study. This nearly hindered the implementation of the study.
3. Only two moderating variables, gender and numerical ability, were covered in the study, therefore, other variables such as anxiety, interest should be noted for further study.
4. Since SS2 syllabus was used, and only few topics were selected for the study. There is need to further extend the study to cover more topics.

5.5 Suggestions for Further Study

Based on the limitations observed above, further studies can be conducted as follow:

1. The study can be replicated at other levels of education especially primary schools to ascertain the effectiveness of the strategies.
2. The study can be conducted in other subject areas such as arts, social sciences and science subjects.
3. Further investigation can be conducted on the effects of the combination of the two strategies simultaneously on mathematics
4. The study can be replicated to cover more local governments or in other states to ensure generalization of findings.

5.6 Contributions of the Study to Knowledge

The study had shown that Mnemonic and Prior Knowledge-based Instructional Strategies are effective at improving students' achievement in and attitude to Mathematics. It has provided teachers with innovative and effective instructional strategies that may ease teaching and learning of Mathematics. The study has also provided empirical evidence that students' numerical ability levels determine to a larger extent their academic achievement in Mathematics. Gender differences between the performance of male and female students in Mathematics in favour of boys were also reported. Teachers are therefore advised in this regards to ensure gender balancing in their teaching strategy. To other stakeholders in education sector, it has been revealed that to make teaching and learning of Mathematics student-centred previous experience must be duly considered, while improvement of students' memory is essential to enhance recall of basic mathematical facts needed to better their achievement in any examinations.

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Appendix I

Student Mathematics Achievement Test

You are required to respond to the following questions as contained in Sections A and B below. Supply all information on your answer sheet.

SECTION A

School: -

…………………………………………………………………………………………………..

Class:-

…………………………………………………………………………………………………

Age:-

…………………………………………………………………………………………………..

Sex:-

……………………………………………………………………………………………………

Time Allowed: 1 hour

SECTION B

Choose the most correct option and write down the letter only in your answer sheet. The test consists of only 30 items with four options lettered A, B, C, and D. You are required to answer all the questions. As much as possible avoid guessing but word towards answers.

1. Simply 1/2 + 3/8 x 16/27

   A. 1/9 B.1/3 C.14/27 D. 5/9

2. A dealer buys a Car for ₦1500 and sells it for N1800, find his percentage gain.

   A. 15% B.20% C.25% D. 30%

3. A trader sold a pair of shoes for N2,800.00 making a loss of 20% on his cost price. Find his loss as a percentage of his selling price.

   A. 16 2/3 % B. 20% C. 25% D. 75%

4. Simplify $\frac{0.5 + 0.75}{0.5 \times 0.75}$ correct to 3 significant figures

A. 1.00, B.2.13, C.42.33, D. 3.33

5. Three men: Alimi, Bola and Chook won N25,000 on the football pools. If they share this amount in the ratio 2:3:5 respectively, how much does Bola receive?

A, ₦5000 , B ₦ 7500 ₦ 12,500 D. ₦17,500

6. If sin Q = 5/7, find the value of tan Q?.

A. 2√6/5 B. 2√6/7 C. 5√3/6 D. 5√6/6

7. If cosQ = sin40; what is Q ?

A. 50^0 B. 30^0 C. 45^0 D. 10^0

8. From the top of a cliff, the angle of depression of a boat on the sea is 22^o. If the height of the cliff from sea level is 40m, find the horizontal distance of the boat from the bottom of the cliff correct to two significant figures.

A. 15m, B. 16m, C.99m, D.68m

9. In a right-angled triangle, hypotenuse is:

A. the side opposite right-angle, B. the base angle, C. the Side adjacent to the right-angle, D. the side opposite based angle.

10. Which of the following is equal to sin 30^o

A. tan 30^o, B. sin 45^o C. Cos 60^o D. tan 60^o, E.30^o

11. One side of a right-angle triangle is 24m long and its hypotenuse is 25m longs calculate the length of the third side.

A. 7cm, B. 8cm, C. 14cm D. 24cm

12. The formula for calculating the length of an arc of a sector is.

A. $2\pi r$ B. $Q/360 \times 2\pi r$ C. $Q/360 \times \pi r$ D. πr^2

13. An arc subtends an angle of 105^o at the centre of a circle of radius 6cm. Find the length of the arc.

A.11cm, B.$11cm^2$, C. 22cm D. 105

14. The angle of a sector of a circle radius 10.5cm is 120^o. Find the perimeter of the sector (take π= 22/7)

A.22cm B.33.5cm C.43cm D. 66cm

15. A sector of a circle of radius 9cm subtend angle 120^o at the centre of the circle. Find the area of the sector to the nearest cm^2. (Take π = 22/7)

A. $75cm^2$ B. $84cm^2$, C. $85cm^2$ D. 86 cm^2

16. An arc of a circle of radius 14cm is 11cm. What angle does the arc subtends at the centre of the circle? (Take π = 22/7).

A. 22 ½ ^{o}, B. 45^0, C. 60^o, D. 90^o,

17. A sector of a circle radius 10cm is folded to form a circular cone. If the angle of the sector is 135^o, find the base radius of the cone.

A. 1 13/22 B.2 2/3 C. 3 2/11cm D. 3 3/4cm

18. One root of the equation $4x^2$-17x+4 = 0 is ¼ what is the other root?

A. -4, B.1, C. 3 D.4,

19. Find the equation whose root are -2/3 and – ¼

A. $12x^2+11x+2=0$, B. $12x^2-11x+2=0$ C. $x^2-11/12x+2=0$

D. $12x^2-11x-2=0$

20. Find the value of (a+b), if a and b are the roots of the quadratic equation $y^2 - 8y+15=0$

A. 8, B. 5, C -4, D. -5

21. Solve the equation y^2-4y=0

A.(0,4), B.(2,4), C.(3,2), D(0,2).

22. Solve the equation (x-2) (x+7)=0

A. (2,-7). B. (2,7), C (-7,6) D. (-3,-7)

23. What must be added to x^2+6x to make the expression a perfect square.

A. 3, B. 6, C. -6, D 9,

24. Find two numbers whose difference is 5 and whose product is 266

A. (14-19) B. (14,19), C. (19,-14) D (12,-17),

25. The 3^{rd} term of an arithmetic progression is 6 and the 15^{th} term is 24. What is the 1^{st} term?

A. 0, B. 3, C.6, D.9,

26. The 1^{st} two terms of a geometric progression are 3 and 12, what is the 4^{th} term?

A. 192, B.108, C.48, D. 36,

27. The first term of a GP is 6. If its common ratio is 2, find the 6^{th} term.

A.60, B.72, C.96, D. 192,

28. The first term of an AP is equal to twice the common difference. Find in terms of d, the 5^{th} term of the AP.

A. 4d, B.5d, C.6d, D.a+5d,

29. What is the common ratio of the GP -36,-12,-4…….

A.-3, B. -2/3, C.-1/3 D 1/3,

30. The 6^{th} term of an AP is 26 and the 11^{th} term is 46. Find the AP.

A. 12,10,8… B. 8,12,16… C.6,21,-21… D.6,10,14…

Appendix II

QUESTIONNAIRE ON STUDENTS' ATTITUDES TOWARDS MATHEMATICS

The following questions are designed to collect information about students' attitude towards Mathematics. You are hereby requested to respond to the questions detailed below according to how you feel about each of them. Your responses shall be treated with strict confidence.

Section A

NAME OF SCHOOL:-...

CLASS: -..

SEX: -.. CLASS...

AGE..

SECTION B:

Tick (x) the space that best satisfies how you feel about each question. Only one space must be ticked among the options: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree

S/N		SA	A	D	SD
1	I am sure that I can learn mathematics				
2.	My teachers have been interested in my progress in mathematics				
3.	Males are not naturally better than females in mathematics				
4.	Mathematics is hard for me				
5.	I will need good understanding of maths for my future work				
6.	I am sure of myself when I do mathematics				
7.	Women can do just as well as men in mathematics.				
8.	Attitude of our teacher makes mathematics difficult for me				
9.	Mathematics helps me understand other subjects				
10.	I'm not the type to do well in mathematics				
11.	I am more confused in mathematics than in other subjects				
12.	Taking mathematics is a waste of time.				
13.	My parental background has helped improved my mathematics performance				
14.	Mathematics has been my worst subject.				
15.	I can get good grades in mathematics.				
16.	I think I could handle more difficult mathematics.				
17.	I feel at ease in mathematics class				
18.	Mathematics is a necessary and worthwhile subject				
19.	Mathematics is interesting and fascinating to me.				
20.	Mathematics is not important for my life.				
21.	I am not good in mathematics.				
22.	I study mathematics because I know how useful it is.				
23.	I hate seen my mathematics teacher				
24.	To me mathematics is a matter of compulsion				
25.	Mathematics is boring because it involves many processes.				

Appendix III

NUMERICAL ABILITY TEST (MAT)

(Adapted From Psycho-metric Success)

This test is designed to determine how best you can think mentally. The instrument consists of only one section with questions of different kinds, and of various degrees of difficulties. You have just 30 minutes to complete the test. Write your answers in the Answer Sheet Provided. As much as possible be independent in your work.

1. Which number comes next in this series?

   1 4 7 10 13 16

   a) 17 b) 19 c) 21 d) 25 e) none of these

2. What is p in this equation?

   $2 + (3xp) = 14$

   a) 2 b) 3 c) 4 d) 6 e) none of these

3. Good Friday was on the 10th April in one year. What day of the week was on the 5th June that year?

   a. Thursday b. Friday c. Monday d. Saturday

4. The sum of two numbers is 22 and their difference is 4. The numbers are

   a.12 and 10 b.16 and 6 c. 14 and 8 d. 13 and 9

5. Olu saw fifteen birds on a tree. He fired a gun. Only two birds fell down. How many were left on the tree?

   a.13 b. 17 c. 12 d. None

6. In an examination 65% of the total examinees passed. If the number of failures is420, the total number of examinees are

   a. 1500   b.1200   c.1000   d.1625

7. Out of an earning of N720, Jide spends 65%. His saving is

   a.N350   b.N390   c.N252   d.N316

8. In two hours, the minute hand of a clock rotates through an angle of

   a.720^o b. 180^o c. 360^o d. 540^o

9. The temperature of Lagos was 2^oC in the morning. The next morning it was -2^oC. What was decrease in temperature?

   a.3^o C   b. 4^oC c. -4^oC d. -2^oC

Arithmetic Questions

10. 139 + 235 =

   A) 372   B) 374   C) 376   D) 437

11. 139 - 235 =

   A) -69   B) 96   C) 98   D) -96

12. 5 x 16 =

   A) 80   B) 86   C) 88   D) 78

13. 45 / 9 =

   A) 4.5   B) 4   C) 5   D) 6

14. 15% of 300 =

   A)20   B) 45   C) 40   D) 35

15. ½ + ¼ x 3/4 =

   A)3/8   B) 13/8   C) 9/16   D) ¾

Number Sequences

These questions require you to find the missing number in a sequence of numbers. This missing number may be at the beginning or middle but is usually at the end.

16. Find the next number in the series

4   8   16   32   ---

A) 48 B) 64 C) 40 D) 46

17. Find the next number in the series

4 8 12 20 ---

A) 32 B) 34 C) 36 D) 38

18. Find the missing number in the series

54 49 --- 39 34

A) 47 B) 44 C) 45 D) 46

These number sequences can be quite simple like the examples above. However, you will often see more complex questions where it is the interval between the numbers that is the key to the sequence

19. Find the next number in the series

3 6 11 18 ---

A) 30 B) 22 C) 27 D) 29

20. Find the next number in the series

48 46 42 38 ---

A) 32 B) 30 C) 33 D) 34

21. Find the next letter in the series

B E H K ---

i) L ii) M iii) N iv) O

22. Find the next letter in the series

A Z B Y ---

i) C ii) X iii) D iv) Y

23. Find the next letter in the series

T V X Z ---

i) Y ii) B iii) A iv) W

Below are the sales figures for 3 different types of network server over 3 months.

Server	January		February		March	
	Units	Value	Units	Value	Units	Value
ZXC43	32	480	40	600	48	720
ZXC53	45	585	45	585	45	585
ZXC63	12	240	14	280	18	340

24. In which month was the sales value highest?

A) January B) February C) March

25. What is the unit cost of server type ZXC53?

A) 12 B) 13 C) 14

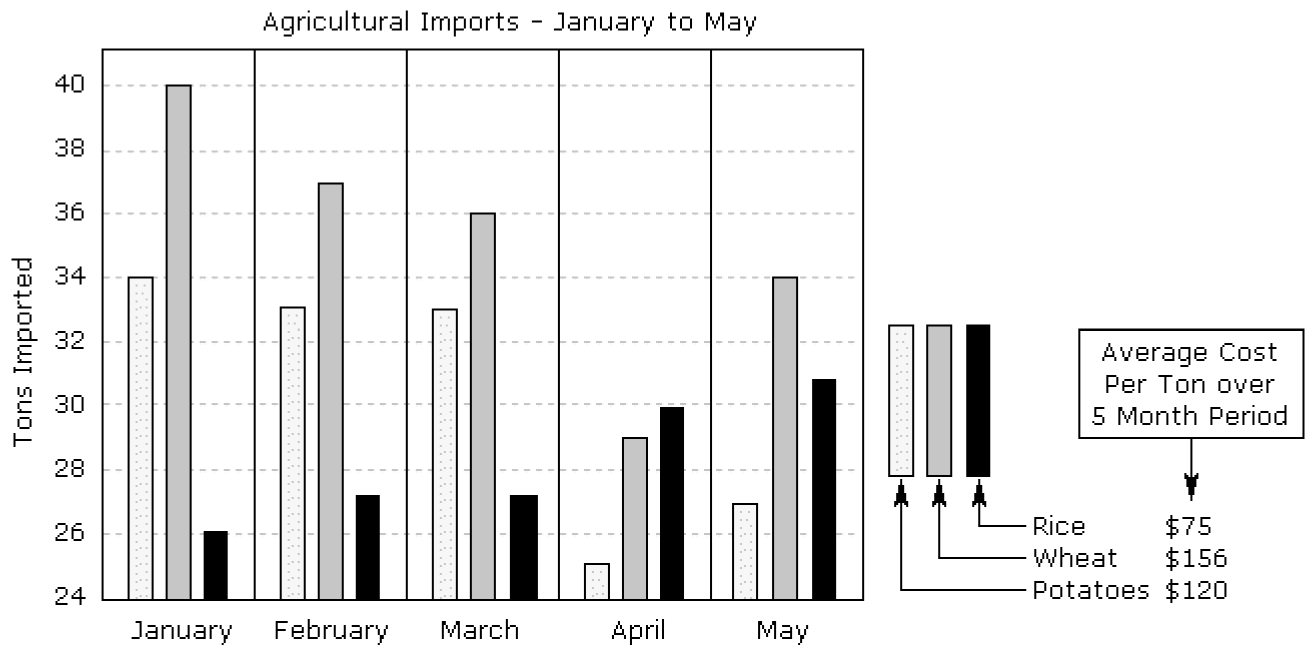
26. How many ZXC43 units could be expected to sell in April?

A) 56 B) 58 C) 60

27. Which server had its unit price changed in March?

A) ZXC43 B) ZXC53 C) ZXC63

Below are some figures for agricultural imports. Answer the following questions using the data provided. You may use a calculator for these questions:



28. Which month showed the largest total decrease in imports over the previous month?

A) March B) April C) May

29. What percentage of rice was imported in April?

A) 17% B) 19% C) 21%

30. What was the total cost of wheat imports in the 5 month period?

A) 27,500 B) 25,000 C) 22,000

Appendix IV

MNEMONIC INSTRUCTIONAL STRATEGY

TEACHING PLAN

Subject: Mathematics

Topic:

Objective:

Duration: 40 minutes

Step	Teacher's Activities	Students' Activities	Duration	Teaching Aids
I	The Teacher introduced the topic and wrote the mnemonic he had developed for the topic.	The students listened and wrote the topic and mnemonic in their note books	3	
2	The teacher explained the steps involved in applying the mnemonic to the topic given in step 1	The students listened to teachers' explanations.	5	
3	The teacher demonstrated with example how to apply the mnemonic given in step1 to solve mathematics questions on the topic of the day.	The students listened and copied the solution in their note books	10	
4	The teacher gave the students assessment questions to solve and moved round the class to offer assistance when needed.	The students solved the questions in the class, using the mnemonic given in step 1.	10	
5	At the expiration of the time allocated for the assessment questions, the teacher collected the students' notes for marking and did the corrections	The students copied the corrections in their notes.	5	
6	The teacher allowed students to ask questions on the topic and the strategy used.	The students listened to teachers' explanations.	5	
7	The teacher gave the students practice questions to be submitted the following day.	The students wrote the questions, solved at home and submitted for marking the following day	2	

Appendix V

Lesson Note for Mnemonic Instructional Strategy

Subject: Mathematics

Topic: Logarithms of Numbers Greater than 1 and Less than 1

Duration: 80 minutes

Instructional Objectives: At the end of the lesson, the students should be able to:

i) Develop mnemonics to solve logarithm problems

ii) Use logarithm tables to multiply and divide numbers

iii) Use logarithm tables to calculate powers and root of numbers greater than 1.

Step 1

Teacher's Activities: The teacher will introduce and write the topic to be taught on the chalk board.

Presentation: The topic to be discussed today is "Logarithms of Number Greater than 1 and Less than 1."

Definition: Logarithm is a series of numbers set out in tables which make it possible to work out problems in multiplication and division by adding and subtracting.

Students' Activity: The students will write the topic in their note books and listen to the teacher's definition of logarithm.

Step 2

Teacher's Activity: The teacher will guide students to develop mnemonics for the topic logarithm, using steps involve in logarithm problems.

Presentation: To solve mathematical problems of logarithms using mnemonic strategy, the teacher will list the following steps that are very important:

- Multiplication means Adding the logarithms of numbers
- Division means subtracting the logarithm of numbers

Students' Activity: The students will listen and generate their mnemonics.

Step 3

Teacher's Activity: The teacher will demonstrate with the mnemonic MADS he has adopted to solve logarithm questions.

Presentation: Evaluate using logarithm table

$$\frac{76.7 \times 308.2}{8.04}$$

Solution: To apply mnemonic MADS to the question above, first find the logarithm of 76.7 and 308.2 and add. Then find the logarithm of 8.04 and subtract it from the result of addition of logarithms of 76.7 and 308.2. Take the anti-logarithm of the difference to obtain the answer as follows:

Number	Logarithm
76.7 308.2	1.8848 2.4889
 8.04	4.3737 -0.9053
2941	3.4684

Therefore, $\frac{76.7 \times 308.2}{8.04}$ = 2940 to 3 s.f.

Students' Activity: The students will listen and copy the solution in their note books.

Step 4

Teacher's Activity: The teacher will give the students the following mathematical question to solve in the class. The teacher will be going round the classroom to ensure that they are doing the right thing and where necessary render assistance:

Presentation: Use tables to calculate the following. Give your answer to 3 s.f

i) $\frac{818.3 \times 72.5}{2.905}$

Students' Activity: The students will solve the question using the mnemonics they have developed or MADS the teacher has adopted, and hence follow the teacher's corrective help.

Step 5

Teacher's Activity: The teacher will allow students to ask questions on the mnemonic strategy and the topic of the day.

Presentation: Please ask questions on the topic covered today and the strategy applied if you need further clarification.

Students' Activity: The students will ask questions to ensure better understanding of the topic and the mnemonic applied.

Step 6

Teacher's Activity: The teacher will give students some mathematical questions to evaluate the lesson. Unlike the step 5, the teacher will only walk round the classroom, but will offer no assistance.

Presentation: Evaluate the following, giving each answer correct to 3 significant figures:

i) $\frac{45.6 \times 40.9}{72.5}$

ii) 3.925×0.01375

Students' Activity: Students will solve the problems in the class.

Step 7

Teacher's Activity: The teacher will grade the students' work and do the correction.

Presentation: The teacher will solve the mathematical problems as follows:

i)

Number	Logarithm
45.6 40.9	1.6590 1.6117
 72.5	3.2707 1.8603
2572	1.4104

Therefore, $\frac{45.6 \text{ x } 40.9}{72.5}$ = 25.7 to 3 s.f.

ii) Number	Logarithm
3.925 0.03175	0.5938 2.5018
0.1247	1.0956

Therefore, 3.925 x 0.01375 = 0.125 to 3 s.f.

Students' Activity: The students will listen and copy the solutions in their note books.

Step 8

Teacher's Activity: The teacher will give students some mathematical questions as take home assignment to be submitted the following day.

Presentation: Evaluate the following, giving each answer correct to 3 significant figures and submit tomorrow:

i) 42.87 x 23.82 x 1.27

ii) $\frac{0.06295}{0.08183}$

iii) $\frac{2.647 \times 0.00921}{0.05738}$

Students' Activities: The students will copy the questions in their note and submit their work for marking the next day.

Appendix VI
Prior Knowledge Instructional Strategy
Teaching Plan

Subject: Mathematics
Topic:
Objective:
Duration: 40 minute

Step	Teacher's Activities	Students' Activities	Duration	Teaching Aids
1	The teacher reviewed the previous topic and then introduced the new concept.	The students listened and wrote the topic in their note books	2	
2	The teacher gave students assessment questions based on the previous topic reviewed in step 1 to activate their prior knowledge.	The students solved the assessment questions.	5	
3	The teacher demonstrated with example how to apply previous knowledge to new concept.	The students listened and copied the example in their note books	10	
4	Teacher gave example covering both previous and new concepts for students to solve, while move round the class to offer assistance when needed by students.	The students solved assessment question.	10	
5	At the expiration of time allocated for the mathematical problems in step 4, the teacher collected their work and do the correction	The students will listen and write the correction in their note books.	8	
6	The teacher allowed the students to ask questions on the topic and strategy, and while he responded.	The students asked questions and listen to the teacher's explanations	3	
7	The teacher will give the students practice questions to be submitted the following day	The students wrote the questions in their note books and submitted their work for marking the following day.	2	

Appendix VII

Lesson Note for Prior Knowledge Instructional Strategy

Subject: Mathematics

Topic: Arithmetic Progression

Duration: 80 minutes

Objectives: At the end of the lesson, the students should be able to:

i) Apply their previous knowledge of substitution and simple equations to solve Arithmetic Progression mathematical problems.

ii) Find the pattern of a sequence

iii) Find the nth or last term of an Arithmetic Progression

iv) Calculate the sum of an Arithmetic Series.

Step 1

Teacher's Activity: The teacher will introduce the topic by writing it on the board

Presentation: The topic to be discussed today is Arithmetic Progression

Students' Activity: The students will write the topic in their note books

Step 2

Teacher's Activity: The teacher will review substitutions and simple equation that were already done previously and may facilitate the understanding of current topic, that is, Arithmetic Progression.

Presentation:

i) Find the value of $3(x + y)$ if $x = -2$ and $y = 7$

ii) Solve the equation $x + 13 = 5x – 7$

Solutions:

i) $3(x + y)$

Substitute for $x = -2$ and $y = 7$ to get

$3(-2 + 7)$

$= 3(5) = 15$

ii) $X + 13 = 5x - 7$

Collect the like terms

$X - 5x = -7 - 13$

$-4x = -20$

Divide by -4

$=-4/4 = -20/-4$

$= x = 5$

Students' Activity: The students will listen and copy the solutions in their note books.

Step 3

Teacher's Activity: The teacher will assess the students' understanding of the previous topics reviewed in step 2, using some mathematical questions. He will be moving round the classroom to assist where necessary.

Presentation: a) Evaluate the expression

$X^2 - X + P - PX$ when $X =-1$ and $P = 1$

b) Solve the equation $2(x + 3) = -4$

Students' Activity: Students will solve the questions in the class.

Step 4

Teacher's Activity: The teacher will demonstrate with examples how to apply previous knowledge of materials to understand the new topic

Presentation

i) Find the 5th and 8th terms of the sequence whose nth term is 2n + 1

ii) Given the AP 9, 12, 15, 18,………, find its 20th term

iii) The 43rd term of an AP is 26. Find the first term of the progression, given that its common difference is ½.

iv) Find the sum of the first 20 terms of the AP 16 + 9 + 2 + (-5) +…..

Solutions:

i) nth term = 2n + 1

Using substitution method, where n = 5, we get

5th term = 2 x 5 + 1

= 10 + 1 = 11

8th term = 2 x 8 + 1

= 16 + 1 = 17

ii) 20th term = a + (20 -1)d

Applying substitution method, where a = 9, d = 3

20th term = 9 + (19) x 3

= 9 + 57 = 66

iii) 43rd term = 26 = a + 42d

Applying substitution, and solve the ensuing simple equation, where a = ?, d = ½, to get

26 = a + 42 x ½

26 = a + 21

a = 26 – 21

a = 5

iv) S = 1/2n(2a + (n – 1)d)

Applying substitution and solve the simple equation that arises, where a = 16, d = -7 n = 20

S = ½ x 20 (2 x16 + (20 – 1) x -7)

= 10 (32 + 19 x -7)

= 10(32 – 133)

= 10(-101)

= -1010

Students' Activity: The students will listen and copy the solutions in their note books.

Step 5

Teacher's Activity: The teacher will write some mathematical questions covering both previous and current topics for students to solve in the class. The teacher will be walking round the class to give the students assistance.

Presentation

i) Evaluate u + at, if a = 10, u = 4 and t = 2

ii) Solve 6(3 – x) = 5(4 – x)

iii) The first and last terms of an AP are 0 and 108. If the sum of the series is 702. Find (a) the number of terms in the AP (b) the common difference between them.

Students' Activity: The students will solve the mathematical problems in the class.

Step 6

Teacher's Activity: The teacher will grade the student's work and do the correction.

Presentation: Solutions to the class work

i) u + at

Using substitution, where a =10, u = 4 and t = 2, we get

4 + 10 x 2

4 + 20 = 24

ii) 6(3 – x) = 5(4 – x)

Open the brackets

18 – 6x = 20 – 5x

Collect the like terms

-6x + 5x = 20 – 18

- x = 2

x = -2

iii) (a) S = 1/2n(a +l)

Using substitution method, where a = 0, l = 108

702 = 1/2n(0 + 108) 702 = 1/2n x 108

702 = 54n

Solve the simple equation and divide by 54

$n = 702/54$

$= 13$

The AP has 13 terms

(b) Using $L = a + (n - 1)d$

Using substitution where $l = 108$, $a = 0$, $n = 13$, $d = ?$

$108 = 0 + (13 - 1)d$

Solve the simple equation

$108 = 12d$

Divide by 12

$D = 108/12 = 9$

The common difference is 9

Student's Activity: The students will listen and write the corrections in their note books.

Teacher's Activity: The teacher will allow students to ask questions on both the strategy and the topic.

Presentation: Ask questions on the topic and the strategy used if need further clarification

Students' Activity: Students will ask questions on the topic and strategy applied.

Step 8

Teacher's Activity: The teacher will give students more practice questions as assignment to be submitted the next day.

Presentation: Assignment

(i) Given that $a = -2$, and $b = -3$, evaluate $a^2 - 2ab - b^2$

(ii) Solve $2(3x - 1) - 10 = 0$

(iii)The 28th term of an AP is -5. Find its common difference if its first term is 31

(iv)The first and last terms of an AP are 1 and 121 respectively. Find:

(a) The number of terms in the AP

(b) The common difference between them, if the sum of its terms is 549

Students' Activity: The students will write the questions in their note books and solve them at home.