EFFECTS OF TESTWISENESS TRAINING ON TEST-ANXIETY AND ACHIEVEMENT IN MATHEMATICS AMONG SELECTED SECONDARY SCHOOL STUDENTS IN EKITI STATE.

BY

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By

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DEDICATION

This work is dedicated to:

Almighty God

The Unquestionable God, Who Knows My Beginning and My End

And

My Beloved Parents, High Chief John Fakorede and Chief (Mrs.) Funmilayo Fakorede for giving me life, the right type of education and sacrificing so much to ensure my success in the race of life.

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ABSTRACT

This study investigated the effects of testwiseness training on test anxiety and achievement in Mathematics among selected secondary school students in Ekiti State. The moderating effect of gender and cognitive ability was also investigated. The study employed the pre test-post test control group, quasi experimental research design. A total of four hundred and twenty five (425) participants consisting of two hundred and nineteen (219) male and two hundred and six (206) female Senior Secondary two (SS2) students drawn from six secondary schools in Ado-Ekiti through stratified random sampling procedure participated in the study. Testwiseness training module and traditional teaching method were used as treatment approaches while the control group was exposed to only the traditional teaching method. Three instruments; Socio-Demographic Questionnaire (SDQ), Mathematics Achievement Test (MAT) and Mathematics Anxiety Rating Scale-Revised (MARS-R) were used to collect data for the study.

Eight hypotheses were formulated to guide the study and data collected were treated statistically using Analysis of Covariance while pair-wise comparisons were performed using Fisher's protected t-test. All hypotheses were tested at the 0.05 level of significance. Results of the data analysis revealed that testwiseness training was efficacious in improving the Mathematics performance of students and in reducing their Mathematics anxiety level while training in test-taking strategies was significantly most effective for low ability students. There was no gender difference in the students' performance in Mathematics. Testwiseness training was equally effective in helping both male and female participants in improving Mathematics achievement and managing their Mathematics Anxiety levels. Based on the findings of this study, some conclusions were drawn, a number of recommendations were made and some suggestions for further research were also stated.

TABLE OF CONTENTS

Contents **Page**

CHAPTER THREE: METHODOLOGY

CHAPTER FOUR: DATA ANALYSIS

CHAPTER FIVE: DISCUSSION OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

LIST OF TABLES

List of Figure

ABBREVIATIONS

The following abbreviations have been used in the thesis:

UTME	-	Unified Tertiary Matriculation Examination
WAEC	-	West African Examination council
WASSCE	-	West African Senior School Certificate Examination
SSCE	-	Senior Secondary Certificate Examination
CTT	-	Classical Test Theory
IRT	-	Item Response Theory
MIRT	-	Multi-dimensional Item Response Theory
SS2	-	Senior Secondary Two
JSS	-	Junior Secondary School
S-R	-	Stimulus-Response Connection
PMA	-	Primary Mental Abilities
NECO	-	National Examination Council
CA	-	Continuous Assessment
MARS	-	Mathematics Anxiety Rating Scale
MARS-R	-	Mathematics Anxiety Rating Scale-Revised
NAS	-	Number Anxiety Scale
STM	-	Science, Technology and Mathematics
ANCOVA	-	Analysis of Covariance
MBE	-	Multi State Bar Examination
IQ	-	Intelligent Quotient
TTM	-	Testwiseness Training Module
SDQ	-	Socio-Demographic Questionnaire
MAT	-	Mathematics Achievement Test
LMA	-	Learning Mathematics Anxiety
MEA	-	Mathematics Evaluation Anxiety

APA - American Psychological Association

LIST OF APPENDICES

Appendix **Page**

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Over the years, the result of students' performance in Mathematics at the Senior Secondary Certificate Examination shows a persistent problem of poor performance (Adegboye, 1998). While teachers and parents are concerned about this, many students also see Mathematics as one of the highest hurdle to cross in their academic life. Mathematics is regarded as a basic tool in the development of any science based knowledge for sound analytical reasoning in daily living in a modern society such as ours (Babalola, 1994).

There are new trends and developments in Mathematics education relevant to our educational efforts in this period of rapid expansion. Some of these are partly responsible for the philosophy behind the Mathematics curricula which are based on the objective of Mathematics education set out in the National Policy on Education, the categories of students that will be utilizing Mathematics for various purposes (utilitarian values) and other values such as cultural and disciplinary issues. The Nigerian government, in her quest to achieving scientific and technological progress, has introduced a number of innovations, policies and practices aimed at encouraging the learning of science in schools. This is because of the nation's need for technological development and advancement of which Science, Technology and Mathematics have vital roles to play. It is expedient that Mathematics teachers know what to teach, when to teach, how to teach and why students are having difficulties in passing Mathematics examinations. Mathematics teachers also have a responsibility to know how to stimulate productive thinking among students. One of the objectives of science is the understanding of nature and part of this understanding is the ability to explain and predict events and phenomena.

Colliers (1997) opined that science is not only an intellectual and practical activity; it is also a social one. The social, intellectual and practical aspects of science are interlocking and help to characterize the enterprise of science. It is within this changing scenario that problem-solving as an activity comes into a sharper focus. In science Education, researchers in performance, attitudes and problem-solving have identified the distinctiveness of science. It is agreed that the various disciplines have their own central concepts and that the concepts of a discipline form a network of relationship with the discipline. Students without conceptual knowledge of Mathematics will find it difficult to solve Mathematical problems and may be enveloped by fear of the subject; hence may perform poorly in tests or examinations. However, poor performance in Mathematics has been attributed to many factors which are traceable to the students, teachers, policy makers, curriculum and the examination (Asun, 1986; Bajah 1996).

Adedayo (2006) attributed poor performance in mathematics examinations to many factors among which are; language problem, teachers' attitudes and methods, students' self-concept and interest, overcrowded classrooms, examination system, testing organization factor, the government, school problems, the society, mathophobia (irrational fear of mathematics), test anxiety, gender stereotypic among others. Adedayo (2006) further classified these identified factors into two. They are social and psychological constraints to the teaching and learning of the subject. The social constraints are the social factors that hinder students' achievement in mathematics which includes; parents, teachers, policy makers on education and the society in general. The psychological constraints are the factors that hinder students' achievement in mathematics such as; mathophobia (irrational fear of mathematics), mathematics anxiety, low self-concept, lack of interest by the student and gender stereotypic image.

Obe and Nigwo (1999) summarized the Mathematics Chief Examiners' reports on variables leading to students' poor performance in Mathematics. The variables identified in the reports include: - Lack of interest in the subject, low quantitative aptitude, weak memory for formulas and inability to derive them, poor comprehension for worded problems, fear of the subject, fear of the Mathematics teachers, avoidance of numbers/figures, absenteeism and lateness to class.

The Federal Government of Nigeria (2008) placed Mathematics in a core position at all levels. By the provision of the curriculum, students are not only expected to acquire Mathematical skills but also be able to apply them in their daily undertakings. All these have been said about government's intention to promote performance in Mathematics. The questions to be asked are: Has it worked? Has there been any significant success recorded in terms of improving students' performance in the subject in external examinations such as Unified Tertiary Matriculation Examination (UTME) and Senior Secondary Certificate Examination (SSCE)? Are candidates scoring well in these examinations (perhaps better as the years go by)? There is one common answer to these questions and that answer is "NO". Alonge (1986) in a survey of WASCE results between 1976 and 1982 found that less than ten percent of the candidates obtained grades that qualified them for courses in science and technology-based disciplines in tertiary institutions. This trend is disturbing considering the fact that the result of secondary education is a pre-requisite for students' entry into tertiary institutions. In essence, the nation's potential for development in Science and Technology is directly tied to secondary education output. A closer look at West Africa Examination Council (WAEC) report between 1999 and 2008 presented in Table1, showed that on the average, only a small proportion of students in Nigeria passed Mathematics at credit level and above in Senior Secondary School Examinations although between 2006 and 2008 there was a slight improvement in the percentage pass but there is still the need for improvement.

Table1: Summary of May/June (SSCE) Mathematics Results (Nigeria) from 1999-2008.

Year	Total Entry	Total Passes at credit level and above(1- 6)	Percentage Pass
1999	756,680	138,098	18.25
2000	643,371	203,244	32.81
2001	1,023,102	373,955	36.55
2002	1,078,901	309,409	34.06
2003	936,506	341,928	36.91
2004	844,525	287,484	34.52
2005	730,379	282,394	38.66
2006	1,149,277	472,674	41.12
2007	1,249,028	584,024	46.15
2008	1,268,213	726,398	57.27
Average	967,998	371,959	37.63

Source: WAEC (1999 – 2008) Research Division Annual Reports.

The situation is not just the low scores recorded but also the fact that scores obtained are not most often true representative of students' abilities. This can be linked to a number of factors such as nature of mathematics test items, guessing tendency, testwiseness and anxiety. The nature of mathematics test items is a serious problem which needs to be investigated. Akpan (1989) opined that mathematics tests are always problem-laden in the sense that a particular item could call for additive ability, multiplicative ability and other complex mathematical manipulations. Based on these, there are normally no step-by-step answers needed in Mathematics objective tests. The failure of an examinee to arrive at the right answer always carries penalty of scoring zero and hence poor performance.

Unidimensionality, an assumption of item response theory holds that, for objective and valid measurement, an instrument must be designed for and used to measure one and only one characteristic or variable. That is, all items must be developed to measure or call for one and only one trait or attribute (Nenty, 2004).

Nickson and Green (1996) found that the degree or context in which mathematics achievement tests are set can create fear for the subject and also affect students' selection of the correct Mathematical operator. It seems necessary to identify the degree of contextualization which is facilitating for students of different abilities.

Quality test items are essential in developing and conducting a successful examination. A good test is as good as the quality of the test items. When individual test items are not appropriate and students do not perform well, test scores from these items cannot be meaningful. In other words, the validity and reliability of such items are questionable (Donath, 2001).

In testing, guessing is considered a problem. This is because it allows testees to score points on chance rather than sure knowledge of the subject. Some test specialists consider this unfair to students who actually know the content area being tested. Guessing reduces objectivity of tests and it makes it difficult to distinguish between a testee who has guessed correctly and the one who actually knows the answer.

Investigating testwiseness is also important to test experts. Scruggs and Mastropieri (1992) opined that a testee who is testwise can outperform a testee of equal ability but who lacks test-wiseness. It is vital that testees master the content of the tests they take but it is also important that testees are knowledgeable and experienced in various test formats and the characteristics of the testing environment. There is a difference between teaching test-taking strategies and "teaching to the test". According to Scruggs and Mastropieri (1992), the latter involves teaching specific item that will appear on the test. Teaching test-taking strategies helps testees to understand the format and convention of a specific type of test and makes them feel comfortable in a testing environment. Learning test-taking strategies actually improves the validity of a test by making scores reflect more accurately what a testee knows. A test-wise testee will answer a question incorrectly only if he or she does not know the content, not because the test format is confusing or intimidating (Scruggs and Mastropieri, 1992). Recent thinking in educational measurement and in language testing recognizes the need to include in the investigation of construct validity, information about how test-takers go about processing test tasks and relating this information to test content and test performance. Anderson (1991) reported that instruction in test-taking skills leads to reduced anxiety and increased confidence in the test situation. In view of this, instruction in testwiseness would serve the purpose of increasing testees' confidence during test-taking.

Richardson and Suinn (1972) stated that mathematics anxiety involved feelings of tension and anxiety that interfere with the manipulation of number and the solving of mathematical problems in a wide variety of ordinary life and academic situation. Implicit in this description is the assumption that mathematical anxiety is a causative agent of some impairment of mathematical functioning. Surprisingly, while there has been a good deal of theoretical surmise about the process by which such an agent would act (Ashcraft and Kirk, 2001; Cooper and Robinson, 1991), there had been a little attempt to verify such causative actions by experiment and observation.

In view of this, the present study attempted an investigation of all the aforementioned variables such as testwiseness and test-anxiety as related to students' performance and thus explored the effectiveness of teaching students to be "test wise" and confident test-takers.

1.2 Statement of Problem

Academic success in any discipline is generally measured in terms of test performance for which knowledge of the content area is a major pre-requisite. In addition to this, students should be able to read and understand instructions and test items based on the knowledge acquired during teaching and learning processes and most importantly work independently with confidence to give correct responses to questions. Ability to acquire this skill and other test-taking skills is essential for obtaining high scores in a test.

Over the years, many researchers have pondered on the academic performance of students especially in secondary school mathematics. While some students perform well, others perform poorly. A lot of factors have been identified as responsible for the differential performance among students. Most studies focusing on the level of examination performance centered on factors such as teacher factors (Isichei and Ubangha, 2007), student factors (Ubangha, 1999; 2000), curriculum (Kalejaiye, 1985), school and classroom environment (Okebukola, 1986).

Despite all the recommendations made for improvement by these researchers, the level of academic performance in secondary school mathematics is still observed to be very low. This situation needs to be addressed because mathematics is one of the oldest and most important subjects in the Nigerian educational system. The subject has gained a lot of attention over the years to the point that it has become a core subject and a pre-requisite for admission of candidates into most first degree programmes in the universities. Students are not only required to pass Mathematics at credit level in Senior Secondary Certificate Examination (SSCE) but also write the subject in the Unified Tertiary Matriculation Examination (UTME) to qualify for admission into certain courses. This has rather yielded more problems than solutions. Students dread the subject and courses related to it. The common practice for students is for them to believe that they can guess and cheat to answer questions during examinations. This is quite an unfortunate situation, and it completely mars the psychometric implication of testing.

Efforts aimed at improving students' performance in mathematics have centered on mastery of facts or concepts and other learning strategies with no attempt at incorporating test taking skills into the Mathematics curriculum. The time has come when the teachers of Mathematics at all levels of educational endeavor should explore certain age long assumptions regarding the teaching, learning and preparation of students for Mathematics examinations. It is surprising; however, that little research has actually investigated the effect of testwiseness training and cognitive ability on students' performance in mathematics at the Senior Secondary Certificate Examination (SSCE).

It is also not clear, and, research evidence appears to be contradictory and inconclusive regarding the relationship between test performance in mathematics and gender and whether this relationship, if any, is mediated by cognitive ability and test anxiety (Chang and Mazzeo, 1994; Adebayo, 2006). In the opinion of this researcher, there is also paucity of studies on the effect of training in testwiseness across various cognitive ability levels and whether test anxiety in Mathematics varies between male and female students. Testwiseness has widely been defined as an individual's ability to improve his or her test score by recognizing and utilizing cues in the test items, format or test situation. Empirical studies by Schunk (1991) shows that test-anxious students usually have low level of self-efficacy. They feel helpless and unable to influence testing events. A few researches also indicate that testwiseness is an important correlate of test anxiety; testwise students tend to perceive test as less threatening than test-naïve students (Sapp, 1999).

Based on these assertions, it becomes necessary to explore if training in testwiseness will be effective in improving students' test scores in mathematics and whether the interaction of training, gender and cognitive ability will have a significant effect on the students' test anxiety and students' performance in mathematics. The researcher therefore focused on the study of testwiseness in order to determine its effect on Mathematics anxiety and performance of students.

1.3 Theoretical Framework

The theoretical framework of this research is hinged on:

1.3.1 Cognitive Insight Theory of Learning

1.3.2 Polya's Theory of Teaching Mathematics

1.3.3 Theories of Anxiety

1.3.1 Cognitive Insight Theory of Learning emphasizes the role of understanding, insight, and intellectual interpretation in the learning process. The cognitive theorists would regard learning as trial - and - error problem solving (similar as stimulus-response reinforcement) but that between the stimulus and final response, there are intervening variables. These intervening variables are significant cognitive or brain processes by which "mental maps" are constructed for guiding the individual's performance. Brunner (1960), Kohler (1925) and Tolman (1932) emphasized intellectual process of learning as against the outcome of learning. They emphasized wholistic approach to the perception of the totality of the learning tasks. Kohler (1925) opined that insightful learning is sudden awareness of relationship between a given purposive behavior or activity and achievement of a desired goal. It emphasizes self-discovery and wholistic approach to learning situation.

According to Bruner (1960), discovery learning is an inquiry-based, constructivist learning theory that takes place in problem solving situations where the learner draws on his or her own past experience and existing knowledge to discover facts and relationships and new truths to be learned. Students interact with the world by exploring and manipulating object, wrestling with questions and controversies, or performing experiments. As a result, students may be more likely to remember concepts and knowledge discovered on their own. Models that are based upon discovery learning include: guided discovery, problem-based learning and simulation-based learning, amongst others. Gestalt theories of learning involve active participation of the students through the guidance of the teacher to discover things by themselves. This is important because when the students are directly involved and they discover the principle underlying the task, the tendency to remember quickly is high because they remember what they do, feel and see. Cognitive insight theory focuses on the role of understanding, insight and intellectual interpretation. It implies therefore that, teachers of Mathematics need to adopt the best strategies to teach students to their understanding. Students must have an insight and intellectual interpretation of the concept taught in the learning process. This may eventually affect their attitude positively towards the subject and alleviate their fear of Mathematics examination and hence, improve their performance.

1.3.2 Polya's Theory of Teaching Mathematics

Polya (1957) identified four phases of problem-soliving as understanding the problem, devising a plan, carrying out the plan and looking back. According to Polya, the first phase, understanding the problem is often the most difficult and probably the most fundamental step. At this stage, effort is made to form suitable mathematical model, define related terms, reject extraneous information and analyze what we want to do. In the process, attempt are made to search for a pattern relationship or similarity with problems earlier solved. This is followed by the second method which is devising a plan for the solution of one given problem. At this stage, all mathematical skills and techniques previously acquired are called to play. It is at this stage that we often discover whether we have sufficient skills and techniques necessary for solving the problem at hand or not. Next to this is carrying out the plan. This involves the use of the plan obtained earlier to find the solution to the problem. The last phase is looking back, which involves the checking of the result obtained, checking the argument used, exploring the possibility of deriving the result through a different approach and finally looking into the possibility of deducing generalization of such a result.

Polya (1957) asserted that an instructor or teacher needs to understand a problem, devise a plan for solving the problem, carry out the plan successfully and look back to find out if the problem has been resolved. He described these as the four necessary phases required in solving Mathematical problems. Polya (1957) identified problem-solving as a major problem in the teaching and learning of Mathematics. A problem is a difficult issue or event which has to be solved. It is an issue which is completely new to an individual and to which he or she has no ready-made response or method of solution. Solving a problem therefore means finding a way out of a difficult situation. Polya (1957) identified the problems area in problem-solving as:

(i) Incomplete understanding of the problem due to lack of concentration

(ii) Rushing into calculation without any plans of ideas

(iii) In carrying out the plans, the most frequently faults are impatience in checking each steps and carelessness

(iv) Failure to read through the work

The principles in Polya's phases of problem-solving are relevant to ideology of testwiseness. Testwiseness principles emphasized on the method of solution to a problem rather than the solution itself and this can be linked to the four phases of problem-solving (Understanding the Problem, devising a plan, carrying out the plan and looking back) as identified by Polya (1957). These phases in Polya's theory of solving mathematical problems corroborate with deductive reasoning, time using strategies, cue using and error avoidance strategies as found in teswiseness principles. Understanding the problem is often the most important and probably the most fundamental step because it involves forming a suitable mathematical model to be defined in related terms, rejecting extraneous information and analyzing the questions. Student solving problems in Mathematics need to apply variety of testwiseness strategies which includes elimination of options known to be incorrect, using content information from the stem (question), work quickly and efficiently, setting up a schedule for progress through the test, avoid minor mistakes, pay careful attention to directions, determining clearly the nature of the task and the intended basis of response or other test information in arriving at correct solutions to mathematical problems. In devising plan for solutions to Mathematics questions, all mathematical skills and techniques previously acquired need to be called to play and also all results obtained at every stage of problem solving need to be verified for accuracy or correctness.

1.3.3 Theories of Anxiety

Each of the major theoretical orientations has conceptualized anxiety somewhat differently in accord with its own views of what constitutes grave danger or threat for people. Thus Freudian formulations emphasize the breakthrough into consciousness of unacceptable impulses, learning theories focus on association with painful or aversive stimulation and phenomenological-existential theories stress the perception of a basic threat to the self or to the individual's very existence as a personality. Still other formulations of anxiety construe it mainly as a state of distress and helplessness in which the organisms have no alternatives. Theory of anxiety will be discussed under the following subheading:

(i) Learning Approaches to Anxiety

(ii) Mathematics Anxiety

Learning Approaches to Anxiety

Dollard and Miller (1983) combined basic learning principles with Freudian psychoanalysis. Dollard and Miller (1983) maintained that anxiety is a learned drive because it is associated with previously recorded mental cues. Anxiety is seen as motivating the person to perform behavior capable of reducing that tension. The person therefore learns which behaviours are capable of reducing anxiety in particular situations. The renowned behavior therapist, Wolpe (1958) views anxiety as a classically conditioned response that is inappropriately learned in response to situations which should not be fear-arousing for the person. This is consistent with Freud's notion of neurotic anxiety, even though Wolpe's explanation of the origins of anxiety differs from that of Freud.

The Social learning approach to anxiety views anxiety as an inability to deal with potentially painful or aversive situations (Bandura, 1977). How does one arrive at the conclusion that a situation may lead to adverse consequences? Consistent with his comments about all learning, for example, the person who has fear of dentist may have developed this fear on the basis of his own previous experiences with the dentist or through observations of the pain of others. Anticipation can lead to severe tension or anxiety and to defensive behavior such as running out of the waiting room in the dentist's office. This is a difficult cycle to break because anxiety is likely to continue unless the person observes a new situation in which the stimulus (dentist) does not lead to undesirable consequences. However, this is unlikely to occur because his defensive behavior of running out of the office removed him from the potential source of painful consequences.

Mathematics Anxiety

Round and Hendel (1980) identified two factors labeled Mathematics Test Anxiety and Numerical Anxiety. Mathematics Test Anxiety involves anticipation, completion and receiving the results of mathematics tests. Numerical Anxiety refers to everyday concrete situations requiring some form of number manipulation. Round and Hendel (1980) discovered that mathematics anxiety was dimensional. They concluded that anxiety about mathematics may be situation ally specific and not transituational. In essence, mathematics anxiety is less a response to mathematics than a response to evaluation of mathematics skills, that is, when used as diagnostic label for an individual client, mathematics anxiety as represented by Mathematics Anxiety Rating Scale total score provide little useful information and may mislead a client or counselor to conclude that the client is anxious about mathematics irrespective of setting. Resnick, Viehe and Segal (1982) identified three factors rather than two. These factors includes; Evaluation Anxiety, Social Responsibility Anxiety and Arithmetic Computation Anxiety. Factor one and three appeared to overlap with the factors labeled by Rounds and Hendel (1980) as Mathematics Test Anxiety and Numeracy Anxiety. The Evaluation Anxiety involves anticipation and receipt of mathematical work that was to be evaluated. The social responsibility Anxiety refers to an individual's fiscal or arithmetic responsibility in organization and clubs. The third factor, Arithmetic Computation Anxiety involves everyday situations requiring arithmetic computations. An individual with mathematics anxiety tends to avoid environments and careers that require the utilization of mathematics skills (Ashcraft, 2002). Therefore, it can be inferred that mathematics anxiety may have influences on students' learning of mathematics and career choice.

1.4 Purpose of Study

The primary purpose of this study was to determine the relative effectiveness of training in testwiseness on test anxiety and achievement in Mathematics among Senior Secondary school students. Additionally, the main effect of training, gender and cognitive ability and their interaction term on Mathematics achievement and anxiety were investigated.

Specifically, the objectives of the study were to:

1. Investigate the relative effect of training in testwiseness on Secondary School Students' performance in Mathematics achievement test.
2. Examine the influence of gender on post-test Mathematics achievement of students in the treatment and control groups.
3. Examine the effect of testwiseness training on students' Mathematics anxiety.
4. Investigate whether male and female students will significantly differ in their Mathematics anxiety level due to experimental conditions.
5. Determine the relative effect of testwiseness training and ability on post test Mathematics achievement test scores of students of different ability levels.
6. Investigate the relative effect of testwiseness training and ability on post test Mathematics anxiety scores of students of different ability levels.
7. Examine the influence of gender on post-test Mathematics achievement of students of different ability levels in the treatment and control groups.

8. Investigate whether male and female students of different ability levels will significantly differ in their Mathematics anxiety level due to experimental conditions.

1.5 Research Questions

The study was guided by the following research questions:

1. Would training in testwiseness lead to significant improvement in the post test Mathematics achievement scores of secondary school students?
2. Is there any gender difference in Mathematics achievement test scores due to exposure to testwiseness training?
3. Is there any significant effect of testwiseness training on Mathematics anxiety of students in the experimental groups?
4. Would male and female students in the treatment and control groups significantly differ in their post-test Mathematics anxiety?
5. Would there be significant difference between students' ability levels and Mathematics post-test achievement due to exposure to training in testwiseness?
6. Would there be significant difference between students' ability levels and Mathematics post-test anxiety due to exposure to training in testwiseness?
7. Would male and female students of different ability levels in the treatment and control groups significantly differ in their post-test Mathematics achievement test scores?
8. Would male and female students of different ability levels in the treatment and control groups significantly differ in their post-test Mathematics anxiety?

1.6 Research Hypotheses

The following null hypotheses were formulated to guide this study:

1. There is no significant difference in post-test Mathematics achievement between students exposed to testwiseness training and those not exposed to testwiseness.
2. There is no significant difference in post-test Mathematics achievement of students in the two experimental conditions due to their gender.
3. There is no significant difference in post-test Mathematics anxiety of students exposed to training in testwiseness and those not exposed to testwiseness.
4. Male and female students in the treatment and control groups will not significantly differ in their post-test Mathematics anxiety.
5. There will be no significant difference in Mathematics post-test achievement of high, moderate and low ability students who received training in testwiseness and those who do not.
6. There will be no significant difference in Mathematics post-test anxiety of high, moderate and low ability students exposed to training in testwiseness and those not exposed to teswiseness.
7. There will be no significance difference in post-test Mathematics achievement between male and female students of low, moderate and high ability exposed to training in testwiseness and those not exposed to training in testwiseness.
8. There will be no significance difference in post-test Mathematics anxiety between male and female students of low, moderate and high ability

exposed to testwiseness training and those not exposed to testwiseness training.

1.7 Scope and Limitation of Study

The study focused on students' performance in multiple-choice questions (MCQs) in mathematics. The study was carried out with Senior Secondary School Two (SSS2) Students in Ekiti State and it was restricted to six selected Secondary Schools in Ado in Ekiti central senatorial district. One of the major difficulties the researcher encountered was harmonizing the mathematics timetable for the six selected schools in order to avoid clashes and travelling time during the experimental period among the schools. There was an initial disinclination to adjust mathematics period on the timetable by the participating schools but after series of appeal and careful justification to the school authorities by the researcher the periods were adjusted.

The extremely large number of students in the classes, as a result of shortage of accommodation made the experimental treatment tedious. The interference from non-participating classes was also another constraint. Furthermore, the study was not extended to many other schools in Ado in Ekiti central senatorial district due to constraint of time. Despite the restricted nature of this study, the researcher is optimistic that the result can be generalized to all schools in Ekiti State and Nigeria as a whole.

1.8 Significance of the Study

This study is significant in the sense that it would be beneficial to the following categories of people: the students, teachers, parents, counsellors and researchers.

The study would make students more knowledgeable with tests and reduce their test anxiety. They would be better equipped with skills and strategies which may assist them in answering multiple choice questions correctly.

The study would also enable teachers and cousellors to identify testwiseness training as an option or strategy to use against the debilitating effects of test anxiety on classroom performance. It is hoped that performance would be improved if the debilitating effects of anxiety are reduced among our students.

Furthermore, in a country such as Nigeria, where teacher effectiveness is often measured in terms of students' performance, such improved student performance would enhance the image and motivation of the teacher. Specifically, the study would improve the teaching and learning of Mathematics in schools and also will reveal to teachers the positive effects of teaching students to be “testwise”.

Educational psychologists and counselors, will be able to determine through this study those factors that affect students’ test scores and determine an effective intervention strategy to be adopted in order to improve students’ examination scores especially in multiple choice questions (MCQ)

Conclusively, the study would serve as a reference material for other researchers.

1.9 Definition of Terms

Testwiseness: is the ability to manifest test-taking skills which utilize the characteristics and formats of a test and/or test-taking situation in order to receive a score commensurate with the abilities being measured. It is a participant's capacity to utilize the characteristics and format of the test/ or test- taking situation to receive a high score.

Test Anxiety: is the anxiety students exhibit before, during or after test situations. The perceived threat of a test and test-like situations arises from several sources. These include: task difficulty, the formalities of testing, physical setting for the testing and the notion about test as a hurdle to be overcome.

Mathematics Anxiety: This refers to a feeling of tension and worry that interferes with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations (Richardson and Suinn, 1972). Mathematics anxiety refers to a state of anxiety in response to situations involving Mathematics which are perceived as threatening to self-esteem. If self-esteem is basically strong and there is a certain level of task-related confidence, the individual may be able to control the anxiety and channel it into the task. When this occurs the anxiety might facilitate performance. However, if the individual is unable to control the anxiety, it can debilitate performance.

Mathematics Achievement Test: Test, be it (Essay/objective) is a measure of behavior designed to measure the extent to which an examinee has acquired certain information or mastered certain skills usually (though not necessarily) as a result of specific instruction (Bloom, 1981). Obe (1980) defines achievement test as a test constructed to measure how much students have learnt in a school subject. In this study, Mathematics achievement refers to the proficiency in the learning of mathematical concepts determined by the students' performance in terms of scores in some selected concepts in Mathematics. It refers to the performance of the students on a researcher compiled 50-item multiple choice objective test in Mathematics. The questions were drawn from relevant topics from past question papers in the Senior Secondary Certificate Examination (SSCE).

Intact Class: This refers to a group of students in a given classroom. There are situations when randomization of individuals may not be feasible especially in Mathematics research, so intact classes are used for studies. In this study an intact class consists of all the students in a given classroom in a Senior Secondary School such as SS 2A, SS 2 Gold, and so on not selected by proper randomization.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Introduction

This chapter focuses on the previous work carried out by various researchers which are of relevance to this study.

The review of relevant literature was done under the following sub-headings:

(i) The Notion about Mathematics

(ii) Importance of Mathematics Education

(iii) Students' Understanding of Mathematics and its language

(iv) The Teaching of and the Teachers of Mathematics

(v) Theories of Intelligence

(vi) Theories of Learning

(vii) Concept of Test as a Measuring Instrument

(viii) Factors that Influence Responses to Test Items

(ix) Concept of Mathematics Anxiety

(x) Studies on Gender difference and Achievement in Mathematics

(xi) Guesswork and The Effect of Guessing on Multiple – Choice Assessment

(xii) Studies on Testwiseness Taxonomies

(xiii) Testwiseness, Gender and Ability as Correlates of Test Anxiety

(xiv) Prior Academic Ability and Students' Mathematics Performance.

2.1 The Notion about Mathematics

Tobias and Ernest (1998) opined that many people regard Mathematicians as Magicians possessed by supernatural powers. Although this is very flattering for successful mathematicians it is yet very bad for those who for one reason or the other are attempting to learn the subject. Many students feel that they will never be able to understand mathematics and they prefer not to attend Mathematics lesson at all because of their belief that it is a dreadful subject. It is extremely very bad for human beings to present the habit of cowardice in any field. The ideal mental health is to be ready to face any challenge which life may bring.

There are different opinions among those involved in research into the causes and treatment of mathematics anxiety. Lazarus (1987) asserts that without a complete re-education in mathematics little can be accomplished on mathematics anxiety. Shatex (1984) also asserts that anxiety is a function of academic deficiencies and must be treated through instructional processes. Tobia and Ernest (1986) posited that Mathematics anxiety is related to demographic and societal factors and should be effectively treated through intervention strategies having both instructional and therapeutic components.

The nature of mathematics has been the focus of much writing over the last few decades (Begg, 1994, 2005; Dossey, 1992; Presmeg, 2002; Winter, 2001). Dossey (1992) argues that different conceptions of mathematics influence the ways in which society views mathematics. This can influence the teaching of mathematics, and

communicate subtle messages to children about the nature of mathematics that affect the way they grow to view mathematics and its role in the world. Similarly, Presmeg (2002) argued that beliefs about the nature of mathematics either enable or constrain "the bridging process between everyday practices and school mathematics".
Different dichotomies have been used to highlight the contrasting ways in which mathematics is viewed. Dossey (1992) distinguished between external conceptions of mathematics held by those who believe that mathematics is a fixed body of knowledge that is presented to students, and internal conceptions that view Mathematics as personally constructed, internal knowledge. Begg (1994, 2005) contrasted mathematical content (knowledge and procedures) with mathematical processes (reasoning, problem-solving, communicating and making connections). Winter (2001) has written about a tension between a mechanistic view of mathematics (as in the development of skills and knowledge), and mathematics as a means towards fostering citizenship and responsibility within society (the development of personal, spiritual, moral, social and cultural dimensions).

A distinction has been made between mathematical activity carried out for its own sake and mathematical activity that is useful for something else (Huckstep, 2000). In order to distinguish between the aims and purposes of mathematics education, Huckstep (2000) asks: "What are we trying to do in mathematics education?" and "What are we trying to do it for?" This particular dichotomy is closely related to the debate about what is mathematics and what is numeracy (Hogan, 2002; Stoessiger, 2002).

Definition of numeracy emphasizes the practical or everyday uses of mathematics in contexts such as homes, workplaces and communities (Stoessiger, 2002).

Odili (1990) defines mathematics as a science precise in method and faultless in logic and that if a person is exposed to it systematically for a sufficient time usually through a course of study, he is bound to be influenced by its contents, method, logic and procedures. According to Olayinka and Omoegun (1998) mathematics is the core of all subjects and the language of science, for there is nothing we do that does not have, at least, an element of mathematics. Even, the date of the year is mathematical. Consequently, there is the need for every student to have an appreciable amount of mathematical knowledge. It is this importance of mathematics that has led the Nigerian government to make it a compulsory subject in Primary, Junior Secondary and Senior Secondary Schools as well as for admission into higher institutions.

Procter and Stock (2004) viewed mathematics as the science of numbers, quantity and space. Smith (1990) in his opinion refers to mathematics as a 'filter' because of the role it plays in the admission process into schools and employment opportunities. This is because, to be admitted to study science based courses and majority of other related courses, one needs a good knowledge of mathematics. For example, degrees in the following areas require good knowledge of mathematics and statistics:

(i) The physical sciences (such as Chemistry, Physics and Engineering)

(ii) Medicine

(iii) The life and health sciences (such as Biology, Psychology, Pharmacy, Nursing and Optometry)

(iv) Business and Commerce

(v) The Social sciences (including Anthropology, Communications, Economics, Linguistics, Education and Geography)

(vi) The Tech sciences (like Computer science, Networking and Software development)

(vii) Actuarial science (Used by insurance companies)

Furthermore, poor performance in the subject will bar one from a variety of careers and lifestyle associated with them. Ojerinde (1999) defined mathematics as the communication system for those concepts of space, shapes, sizes, quantity and orders used to describe diverse phenomena both in physical and economic situations. According to Fakuade (1977) mathematics is a tool for use in science, technology and Industries. It is believed that once a country breaks through in science and technology it will be highly rated by other countries. The key to such breakthrough is mathematics because it has a privileged function of exerting decisive influence on the nation's technological breakthrough.

2.2 Importance of Mathematics Education

Laure (2008) asserted that students who choose to ignore Mathematics, or not take it seriously in school forfeit many future career opportunities that they could have. They essentially turn their backs on more than half the job market. The vast majority of university degrees require Mathematics as an entry requirement. The importance of Mathematics for potential future careers cannot be over emphasized.

According to Kulbir (2006), Mathematics holds the mirror up to civilization. It is no exaggeration to say that the history of Mathematics is the history of civilization. The geometry of the Greeks and the Arithmetic of the Hindus are as useful and admirable as any research of today. Mathematics has been a progressive science and has pushed and is still pushing forward the frontiers of scientific and technological advancement, discoveries and inventions. It is the language of science and background to the humanities. The development of any ideal society depends mostly on both economic and technological advancement. These can be achieved through sound education at all level and in any form which requires basic knowledge of Arithmetic progressively to Mathematics.

According to Lawrence and Kolawole (2007) Mathematics Education in Nigeria has come a long way. In the traditional society, before the introduction of formal education, Mathematics was used mainly in taking stock of daily farming and trading activities. Most traditional societies have their number systems which were either base five or twenty. These could be seen in their market days and counting systems. However, the coming of the missionaries introduced formal (or Western type) education to Nigeria. In this system of education, Mathematics occupied a central position in the school curriculum. This has remained the position in the Nigerian education system today, even with the introduction of the 6-3-3-4 system of education. In this system, Mathematics is a core subject from the primary through the

Junior Secondary to the Senior Secondary School levels of the educational system. This important position occupied by the subject in the school curricula is borne out of the role of Mathematics in scientific and technological development, a sin-quano in national building. Baiyelo (1987) observed that Mathematics is widely regarded as the language of science and technology. This observation was also made by Abiodun (1997) when he stated that while science is the bedrock that provides the spring board for the growth of technology, Mathematics is the gate and key to the sciences. Ukeje (1997) in acknowledging the importance and contribution of Mathematics to the modern culture of science and technology stated that without Mathematics there is no science, without science there is no modern technology and without modern technology there is no modern society. In other words, Mathematics is the precursor of science and technology and the indispensable single element in modern societal development. Mathematics education is therefore indispensable in nation building.

Lawrence and Kolawole (2007) opined that it is a reality that it is the creation, mastery and utilization of modern science and technology that basically distinguishes the so called developing from the developed nations of the world. That is to say that the standard of living of a nation is dependent on the level of science and technology of that nation. Science is the bedrock that provides the springboard for the growth of technology; Mathematics is the gate and key to the sciences. In other words, it is the level of Mathematics that determines the level of the science and technological component of any nation. The foundation of science and technology, which is the basic requirement for development of nation, is Mathematics. Therefore, Mathematics plays a vital role in nation building. Mathematics as observed by Abiodun (1997) is the major tool available for formulating theories in the sciences as well as in other fields. It is used in explaining observation and experiments in other fields of inquiry. Adeyegbe (1987) observed earlier that there is hardly any area of science that does not make use of mathematical concepts to explain its own concepts, theories or models. Mathematics is a science of the methods by which quantities sought are deducible from others known or supposed. Thus, anyone who neglects Mathematics may not be able to go far in the sciences, and in fact other things of the world. Practical work and observation of nature are the main source of scientific discoveries. Mathematical methods play a very important role in this. Mathematical methods lie in the foundation of Physics, Mechanics, Engineering, Economics and Chemistry. According to Bermant in Harbor-Peters (2000), an important feature of the application of Mathematics to sciences is that it enables us to make scientific predictions that are to draw on the basis of logic and with the aid of mathematical methods, correct conclusions whose agreement with reality is then confirmed by experience, experiment and practice. Thus Mathematics is the bedrock of science and technology, which is the springboard of national development.

2.3 Students' Understanding of Mathematics and Its Language.

According to Dearing (1996), an examination is only as difficult as the questions and marking schemes from which it is built up. Hart (1981) wrote questions which aimed at testing student's understanding of Mathematics and not just repetition of skills. Using outcomes of trials of these questions on 11 – 16 year old students, Hart classified questions into a level of difficulty of Mathematics questions. Firstly, three features were prevalent in the questions which students with a lower understanding of mathematics could answer.

(i) Questions involving only one or two stages to the solution.

(ii) Questions containing first operation elements (addition or fraction)

(iii) Question that do not contain abstraction or the formulation of strategies.

Secondly, Hart concluded that there was a need to talk to pupils to assess their true understanding of Mathematics. Finally, questions which contained mathematical language that was not part of student's vocabulary were found difficult.

Mayer (1984) found that students make four classes of errors when solving mathematical word problems. These errors relate to knowledge requirements. Below are the relationship between error and knowledge.

Types of Error	**Type of Knowledge**
Translation and Understanding	Logistic and factual
Understanding and calling upon relevant Knowledge	Schematic
Planning	Strategies
Execution	Algorithmic

The literature presented here has thrown up key issues which could affect the difficulty of examination questions. These are:

(i) Language of the question

(ii) The capacity of working memory

(iii) The level of contextualization

(iv) Mathematical (technical) language

Rothery (1980) distinguished three (3) broad categories of mathematical words:

(i) Words which are specific to Mathematics and not usually encountered in everyday language (e. g. hypotenuse, coefficient).

(ii) Words which occur in Mathematics and ordinary English, but involve different meanings in these two contexts (for example, difference and volume).

(iii) Words which have the same or roughly the same meaning in both contexts (for example, fewer and between).

The use of these words in questions must be considered carefully, especially with some age group.

Mayer (1984) identified types of knowledge used in solving a Mathematics problem. Firstly, they suggested linguistic and factual knowledge be employed; this leads the student to construct their interpretation of what is to be done. This is the initial stage in the question response process and is dependent on reading ability. It has been argued by practicing teachers that assessment of Mathematics should assess mathematical, linguistic skills and abilities. Thus, the presentation of the question is the key to the validity of the test.

2.4 Teaching of and the Teachers of Mathematics

Seers(1989) opines that developing the curriculum without taking into consideration the teacher who is the implementer of the curriculum will be perilous and therefore stimulate systems inefficiency. The teacher is the key to the success of the students.

The teacher plays an invaluable role in imparting the lessons and educating the child to be useful person to himself and the society. Teachers have contributed immensely to the development of the nation.

With respect to the responsibility of the teachers for the useful guidance of the child, the teacher has to possess basic knowledge about the learners, the learning environment, the available resources and the subject matter. This implies that the teacher should be a professionally trained individual to enable him handle the work effectively. According to Soar andSoar (1978) there is no best way to be a good teacher. No single teaching behavior is highly correlated with student achievement.

McDonald (1975) observed from his research with teachers that one could only find "patterns" of teacher behaviors that are associated with effective and ineffective teachers.

Although it is true that good teachers are not alike in all ways, it is equally true that they nonetheless share particular characteristics whether in the way they manage their instructional activities, the way they view themselves or the way they interact with students. Good teaching is both an art and a science. Put another way, good teaching is done by an artist who is able to utilize human resources and technological advances (McDonald, 1975).

Research efforts aimed at studying teacher effectiveness have attempted to probe one or more of the following three dimensions of teacher behaviors:

(i) Personality traits

(ii) Intellectual Characteristics and

(iii) Instructional Approaches

The Personality Trait

The impact that a teacher's personality can have on a student's emerging self and emotional stability is considerable. In an analysis of over 12000 letters written in conjunction with the "Quiz kids" program on the theme, "The Teacher Who Helped Me Most", Withy (1997) found that the top ranking personality traits associated with these teachers were the following:

(i) Cooperative and democratic attitude

(ii) Kindness and considerations for the individual

(iii) Patience

(iv) Broad Interest

(v) Pleasant appearance and manner

(vi) Fairness and impartiality

(vii) A sense of humor

(viii) Pleasant disposition and consistent behavior

(ix) Interest in pupils' problems and,

(x) Flexibility

According to Makinde (2010), humans are endowed with unbelievably amazing brain which is quite superior to that of any animal and this is why an average child is so curios to discover knowledge. In infancy up to childhood, they ask series of questions like: "why, how, when, what…" to the extent that they test the parents' patience. If parents are exhausted by the endless barrage of children's questions, it is more tasking on the part of the teachers who may face not less than forty of such curious children in the classroom. The situation is worse when the teacher is extrinsically motivated to teach, that is, to teach first to make end meet. Students of such teachers are less inspired, less eager to learn and later view schools as stressful or drudgery. Even the pressure to obtain good grades causes unbearable anxiety.

Soar and Soar (1979) observed that warmth, friendliness, and understanding are teacher traits that are strongly related to positive students' attitude. Seers (1989) found positive correlations between the extents to which a teacher reflects a personal interest in and willingness to listen to students' ideas and the creativity shown by elementary level students. Tikunoff (1975) found that second and fifth-grade students of teachers who were accepting, cooperative and involved, showed greater learning gains in Mathematics and reading than students whose teachers were rated lower on these characteristics.

Intellectual Characteristics

According to Good and Brophy (1987), expert teachers differ from novice and less effective teachers in much the same ways that expert physicists, physicians, or even chess players differ from novices in these fields. Skilled, effective teachers, for example, work from integrated, underlying principles for action, which allow them to have access to richer and more elaborated strategies for coping with problems in teaching. Good and Brophy (1987) cautioned that subject-matter knowledge and action system knowledge do not guarantee that one will be an effective teacher.

Leihardt (1986) found that effective Mathematics teachers could review a previous day's work with students in two or three minutes, compared to the fifteen minutes or so taken by less effective teachers.

Milgram (1979) found in her research with 459 gifted and non- gifted children in grades four through six that all children, regardless of level of intelligence or of creative thinking, sex, or age value the intellectual preparedness of teachers more highly than teachers' creativity and personality.

Regarding gifted high school students, Bishop (1976) reported that teachers who are judged successful by these students were characterized as being more intellectually prepared than less successful teachers.

Instructional Approaches

Rosenshine (1987) opined that there are basically two instructional modes from which we can choose our own way of classroom teaching. These are: The direct route and the indirect route.

Direct Versus Indirect Teacher-Student Interaction Pattern

Teacher Talk - Indirect Influence

<u>Accepts feelings</u>: accepts and clarifies the feelings of the pupils in a non-threatening manner. Feelings may be positive or negative. Predicting or recalling feelings are included.

Praises or encourages: praises or encourages pupil action or behavior. Jokes that release tension but not at the expense of another individual, as well as nodding head or saying "um-hum" or "go on" are included.

Accepts or uses idea of pupil: clarifies or develops ideas suggested by a pupil as the teacher brings more of his own idea into play.

Asks questions: asks a question about content or procedures, with the intent that a pupil answers.

Teacher Talk – Direct Influence

Lecturing: gives facts or opinions about content or procedures; expresses his own ideas; asks rhetorical questions.

Giving directions: directs, commands, or orders with the intent that the pupils comply.

Criticizing or justifying authority: makes statements intended to change pupil behavior from non acceptable to acceptable pattern; criticizes or rebukes; states why he is doing what he is doing; refers extensively to himself.

Student Talk

Response: pupil makes a predictable response to teacher. Teacher initiates the contact or solicits pupils' statement and sets limit to what the pupils say.

Initiation: a pupil initiates communication with the teacher including unpredictable statements in response to teacher.

Undirected Activity

Silence or confusion: pauses, short periods of silence and periods of confusion in which communication cannot be understood by the observer.

Ukeje (1971) pointed out that it is true that if a pupil has not learned, then the teacher has not taught. Bajpai (1972) commented that a teacher of Mathematics has a great responsibility that demand good training, patience, dedication and sound knowledge. He added that the most important duty of the teacher is to help his student in Mathematics through his own experiences and understanding.

2.5 Theories of Learning

Theories of learning provide the scientific explanations of how learning takes place. It is a guideline for helping students to surmount their learning problems. Ilogu (2005) asserted that psychologists have developed many theories of learning which may be broadly classified under four categories as stated below:

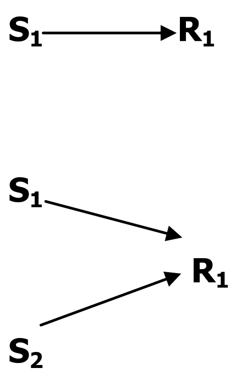
(a) Stimulus-Response Contiguity Learning Theory: The behaviorists as developed by Guthrie, Skinner and Hull (1958).

(b) Cognitive Insight Theories: Gestalt Theory of Learning (developed by Tolman, Brunner, Lewin, Koffka and Kohler, 1932).

(c) Stimulus-Response Reinforcement Theory: The connectionists essentially developed by Thorndike (1931).

(d) Cognitive Development Theory of Piaget (1969)

Stimulus-Response Contiguity Learning Theory states that when a neutral stimulus is paired with unconditional stimulus over a period of time, the neutral stimulus will then become condition to elicit a response (stimulus shift). Learning consists essentially of shifting a given response R_1 from its original stimulus (S_1) to a substitute stimulus (S_2), and this is possible only because of the contiguity in time between the stimulus and response.



According to this theory, learning is habit formation resulting from conditioning or association of a stronger stimulus with a weaker stimulus to the end that the organism is enabled, as a result of this associative learning, to transfer the response ordinarily connected with the stronger stimulus to the weaker stimulus when the stronger stimulus is removed. Guthrie (1953) law of learning states that, a combination of stimuli which was accompanied by a movement will on its recurrence tend to be followed by the movement. In other word, the stimulus (S) and response (R) forms a bond or association usually denoted as S - R and referred to as Stimulus-Response Bond. Contiguity is one of the variables that affect learning. It refers to the closeness or interval between events. In this study, the pre-test was followed immediately by the teaching of Mathematics topics and later, the administration of post-test to find out if learning has actually taken place. The testwiseness training module serves as the treatment in improving students' performance.

Cognitive Insight Theory: Gestalt was a holistic approach and rejected the mechanistic perspectives of the stimulus response model. A Gestalt is an integrated whole system with its parts enmeshed. The whole is greater than sum of the parts. Gestalt principles suggest that the learner receives new material; the new material is assimilated and undergoes cognitive existential remodeling of thought and development of insight. Gestalt learning theory proposed several laws of organization which are innate ways that human beings organized perceptions. The trace factor as emphasized by Gestalt theory proposes a mechanism for learning in which neurological changes occur as connections are made in the brain. The change called traces represents the links connecting thoughts, ideas, and concept images and so on. Repetition and uniqueness reinforce a trace. Thus learning is the creation of traces. Traces group together to form maps.

Stimulus-Response Reinforcement Theory: Thorndike (1931) states that when a response is made to a stimulus and reinforcement follows (something pleasant), the rate of response remains the same or increase. This indicates that the bond, stimulus (S) - response (R) becomes stronger. Thorndike explained learning as a change in performance or observable behavior due to experience. According to the reinforcement theory, learning consists of three components:- Stimulus, response and reinforcement.

It is the reinforcement that strengthens the S – R bond. Thorndike asserts that connections or bonds are formed in the nervous system between stimuli and response, S – R (connectionism). The three major laws guiding the S – R connection are:

Law of Readiness: When any connections are ready to be made, it is satisfying for this to occur, while failure to occur is annoying. The law states that, it is pleasurable to perform a task when one is prepared for the task. It takes into consideration the students' background, previous experience or knowledge and mental set (attentiveness).

Law of Exercise: Repeated exercise is appropriate and provides motive satisfaction that strengthens the S – R connection. If a learner puts into practice what he has learnt, the more efficient the learner becomes; and if the learner does not put into use what he has learnt, the learner forgets. The theory emphasizes practice which leads to perfection.

Law of Effect: When the S – R bond is followed by something satisfying (reinforce) the strength of that bond is increased, but a bond followed by unsatisfactory results will be weakened.

Olusakin and Ubangha (2010) opined that some students just manage to read through their textbooks or notes once and they think they have studied well enough but this may not be true as such, they need to be helped to understand the essence of practice and rehearsal. Regular practice would help to improve their retention and performance. Teachers need to reinforce and motivate students to develop positive attitude toward the learning of Mathematics and also encourage them to practice mathematics questions on their own using various test taking techniques or strategies.

Cognitive Development Theory: Piaget (1969) opined that cognitive development occurs in stages. He described four major developmental stages through which one has to proceed in a fixed order.

(i) Sensory motor - birth to 2 years

(ii) Pre-operational - 2 to 7 years

(iii) Concrete operational - 7 to 11 or 12 years

(iv) Formal operational - 11 or 12 to 14 or 15 years

Although each stage is different from every other stage, each stage is both a consequence of the preceding stage and a preparation for the succeeding stage. At each stage, a schema is formed to facilitate learning. The process is by no means a static one but a continuous one, with each stage blending into the next one with the corresponding characteristics of a stage evolving along with chronological age. According to Piaget's model, five concepts are essential to a better understanding of the processes of learning. These are: Schema (Schemata), Equilibrium, Disequilibrium, Assimilation and Accommodation. Piaget (1969) believed that the child is a developing organism passing through cognitive stages that are biologically determined. Based on this, the four distinct stages should be taken into consideration when planning a curriculum so that appropriate learning experiences could be provided at each stage. The cognitive development stage of the students at the senior secondary school level should be taken into consideration by the teacher and appropriate teaching methodology be adopted for learning to take place.

The theory is of paramount importance to the treatment of student learning achievement. This is because the curriculum at the senior secondary level seems to demand abstract thinking and at this stage, students are functioning both at concrete and formal operational level, of intellectual development. It therefore follows that teachers should take into consideration the appropriate methods of teaching, encouraging interactive learning among students, motivate the students to learn, involving students' more in the teaching and learning through class work, home work and assignment, teaching them various strategies to be adopted in tackling examination questions so as to become confident test-takers and also accommodate individual differences.

2.6 Theories of Intelligence

In education, Intelligence refers to ability to learn or understand or deal with new or challenging situation. In psychology, the term may more specifically denote the ability to apply knowledge to manipulate the environment or to think abstractly as measured by objective criteria (such as Intelligence Quotient test).

Thurstone (1938) - Intelligence as a Person's "Pattern" of Mental Abilities

Thurstone (1938) opined that intelligence is a cluster of abilities. Thurstone emphasized different types of intelligence rather than focusing on a single factor of general intelligence, and thus better recognizes the diversity of human abilities. Thurstone's theory of intelligence centered on the existence of primary mental abilities (PMA). Thurstone (1938) felt that differences in the results of intellectual tasks could be attributed to one or more of seven independent abilities. These seven abilities were named space, verbal comprehension, word fluency, number facility, induction, perceptual speed, deduction, rote memory and arithmetic reasoning. The space primary mental abilities represent the ability to recognize that two shapes are the same when one has been rotated. Perceptual speed is the ability to recognize similarities and differences between pairs of stimuli. Verbal comprehension involves recognizing synonyms. Induction requires establishing a rule or pattern within a given set. Deduction involves drawing a logical inference from a set of facts or premises.

Spearman (1904) – General Intelligence "g" Factor

Spearman (1904) theorized that a general intelligence factor (g) underlies other, more specific aspects of intelligence. He based this on how he noticed people who did well on one test tended to do so similarly well on others. Spearman (1904) defined (g) as a particular quantity derived from statistical operations. Under certain conditions the score of a person at a mental test can be divided into two factors, one of which is always the same in all tests, whereas the other varies from one test to another; the former is called the general factor of (g), while the other is called the specific factor. Therefore, (g) term means, a score factor. Spearman (1904) opined that "g" was not a single ability but composed of two very different abilities which normally worked closely together. These he called "eductive" ability and "reproductive" ability. He opined that to understand these different abilities "in their trenchant contrast, their ubiquitous cooperation, and their genetic interlink age" would, for the study of "individual differences – and even cognition itself" – "be the very beginning of wisdom".

Gardner (1983) – Theory of Multiple Intelligences

Gardner (1983) theorized multiple intelligences consisting of eight separate kinds of intelligence. According to Gardner, multiple intelligences are several independent mental abilities that allow a person to solve problems, create products that are valued within one's culture. Gardner (1983) opined that there is a wide range of cognitive abilities, and that there are only very weak correlations between these. For example, the theory predicts that a child who learns to multiply easily is not necessarily generally more intelligent than a child who has more difficulty on this task. The child who takes more time to master simple multiplication (1) may best learn to multiply through a different approach, (2) may excel in a field outside of Mathematics, or (3) may even be looking at and understand the multiplication process at a fundamentally deeper level, or perhaps as an entire different process. Such a fundamentally deeper understanding can result in what looks like slowness and can hide a mathematical intelligence potentially higher than that of a child who quickly memorizes the multiplication table despite a less detailed understanding of the process of multiplication.

Gardner (1983) articulated several criteria for a behavior to be intelligent. These were that:

(i) Potential for brain isolation

(ii) Place in evolutionary history

(iii) Susceptibility to encoding (symbolic expression)

(iv) A distinct developmental progression

(v) The existence of savants, prodigies and other exceptional people

(vi) Support from experimental psychology and psychometric findings

According to Gardner (1983) eight abilities meet these criteria:

(i) Linguistic Intelligence:-Adapt use of language.

(ii) Logical-mathematical intelligence :- Logical, mathematical, and scientific ability

(iii) Musical Intelligence :- Ability to create, synthesize, or perform music

(iv) Spatial Intelligence :- ability to mentally visualize the relationships of objects or movements

(v) Bodily-kinesthetic Intelligence :- Control of bodily motions and capacity to handle objects skillfully

(vi) Interpersonal Intelligence :- Understanding of other people's emotions motives and intentions

(vii) Intrapersonal Intelligence :- Understanding of one's own emotions, motives and intentions

(viii)Naturalist Intelligence :- Ability to discern patterns in nature

Logical mathematical has to do with logic, abstractions, reasoning and numbers. While it is often assumed that those with this intelligence naturally excel in mathematics, computer programming and other logical or numerical activities, a more accurate definition places less emphasis on traditional mathematical ability and more on reasoning capabilities, recognizing abstract patterns, scientific thinking and investigation and the ability to perform complex calculations. Logical reasoning is closely linked to fluid intelligence and to general ability.

2.7 Concept of Tests as a Measuring Instrument

The commonest form of measurement device for use in determining the efficacy of instruction is a collection of questions known as a test or an examination (Abidogun, 1997).

Okoli (2002) defines a test as a set of standardized questions or inventories administered to an individual for the purpose of measuring or obtaining quantitative information about several aspects of the individual's behaviour. Test is a systematic procedure for comparing the performance of an individual with a designated standard of performance (Chase, 1979).

According to Obe (1998) and Olusakin and Ubangha (2010), the functions of educational tests are numerous and varied. These functions may be briefly categorized as follows; Instructional and motivational aids, evaluation of scholastic achievement for promotion, certification, selection and counselling, research for evaluating curricula, teaching methodology and effectiveness.

As an instrument for assessing individual differences along a given dimension of behaviour, tests are important in key areas of life. They are most commonly used to evaluate students' achievement and the effectiveness of an educational program (Afolayan, 2006).

Afolayan (2006) asserts that beyond the narrow confines of the classroom, they are used to determine personality characteristics such as intelligence, motivation, aptitude, readiness and creativity. Also, in a world dominated by work, tests are powerful instruments for administrative decisions concerning selection, appointment, placement, evaluation of job performance and promotion. He opined that the uses of test are so pervasive that they can be said to be overused. They are also often abused and misused. Consequently, they have become much of a bogey to students, a clog in the wheel of much purposeful learning and a source of public discontent against formal education. Test is the aspect of the educational system most feared by students and most criticized by the public; yet in the absence of any better alternative, tests and testing cannot be abolished. The shortcomings of tests and testing have, however, continued to stimulate efforts in the direction of developing new and better tests and improving testing situations and procedures. A good example is the development of criterion referenced tests.

Badmus (1977) has attempted a brief synthesis of some of the issues and problems on which much of the discussion and controversy have centered. These are issues concerning definition of the term, the differences between the test and the classical norm-referenced test, item construction, analysis and selection, establishment of reliability and validity, and the uses of the tests. Cox and Graham (1966), Millman (1970) and Gorth and Hambleton (1972) have all emphasized that while the primary purpose of a norm – referenced test is to compare individuals; the main purpose of a criterion referenced test is to make decisions in terms of the individual student's performance with respect to some criterion. A perfect measurement system would produce measurements that contain only variations attributable to differences in knowledge where the variation attributable to a lack of accuracy and objectivity equal zero (Stout, 1987).

According to measurement system based upon a test or examination, the percentage inaccuracy is determined by the application of both logical and statistical proofs. Specifically, producing accurate measurements using a test or examination involves minimizing three sources of inaccuracy which are; Content sampling errors, mis-classification errors and the influence of guessing.

δ^2 inaccuracy = δ^2 content sampling + δ^2 Misclassification + δ^2 Guessing.

According to Oluwatayo (2004), evaluation is a human activity usually carried out to ascertain the worth, value or credibility of an action, operation or a programme.

Studies by Yoloye (1991), Okpala, Onocha and Oyedeji (1993), Afolabi (1998), Bamidele(1998) and Ojerinde (2000) revealed that evaluation involves such activities as gathering of valid information on attainment of educational objectives, analyzing and fashioning information to aid judgment on effectiveness of an educational programme. Evaluation of programme in this context is unidimensional. That is, it focuses on the assessment of the objectives of the programme along the line of its consistency, trustworthiness, effectiveness and efficiency such as assessing the conduct of the teacher made test for Continuous Assessment (CA), Senior Secondary

Certificate Examination (SSCE) conducted by the West African Examination Council (WAEC) and the National Examinations Council (NECO) in Lagos State. One can then ask how valid and reliable the test items which constitute the instruments for all these examinations are and whether one can assume that the responses to these test items by students reflect the true picture of what they have gained through the course of learning without recourse to some variables such as dimension of the test item, test anxiety, students' exposure to test performance-enhancement-strategy (testwiseness) and other intervening variables that affect test scores.

Multiple-choice questions (MCQs) are used more and more in class tests or as comprehensive examinations at the end of an academic session. It may be used to determine progress or to make decision regarding the certification of a student. They may also be used to identify strengths and weaknesses in students as well as to provide feedback to teachers on their educational actions. The manner in which the test questions are prepared and put together to form an examination, and the procedure for scoring, analyzing and reporting the results, all have a bearing upon the conclusions drawn from the performance of the individuals and group tested (Debra 2006).

Ilogu (2005) opined that poor items such as items which are too easy, too difficult or with zero and negative discrimination indices can be diagnosed through the analysis of the choices per item. This analysis of item choices merely involves the comparison of the responses of the upper and lower groups of students for each choice.

According to Ilogu (2005), item analysis is the statistical technique of reviewing every item on the test with a view to refining the whole test. Item analyses are usually done by the determination of the difficulty and discriminating indices of each item.

The item difficulty statistics is an appropriate choice for achievement or aptitude tests when the items are scored dichotomously (Correct vs. Incorrect). It is computed for true-false, multiple-choice, and matching items, and even for essay items, where the instructor can convert the range of possible point values into the categories " passing" and "failing". Ilogu (2005) further described item difficulty as the degree of easiness of items.

The item difficulty index, represented by p, can be computed simply by dividing the number of test takers who answered the item correctly by the total number of students who answered the item.

Difficulty Index = $^{P}/_{N} \times {}_{100/1}$

P = No of students who got the right answer

N = the total number of student taking the test.

As a proportion, P can range between 0.00, obtained when no examinees answered the item correctly and 1.00 when all examinees answered the item correctly. For a test to be good, index of difficulty should range from 0.4 to 0.6.

On the other hand, item discrimination index refers to the ability of a test item to discriminate between those who know the content and those who do not. Item discrimination deals with the fact that often, different test takers will answer a test item in different ways. It addresses questions of considerable interest to most educators, such as "does the test item differentiate those who did well on the examination overall from those who did not"? Or "does the test item differentiate those who know the material from those who do not?" In a more technical sense item discrimination analysis addresses the validity of the items on a test, that is, the extent to which the items tap the attributes they were intended to assess.

Item Discrimination index is determined by:

$$D = \frac{H - L}{N/2}$$

H = Students in high scoring groups who got the right answer

L = Students in low scoring group who got the right answer

N = Number of students who sat for the test in high and low scoring groups.

The procedure is simply as follows:

- Divide the group of test takers into two groups, high scoring and low scoring. The simplest way to accomplish this within Excel is to sort the test takers by score in descending order. Ordinarily, this is done by dividing the examinees into those scoring above and those scoring below the median or the middle number of test takers. (Alternatively, one could create groups made up of the top and bottom quartiles or even deciles).
- Compute the item difficulty levels separately for the upper (P upper) and low scoring groups.
- Subtract the two difficulty levels such that

D = P upper – P lower.

D = (P upper half of the class) - (P lower half of the class).

Unlike the item difficulty level P, the item discrimination index can take on negative values and can range between –1.00 and 1.00. In such a situation P upper = 1.00 and P lower = 0.00. As such, the value of the item discrimination index D is 1.00 and the item is said to be a perfect positive discriminator. Many would regard this outcome as ideal. It suggests that those who knew the material and were well – prepared passed the item while all others failed it.

According to Holmes (2002), Number Right (NR) scoring method is a very coarse measuring tool which lumps all personal certainties, doubts, fallacies and guess work into just two categories; correct or incorrect. Number Right (NR) scoring method is a conventional scoring method for multiple choice items, where students need to pick one option as the correct answer. One point is awarded for the correct response and zero for any other response. However, it has been heavily criticized for guessing and failure to credit partial knowledge. Also, the current assessment practices do not take students' misconceptions into consideration. Thus, there is a need to propose a new scoring method that is able to diagnose misconceptions.

Dirkwager (1996) stated that based on partial knowledge, students can identify option which is more likely to be true than others. In a survey of test-taking strategies employed by students, Oh (2004) reported that out of 264,900 students who took the

Fall, 2001 administration of the SAT, 60% or roughly 159,940 students first eliminated incorrect alternative before selecting one alternative as the answer. Likewise, Dirkwager (1996) also discovered that most students used this strategy. Thissen (1976) noted that students who do not possess the necessary knowledge to answer an item do not randomly select an answer, but rather use partial knowledge to first eliminate the incorrect and select one of the remaining option. Tomkowiez(2000) also shares his view.

According to Mehrens and Lehmann (1991), logic and evidence suggest that it is informed guessing that predominates. Dowing(2003) further argued that informed guessing should not be discouraged because it is a reality of life. Much of what individual does throughout is in fact based on incomplete knowledge. Although frequently used by students, the strategy of first eliminating incorrect option before selecting the answer is only regarded as a test taking strategy to maximize test score. It has not been formalized as a scoring method. According to Item Response Theory (IRT), the test information is simply the sum of each item's information. This means that we can create a test to have any kind of information we like by judiciously choosing our items.

2.8 Factors that Influence Responses to Test Items.

Okoli (2000) opined that classroom tests are used to quantify the pupil's achievement by assigning a meaningful number value to the achievement of each student who takes the test. He further asserted that in counselling, the concern is the assessment of students' attributes such as achievement, aptitude, interest, values, personality and intelligence. These attributes exist in the abstract as psychological constructs. Their presence can only be inferred indirectly through their external manifestations. The reliability and accuracy of a test depends on how accurately you can describe the attribute in the question. The description is done through test items because each item calls for a specific behavior. The test items depict the attributes to be measured but test scores have no proportional relationship to the attributes measured. This is because a test does not measure directly. Okoli (2000) concluded that there is no guarantee that the test items actually describe the attributes.

Ebel and Damrin (1990) noted that essentially, there are four bases on which candidates respond to multiple choice questions and they are: direct knowledge, testwiseness, response set and chance guessing.

Direct Knowledge: In this case, an individual's response is based on his information about the content of the question and as such the decision to select an answer is always knowledge- based. The answer may be selected with complete knowledge and unerring certainty or only enough knowledge to arrive at the answer through vague, almost intuitive reasoning.

Testwiseness: In this case, an individual's response is based upon his knowledge of the design and format of the objective tests.

Response Sets: In this case, the subject's response is based on an ingrained set of personality habits which are independent both of his knowledge of the content of the question and of his testwiseness.

Chance Guessing: This refers to choosing an answer exclusively by chance and is also called blind guessing. This strategy allows the examinee to gain points beyond that which he/she would have received on the basis of sure knowledge of the subject matter.

Millman, Bishop andEbel (1985) made a distinction between informed and blind guessing. Informed guessing is one where the examinee can eliminate one or more options as incorrect and then choose from the remaining options. Ability to eliminate some options increases the probability of selecting the right option. It must be noted that the ability to eliminate some options implies partial knowledge of the subject matter. Blind guessing on the other hand is selecting an answer at random without considering the content of the options.

Davis (1984) opined that testees select their answers on one or more of the following bases:

(i) Sufficient knowledge to identify the correct choice

(ii) Partial knowledge that permits choice followed by guessing among all of the remaining choices or by resorting to irrelevant considerations like characteristics irrelevant to content of the item.

(iii) Guessing among all the choices after considering the item as a whole.

(iv) Partial misinformation that leads to elimination of one or more choices, including the correct choice, followed by guessing among all of the remaining choices or by resort to irrelevant considerations like those listed in the next point below

(v) Characteristics irrelevant to content of the item, such as length of the choices, precision of wording of the choices, number of times each position (A, B, C, D.E, etc.) has been marked as a correct option, pattern of choice positions that appears on the answer sheet.

(vi) Sufficient misinformation to identify as corrects, one of the incorrect choices.

(vii) Random marking of choices in items that have not even been read. This refers to blind or chance guessing which normally occurs when a testee is under examination tension with little time left to leave the examination hall or when he/she has little or no idea of the subject matter.

Nenty (1987) remarked that when an examinee encounters a test item, the intention is that he will respond to the item within the best of his ability, that is, on the basis of how much of what the item measures that he possesses. In an ideal situation, the factors in the encounter are: the ability of the examinee in what is being measured and the difficulty of the item.

According to Nenty (1987), an examinee enters a testing situation with a variety of background characteristics besides his level of ability on what the test is trying to measure. Such characteristics include: his level of anxiety, carelessness, motivation and mood, his level of testwiseness and ability to guess, his tendency to copy from others, his level of exposure to and familiarity with related subject matter, his disposition to the type of item format used in the test and the individual's idiosyncratic cognitive mode. Similarly, items on the test enter the test situation with a variety of characteristics other than its ability to elicit that behavior the test was designed to measure. These include its level of demand on skills and knowledge other than that which the test was designed to measure, its level of bias, the order of presentation of items, the specificity of the test and item directions and its level of ambiguity.

A closer review of the factors highlighted by researchers (Ebel andDamrin, 1990; Davis, 1984; Nenty, 1987) shows that apart from true/direct knowledge other factors such as the nature of the test item, chance guessing, testwiseness and anxiety have significant roles to play in students' academic achievement.

It is clearly evident that guessing strategy and testwiseness deserve much more attention than they are presently being given in schools because it is an important construct which affects test scores hence training in it may be used to improve test scores of Students in Mathematics.

2.9 Concept of Mathematics Anxiety

Research on Mathematics anxiety started in the 1950s with the personal observations of Mathematics teachers and since then different researchers' defined Mathematics anxiety in various ways. Dreger and Aiken (1957) defined Mathematics anxiety as an emotional syndrome response to Arithmetic and Mathematics. The first Mathematics anxiety instrument, the Number Anxiety Scale (NAS) was developed by Dreger and

Aiken (1957) from a modification of the Taylor Manifest Anxiety Scale (Taylor, 1953). Richardson and Suinn (1972) referred to Mathematics anxiety as feelings of tension and anxiety that interfere with the manipulation of numbers and solving of mathematical problems in a wide variety of ordinary life and academic situations. They developed one of the comprehensive scales known as Mathematics Anxiety Rating Scale (MARS).

Tobia (1976) adopted a very simple definition of Mathematics anxiety as "I can't" syndrome. Fennema and Sherman (1976) described Mathematics anxiety as feeling of anxiety associated with mathematical classes, courses, problems and tests. They developed the Mathematics Anxiety Scale (MAS) which was targeted to assess "feelings of anxiety, dread, nervousness and associated bodily symptoms related to doing Mathematics". Kelly and Tomhave (1985) regarded Mathematics anxiety as the feeling of fear, avoidance and dislike when dealing with mathematical situations.

Round and Hendel (1980) factor analyzed the Mathematics Anxiety Rating Scale developed by Richardson and Suinn (1972) and discovered that Mathematics anxiety as measured by the scale was not uni-dimensional. Round and Hendel (1980) identified two factors labeled; Mathematics Test Anxiety involves anticipation, completion and receiving the results of Mathematics test. On the other hand, Numerical Anxiety refers to everyday concrete situations requiring some form of number manipulation. They administered Mathematics Anxiety Rating Scale to a sample of 350 University who participated in a Mathematics anxiety treatment programme. The programme was designed for individuals who were anxious about Mathematics and/or concerned about their performance in Mathematics courses.

The results of the study revealed that for the female participants, the domain of Mathematics anxiety as measured by Mathematics Anxiety Rating Scale is best described not as about everyday numerical manipulation but primarily as test anxiety and secondarily as anxiety associated with Mathematics. Result from their study showed that the female participants were relatively unconcerned about numerical manipulations in the context of daily activities. Based on the distribution of the Mathematics Test Anxiety Scale and Numerical Anxiety Scale scored together with relative independence of (r = 0.34) of the two scales. Round and Hendel (1980) concluded that anxiety about Mathematics may be situationally specific and not transituational. In essence, Mathematics anxiety is less a response to Mathematics than a response to evaluation of Mathematics skills, that is when used as diagnostic label for an individual client. Mathematics anxiety as represented by Mathematics Anxiety Rating Scale total score provides little useful information and may mislead a client or counselor to conclude that the client is anxious about Mathematics irrespective of setting. They suggested that if Mathematics Anxiety Rating Scale is to be useful for counseling purpose, the Mathematics Test Anxiety Scale and Numerical Anxiety Scale should be scored, and treatment tailored to meet the client's needs relative to the amount of anxiety reported.

Resnick, Viehe and Segal (1982) confirmed the findings that Mathematics anxiety as measured by Mathematics Anxiety Rating Scale (MARS) is not a uni-dimensional construct. However, contrary to the earlier findings, three factors rather than two were identified. The factors are Evaluation Anxiety, Social Responsibilty Anxiety and Arithmetic Computation Anxiety. Factors one and three appeared to overlap with the factors labeled by Rounds and Hendel (1980) as Mathematics Test Anxiety and Numerical Anxiety. The Evaluation Anxiety involves anticipation and receipt of mathematical work that was to be evaluated. The Social Responsibilty Anxiety refers to an individuals' fiscal or arithmetic responsibility in organization and clubs. The third factor, Arithmetic Computation Anxiety involves everyday situations requiring arithmetic computations. Resnick, Viehe and Segal (1982) opined that the predominant factor in the Mathematics anxiety of college students involves evaluation mathematical work, thus, suggesting that the other two factors may be highlighting types of Mathematics anxiety found in other settings.

2.10 Studies on Gender Difference and Mathematics Achievement

The enterprises of science and science education, according to Alebiosu (2003), have immense contribution towards the growth, development and the survival of mankind. Science simply forms the avenue through which human beings interact and explain the universe of nature. It is concerned with clarity, truth-seeking and truth communication within empirical validity. Olatoye (2002) opined that science education lays foundation for work in science related fields by acquainting learners with certain knowledge, skills and attitudes. Ogbona (2007) observed that there has been a worldwide recognition of science and thereby science education has found a central place in the curricula of schools at all levels. Olutosin (2007) asserted that Mathematics cannot be separated from science because of its application to physical sciences.

Hudson (1993) gave insight into Science, Technology and Mathematics education as comprising the following areas;

(i) Acquiring and developing conceptual and theoretical knowledge

(ii) Developing and understanding of the nature and methods of science as well as the awareness of the interaction of science, technology and Mathematics (STM) and the society.

(iii) Engaging and developing expertise in scientific enquiry and problem- solving.

Mathematics in itself is identified as a specialized language in which knowledge of the physical world has been recorded; a language in which idea originating in the minds of scientists can be encoded, transmitted to others and decoded with a much exact method and much less error (Oyedeji, 1999). Olutusin (2007) described Mathematics as an instrument to ease or facilitate the learning of other subjects and that today, the importance of Mathematics permeate all aspects of human endeavour.

Solarin (2005) noted that as important as science and Mathematics are to our national life, it is regrettable to note that both enrollment of students in science and their performance in science and Mathematics examinations are not encouraging.

Olatoye (2002) found out that the students' science achievement in Lagos State Secondary schools was generally poor with the overall mean score being 31.3%. The poor achievement in Mathematics indicated by various empirical studies has attracted the concern of all stakeholders including the researchers. Subsequently, many factors have been identified and regarded as being responsible for the dwindling trend in the performance of students. These factors include school and teacher-related characteristics, student factors, socio-economic conditions, social incentives, home and family background and parental involvement (Glazero, 2001; Olatoye, 2002; Olatoye and Ogunkola, 2008).

Furthermore, socio-cultural factors have been suggested as possible influences on gender differences in Mathematics achievement and participation. These factors includes differential expectations of parents and teachers (Parson and Mclee, 1982), differential treatment of boys and girls in Mathematics classroom, differences in advice given to boys and girls by high school counsellors, limited opportunities for participation in Mathematics and attitudes toward Mathematics (Catsambis, 1994).

Research on Mathematics and achievement has showed that high Mathematics achievement is related to low Mathematics anxiety and vice versa for students from elementary school to college (Betz, 1978; Teo, 1997; Satakeand Amato, 1995).

Lussier (1996) opined that students with a strong mathematical background should be less anxious than the ones with a weak mathematical background. Betz (1978) asserted that poor Mathematics performance and mathematics avoidance are best explained by Mathematics anxiety.

Resnick (1996) conducted a research on gender difference in Mathematics anxiety. The results of his finding indicated that there are no significant difference in mathematics anxiety scores between the male and the female students. Another study by Leder (1992) on 154 form four students also did not indicate significant gender difference in Mathematics anxiety. This was further confirmed by Resnick (1982), using a sampling of 1045 freshmen who exhibited a very low level of Mathematics anxiety. There was no significant difference in genders either in the whole sample or within the different courses in which students had enrolled themselves.

The importance of attitudinal effects on science teaching and learning process has been largely acknowledged. Olayinka (1993) opined that for a student to understand a subject, the student must show or have very high interest in the subject. In other words, students must have high positive attitudes towards a subject to perform well in the subject. Leder (1992) asserted that the differences between the attitude of males and females increase as student progress in school. Fakunle (1983) opined that the gender of Mathematics teacher and the school type affect students' attitude to Mathematics negatively.

Knol and Berger (1991) carried out a study to investigate the influence of sex or gender on performance ability among students in Mathematics and to determine the relative influence of locally independent and unidimensional test items between male and female students. A 72 – item multiple choices Mathematics test was assembled from items of the ACT college Mathematics placement program to represent a range of items covering content from elementary Mathematics through college algebra. 246 students who enrolled in three introductory Statistics classes at the 8th and 9th grade school in Washington were used as participants. Three factors fixed effect analysis of covariance (ANCOVA) was used. The result showed that the effect of sex as a variable on performance among the students was significant.

Yen (1993) reviewing literature on influence of sex on locally independent test items in Mathematics explained that there is a stable response pattern among boys than girls. He blamed the fluctuations of the response pattern on differential orientation of boys and girls that, while boys' orientation are tilted towards mechanical objects and ideas, the girls are oriented towards more of values and morals.

Chang and Mazzeo (1994) investigated the influence of sex on response frequency of male and female students based on a test of locally independent items. They found out that there was a higher frequency of lower scores among females than males in Mathematics especially when test items are locally independent. In the study, they further investigated the interaction of subjects and sex differences in reading passages and test items. A total number of 240 Senior Secondary School Students (120males and 120 females) were used. The statistical design used was a 2x2x2 factorial analysis of variance. The result showed no significant effects or interaction between sex of subjects, passage and items.

Smith (2002) asserts that male superiority in numerical ability during the early years may be a myth after all. Adebayo (2006) found no significant difference between the scores of male and female students in Mathematics test. Feingold (1988) found that the gender differences are disappearing in Mathematics ability and that it is becoming increasingly difficult to make simple generalization concerning superiority of either gender. Kalejaiye (1985) found that grades of males and females within a given

Mathematics course generally show no gender related differences and on a few occasions that gender differences occur, the females were superior in performance.

Olanrewaju (1986) carried out a study to investigate the effects of instructional objectives and hierarchically organised learning tasks on students' problem-solving skills in Mathematics, the female students were found to be better problem-solvers than male students. Analysis of the scores according to ability levels revealed that high ability students were significantly better problem solvers than low ability students. Medium ability students were also significantly better than low ability students. They also indicated that ability to reflect on and analyze a problem is necessary for a problem-solver.

Ashmore (1979) opined that in solving any problem, both the information needed for arriving at a solution (content) and the reasoning which goes towards the solution (process) are important factors. Ashmore (1979) maintained the view that better chances for success in problem-solving rests on a combination of the following factors:

(i) Strong background knowledge of Mathematics; and

(ii) Knowledge of problem-solving strategies and tactics (particularly those used in the sciences) and confidence.

2.11 Guesswork and the Effect of Guessing On Multiple Choice Assessments

The issue of guessing is important to multiple-choice assessments. According to Rogers (1999), guessing increases measured error since it raises the possibility of correct responses. Also as indicated by Messick (1995), guessing propensities can be the source of construct-irrelevant variance, which provides a major threat of construct validity. In addition, the use of guessing strategies introduces error and attenuates the relationships among items. Therefore, it is reasonable and important to consider guessing in the assessment of dimensionality, especially with regard to multiple choice tests. Although, the guessing parameter is included in the three parameter models in Items Response Theory (IRT), most of the methods for factor analysis do not include guessing in their models. In addition, most multi dimensional item response Theory (MIRT) approaches only allow fixed values of guessing in models.

Tate (2003) focused on the comparison of empirical methods in assessing test structure as well as the evaluation of guessing effect. He evaluated the estimated number of dimensions and parameter recovery in unidimensional and multidimensional data using both parametric and non parametric approaches. Some conditions might be expected to be problematic for some of the methods, such as data with extreme difficulty and discrimination parameters and one item pair with local dependence. For the evaluation of guessing effect, the results of exploratory factor analysis using Mplus obtained the correct decisions in 3 out 14 simulation cases. Without modeling guessing, Mplus did not perform well in the confirmation of correct dimensionality and overestimated dimensionality for all of the cases with guessing. Also, the effect of guessing was reflected in the recovery of the true item parameters.

Stone and Yeh (2006) conducted another study about the assessment of dimensionality using real data, the Multistate Bar Examination (MBE), provided more understanding of the relationship between items and the internal structure of a test when guessing was modeled. The MultiState Bar Examination was a four-option multiple – choice exam with 200 questions. For the 2001 February administration, the examination of the average proportion correct for low-ability examinees showed that more than 50 percent of items showed that guessing was operating. The results of the two studies mentioned above demonstrated the effect of guessing in determining the dimensionality or examining the internal test structures although the studies did not fully examine the interaction between guessing and other factors, such as difficulty and discrimination item parameters.

2.12 Studies on Testwiseness Taxonomies

Testwiseness is the ability to use a set of principles to answer test items regardless of the content of the items or of the skills supposedly elicited by the items. A detailed inventory of these principles was set out and exemplified by Millman, Bishop and Ebel (1965). They based it on principles described in handbooks on test construction and on reports from test takers about the strategies they used to answer different kinds of tests and test items. The first part of the inventory contains four subdivisions dealing with time management, minor error avoidance techniques, guessing strategy and deductive reasoning strategy. Testwiseness is a skill that permits a test-taker to utilize the characteristics and forms of tests and / or test-taking situation to receive a high score. Benson (1988) believed that testwiseness is a cognitive ability or a set of test-taking strategies a test-taker can use to improve a test score no matter what the content area of a test.

Bond (1981, p. 54) distinguishes between testwiseness and test coaching. According to Bond, testwiseness is independent of content areas whereas test coaching refers to: "sustained instruction in the domain presumably being measured". Rogers and Bateson (1991) opined that the effective application of testwiseness strategies is dependent on some partial knowledge of content. He believed that, although partial knowledge may not be adequate to respond to a test item solely but is sufficient when coupled with testwiseness principles. The association of the two increases the probability of correctly responding to items susceptible to testwiseness. Roger and Bateson (1991) provided evidence that the cognition of the skilled test-takers consist of:

(i) A cognitive monitor that controls which abilities and skills are going to be engaged to answer the item under consideration;

(ii) Knowledge, abilities and skills relevant to the content or trait being measured

(iii) Knowledge of testwiseness principles; and

(iv) The response (selection and record of choice).

Millman et al (1965) developed a conceptual framework for the construct of testwiseness. This categorization consisted of a combination of the literature of test construction principles and problem solving styles of testees. It also denotes that testwiseness encompasses both the method of measurement (test-testing situation) and characteristics of testees (states-traits), indicating that testwiseness is indeed a factorially complex construct. This further underlines the necessity for a comprehensive examination of the construct, and implies that testwiseness may be profitably studied as a trait-method unit following the procedure documented. According to Millman (1965), figure 1 below describes the outline of testwiseness taxonomy.

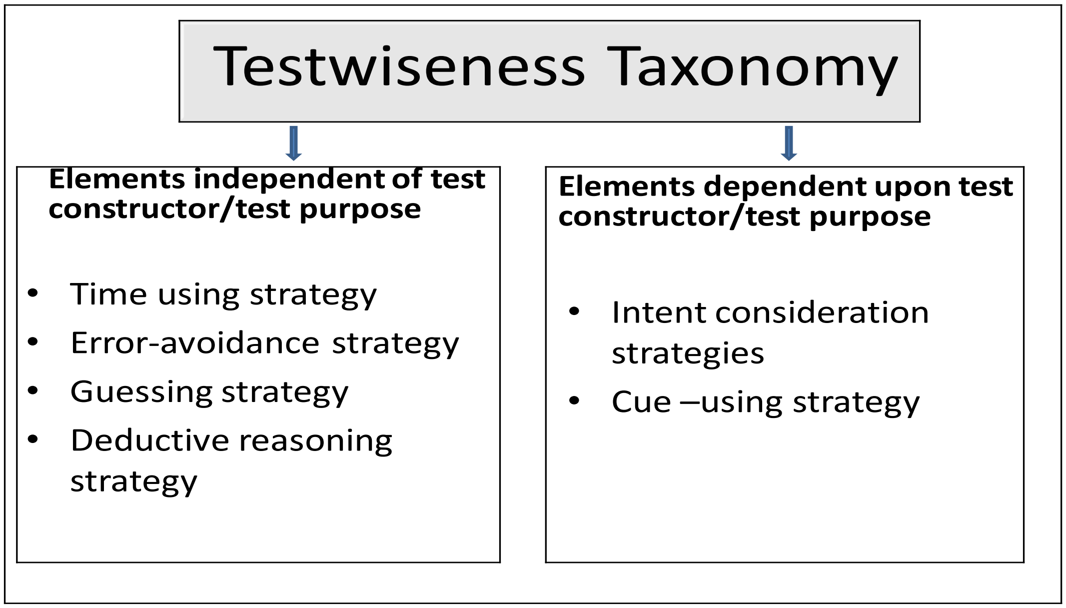


Figure1. Description of Testwiseness Taxonomy

The outline of the taxonomy contains two different divisions. The first division contains principles of testwiseness which are independent of the test-constructor or test purpose. The elements presented here are applicable in most testing situations regardless of previous exposure (or a lack of it) to either test-maker or other tests with a similar purpose. There are four subdivisions in this division. These are time using strategy, error-avoidance strategy, guessing strategy and deductive reasoning strategy. Below are the discussions on the first division:

Elements Independent of Test constructor or Test Purpose

(i) Time Using Strategy: These are general guidelines which emphasize adequate time management and also enable the testee to fully exhibit the knowledge of mastery of the subject matter. This approach applies to almost all types of tests because testees are usually given instruction on specific time frame within which they are expected to complete the tests. Powers and Alderman (1983) observed that this strategy is usually in test information bulletins or test directions and it include appropriate test-taking strategies such as; Budgeting on available time, not spending too much time on difficult questions and guessing if one cannot eliminate one or more options.

(ii) Error-Avoidance Strategy: This strategy takes into cognizance, guidelines on how to avoid minor or careless mistakes so that the testee is not loosing marks based on his/her carelessness. It emphasizes the importance of following test directions and being able to determine the depth, nature and requirements of a question. Both time-using and error-avoidance strategies are superfluous cares which the testees need to take into consideration whenever in testing situations or while taking test.

(iii) Guessing Strategy: This strategy allows the testee to gain scores more than which he/she would receive on the basis of sure knowledge of the subject matter. It allows a testee to receive scores for responses made on a completely chance basis which is also called blind guessing. Millman, Bishop and Ebel (1965) made dissimilarity between informed and blind guessing. Informed guessing is one where the testee can eliminate one or more options as incorrect and then choose from the remaining options. Ability to eliminate some options increases the probability of selecting the right option. The ability to eliminate some options by testee indicates existence of partial knowledge of the subject matter while blind guessing is selection of an option by testee at random by testee without considering the content of the options. That is, without knowledge of the subject matter. Guessing principle recommends that testee should always guess if scoring is by "Right only". That is, only right answers are scored. For instance, in a four alternative multiple-choice item, a random guess is expected to earn one quarter point (Millman, Bishop and Ebel, 1965). If a testee is not sure of the answer to an item but decides to guess, he has one in four chances (25% probalility) of choosing the correct option. Another principle of guessing is concerned with guessing on tests scored with the "correct-for-guessing" formula. The correction formula is a way of controlling for guessing. The application of the correction formula is based on the assumption that wrong answers are due to chance or blind guessing and that all individuals respond to every item. The correction-for guessing formula is given as

S = R – W/ (n-1)

where:

S = testee's corrected score

R = the number of right responses

W = the number of wrong responses

n = the number of alternatives per item.

Obe (1971) asserted that the use of this formula is based on four basic assumptions. These are:

1. That all the alternative per item are equally attractive to the ignorant student
2. That the testee who does not know the correct answer automatically guesses by randomly selecting one of the item options
3. That the probability of success by guessing is the same for every testee and every item
4. That since the alternative to knowing the correct answer is random guessing, there is neither partial information nor misinformation to be accounted for in scoring.

Obe (1971) recommended that the "Right only" scoring is a more accurate indication of students' knowledge and that further use of the correction formula should be discontinued.

(iv) Deductive Reasoning Strategy: This strategy is autonomous of the test constructor or test purpose. It also allows the testee to gain points beyond that based on direct knowledge of the subject matter as in the case with guessing strategy. A testwise student who does not know the correct answer directly may be able to deduce the answer by logical analysis or by using information gained from other items. Usually, in this case, the correct answer is not known without the presence of other options or items which serve as cues in the reasoning process. Successful use of deductive reasoning is dependent on some knowledge of the tested subject matter. According to Millman et al (1965) the different forms of this strategy may be used successfully in any objective testing situation while the success depends on the testee's ability to reason in a logically valid manner. These different forms include:

1. Eliminate options which are known to be incorrect and choose from among remaining options. This strategy is also known as the "absurd options" because the testee may eliminate one or more alternatives due to their logical inconsistencies with the stem. The testee is able to do this through partial knowledge of the subject matter.
2. Choose none of two options which imply the correctness of each other. This involves the elimination of two options that express the same fact, since they imply each other's incorrectness. Slakter (1970) opined that in an item that has five options where only one is the keyed answer, and then two options which mean the same should be eliminated. This concept was referred to as "similar options".
3. Choose only one or none of the two statements, which are such that one being correct would imply the incorrectness of the other. Millman et al (1965) noted that this situation occurs most frequently with items containing options which are opposite in meaning. They pointed out that even with two opposite options; a third option may still be the keyed answer. Langer, Wark and Johnson (1973) in listing various testwiseness cues implies that when two options are opposite in meaning, one of them

will be correct. Generally, when a testee is faced with an item with two options opposite in meaning, the testee can safely eliminate at least one of the options and cannot select both options since one implies the incorrectness of the other.

4. Restrict choice to those options which encompass all two or more given statements known to be correct. This principle emphasized that the testee should make frantic effort to select an option which encompasses all other options known to be correct. According to Sarnacki (1979) this principle has received little attention in research on testwiseness. He classified such an option as “umbrella Term” because it encompasses two or more correct response options. Umbrella terms may clearly state which options are included for consideration or may imply the inclusion of other options that are essentially contained in the meaning of the umbrella.

Elements Dependent of Test Constructor or Test Purpose

The second division contains elements dependent upon the test constructor or purpose. Here the test-taker may profit from knowledge of a particular test-maker’s idiosyncrasies or past experiences on test with similar purposes. There are two subdivisions in this division. Those are intent consideration strategy and cue-using strategy.

(i) Intent Consideration Strategy: Millman et al (1965) asserted that it is possible for a testee to receive a low score in an objective test based on his/her opinion or view which is different from that of the test constructor's or that his/her level of knowledge is higher than that which is being tested. They advised that by recognizing and acting upon the biases of the test constructor or the intent of the test, the testee may avoid loss of points due to mis-interpretation rather than lack of knowledge of the subject matter. Students should be testwise and present the type of answer expected by the examiner. The points to take into consideration include:

1. Interpret and answer questions in view of previous peculiar emphasis of the test constructor or in view of the test purpose.
2. Respond to items as the test constructor required.
3. Adopt the level of sophistication that is expected. An item (especially a true-false item) may have different correct answers depending on the depth or level which the constructor or purpose demands. A testwise testee will recognize and adopt the appropriate level.
4. Consider the relevance of specific detail.

(ii) Cue-using Strategy: This method pinpoints item features that testee may capitalize on as a guide to selection of correct response. This guide always emanate from item writing flaws of the test constructor. Milman et al believed that the cues should be used only when the testee is unable to arrive at the answer using the knowledge of the subject matter and his reasoning ability. They observed that successful use of cues is dependent upon previous contact with similar tests to establish the relationship between the cues and the correct answer. The adoption of this strategy involve:

1. Recognizing and making use of any consistent idiosyncrasies of the test constructor which distinguish the correct answer from incorrect options. For examples, making correct answer longer or shorter than the incorrect options, qualifying correct option more carefully or makes it represent a higher degree of generalization, placing correct answer in certain position among the options and using of familiar words while expressing the concept that is being described.
2. Consideration of the relevancy of specific detail when answering a given item. In this instance, the testee is sure of the correctness of the statement but has to decide if the additional details given alter the meaning of the statement.
3. Recognize and make use of specific determiners. This strategy has been extensively used by researchers. Such studies include the effects of testwiseness on test difficulty, correlates of testwiseness (Diamond and Evans, 1972), and effects of testwiseness in reading tests (Erickson, 1972).
4. Recognize and make use of resemblances between the options and an aspect of the stem. This principle is based on the ability of the testee to select a correct answer based on obvious resemblances between the stem and keyed option. This flaw emanates from the test-constructor. Studies by (Diamond and Evans 1972; Board and Whitney, 1972; and Woodley, 1973)

confirmed that the existence of this flaw allowed testees to gain higher score than they would have if the flaws were absent.

5. Consider the subject matter and difficulty of related items when interpreting and answering a given item. Sarnacki (1979) concluded that in terms of difficulty, a testee should be aware if the test-constructor tends to cluster difficult items at the end of the test or randomly disperses it. If the testee can decipher the ordering of the test-maker, he can make use of appropriate strategies for the test.

Sarnacki (1979) examined testwise taxonomy and pointed out two important points. First, he noted that most of the strategies are applicable to multiple-choice questions and true and false tests but cautioned that this does not mean that testwise skills may not be employed in other types of tests. He opined that some aspects of the time-using and error avoidance strategies are applicable to tests more subjective in nature of which essay test is one. Furthermore, he noted that knowledge of the test-constructor's intent and idiosyncrasies in test making and grading will aid the testee in maximizing scores regardless of the question format. Apart from this, knowledge of testwise strategies allows the testees to feel more confident while taking tests.

Secondly, Sarnaki (1979) observed that the techniques highlighted in the outline are not always applicable and at times may seem contradictory to one another. He pointed out that the principles in the description are well known to some test-constructors who may intend to use them as baits intended to lure the testwise testee into selecting an incorrect option. He concluded that a viable suggestion is to construct a hierarchy of cues appropriate to the specific examiner or type of test.

Beside the taxonomy, there are a number of additional testwiseness principles that have been proposed by various other theorists as the delimitation of the domain of testwiseness. In addition, in the general educational literature, different measurement experts have highlighted some theoretical approaches to the study of testwiseness.

Nitko (2001) classified test taking strategies into three categories.

Category 1 - Time using strategies (e. g., Begin to work as rapidly as possible with reasonable assurance of accuracy;

Category 2 - Error avoidance strategies (e. g., pay careful attention to directions, determining clearly the nature of the task and the intended basis of response);

Category 3 – Guessing strategies (e. g; always guess if right answers only are scored).

Sarnaki (1979) used five-category taxonomy;

- Time-using strategies (being able to work as rapidly as possible with reasonable accuracy);
- Error-avoidance strategies (paying close attention to directions);
- Guessing strategies (guessing when there is not a severe penalty for guessing);
- Deductive reasoning strategies (making use of relevant content information in other test items and options);

- Intent consideration and cue-using strategies (recognizing and making use of any consistent idiosyncrasies of the test that distinguish the correct answer from incorrect options).

A widely used taxonomy classified testwiseness strategies into three major categories (Walter and Siebert, 1990: Wenden, 1991):

Strategies used before answering the test such as;

- Write an outline for each question first.
- Read all questions first to start with the easy one(s)
- Read instructions carefully
- Budget time (allocate specific time to each question according to its difficulty and length).
- Form a mental image of the answer.
- Underline key words in the questions.

Strategies used during answering the test such as;

- Answer questions in chronological order.
- Revise each question immediately after answering it
- Use all available test time.
- Immediately write what comes to mind.
- Answer all questions even the one/s I do not know

Strategies used after answering the test such as:

- Revise answers to correct spelling and grammatical mistakes
- Re-read all questions to make sure I understand them correctly

- Revise both content and language
- Avoid last minutes changes.

Thorndike (1951) asserted that testwiseness present more of a problem of validity rather than reliability since testwiseness consistently represents invalid variance.

The score variance may be systematic but may be invalid since it does not relate to the criterion of interest. He opined that since testwiseness represent systematic variance, it is therefore a general lasting quality of the individual.

In support of Thorndike's opinion, Gibb (1964) pointed out that individual differences in testwiseness is best accounted for in terms of an individual's abilities, traits and states and not by the characteristics of tests.

Woodley (1973) acronized testwiseness as "factorially complex and motivated by certain personality characteristics as well as by the nature of the test, the test situation and the examiner".

In a nutshell, as an issue in educational and psychological measurement, numerous researchers have investigated testwiseness rather extensively and independently. There are three theoretical perspectives which have been adopted in studies related to testwiseness. The first perspective considers testwiseness as an additional source of variance in test scores. Hence, testwiseness is evaluated for its effects on test score, reliability and validity. The second perspective labels testwiseness as a lasting and persistence trait of testee. The concern here is an individual's ability to employ testwiseness skills. The third theoretical approach suggests the synthesis of the first two. According to this perspective, although both viewpoints offer necessary information concerning testwiseness, neither theory alone is sufficient in explaining the construct. Since testwiseness encompasses both the method of measurement, and the characteristics of the test-taker, it is vital to include elements from both viewpoints in any thorough treatise of testwiseness. From 1950's to 1970's, most of the studies done were related to either one of the first or the second perspectives, whereas in the 1980's and 1990's most studies were mostly a combination of both of the two perspectives. All these theoretical approaches are considered very important and were therefore adopted in the study.

2.13 Testwiseness, Gender and Abilty as Correlates of Test Anxiety

Several studies have been conducted to investigate the possible relationship between testwiseness and various other constructs such as test anxiety, motivation, intelligence and verbal achievement. Diamond and Evans (1972) found moderate, positive correlations between intelligence, as measured by the Lorge-Thorndike Intelligence Test and three specific testwiseness cues. The results of their study show that testwiseness is moderately correlated with intelligence. The study also showed that testwiseness is specific to certain cues only, and therefore not a general trait.

Ardiff (1965) obtained low positive correlations between testwiseness and intelligence in both third and sixth grade. Dunn and Goldstein (1979) carried out a study to investigate the correlation between intelligence and Testwise abilities (specific determiners, grammar, length of option, questions vs. incomplete statements.). Their findings show that there are no correlations between intelligence and illustrated testwiseness abilities.

Diamond and Evan (1982) investigated cognitive correlates of testwiseness in a sample of 6^{th} grade students by using a test instrument which contained fictitious materials. The data indicated that testwiseness is not a general trait, but rather is specific to the particular clue or clues under investigation. Millman (1966) found that differences among examinees in test performance were due to differences in testwiseness abilities and not the knowledge of the subject-matter. His findings supported the findings of Gibb (1964) that students possessing testwiseness skills could gain credit in a test without knowledge of the subject matter being tested.

However, Rogers and Bateson (1991) questioned the simple interpretation made by some that testwiseness and subject matter knowledge are independent. Based on the findings of their research, they suggested that it appears that the effective application of testwiseness reasoning strategies is dependent on some partial knowledge. This partial knowledge, although inadequate to respond to the test item solely but is sufficient when with knowledge of the testwiseness principles to increase the probability of correctly responding to items. They claimed that students with low partial knowledge but test-wise knowledge will perform less well than students who possess both on such items.

Testwiseness gives evidence of poor item-writing practices, especially when dealing with teacher-made tests. Empirical evidence for the strong positive relationship between testwiseness and multiple choice items was provided in two similar studies. These are studies done by Alker, Carlson and Hermann (1979) and Rowley (1974). Rowley (1974) found a significant positive correlation between testwiseness and performance on a multiple-choice vocabulary test

However, Millman (1966) found no relationship between testwiseness and test anxiety. It was observed that the difference in approach between the test-wise and test-naive students could be explained by differences in cognitive monitoring. Test wise students experience Meta cognitive success while test naive students experience cognitive failure (Garner, 1990). Research also indicates that testwiseness is an important correlate of test anxiety: test -wise students tends to perceive tests as less threatening than test-naive students (Sapp, 1999). On the other hand, test anxiety is closely related to self efficacy; an individual's perceptions that he can successfully perform behaviours necessary to produce a desire outcome (Bandura, 1986).

Test-anxious students usually have low levels of self-efficacy. They feel helpless and unable to influence testing events (Schunk, 1991). As a result, they believe that any efforts to succeed on any tests are futile. When obstacles occur during a test individuals with debilitating test anxiety are likely to quickly capitulate if initial attempts to overcome these obstacles are ineffective. Individual with high self-efficacy in contrast are better able to cope with obstacles during a test. They are more likely to keep attempting to overcome obstacles. The higher level of self-efficacy gives low test-anxious student greater confidence in their abilities and this result in sustained effort and constant work to overcome obstacles that lead to better performance on tests (Sapp, 1999).

Yien (2001) investigated the relationship between Taiwanes EFL test-takers' characteristics, test-taking strategies, and test performance. The results suggest that test-taking strategies play a mediating role between test-takers characteristics and test performance. Olanrewaju (1986) carried out a study to investigate the effects of instructional objectives and hierarchically organized learning tasks on students' problem-solving skills in Mathematics, the study shown that the female students were found to be better problem-solver than the male students. Analysis of the scores according to ability levels revealed that high ability students were significantly better problem solvers than medium and low ability students. Medium ability students were also significantly better than low ability students.

Strussy (1989) reported by orukotan (2000) created a model for the development of reasoning abilities in adolescent. A battery of assessments for locus of control, field dependence / independence, IQ rigidity / flexibility and reasoning was administered. The participants consisted of one hundred and ninety students in seventh through twelfth grade. In addition, student variables of gender, age and experience with science related activities were also considered. The model was tested and revised using path analysis which revealed significant path coefficients for age (0 – 54) experience (0 – 11), IQ (0.49) and field dependence / independence to reasoning was also significant.

Wavering (1989) examines the effect of logical reasoning on success in science. The study involved sixth through twelfth grade students and they were expected to graph data resulting in a positive slope and exponential curve. Analysis of the graph showed that students ability to draw graph increases with grade level and that the patterns of errors and abilities parallel piagetian categories of reasoning from pre-operational; at the eleventh and twelfth grade students developed ability to correctly graph data that resulted in exponential curve.

Niaz (1989) investigated the learners' ability to translate sentences into algebraic equations, and algebraic equations into sentences. The sample for the study was drawn from college students in an introductory level chemistry course. Orukotan (2000) opined that the underlying assumption was that formal reasoning and proportional reasoning would be related to success in chemistry. Findings revealed that as formal reasoning and proportional reasoning increased, so did achievement in chemistry. This also led to increase in ability to translate sentences into equations and equations into sentences. The ability of translating an equation to a sentence also correlated with achievement in chemistry. There was no correlation between achievements in chemistry with the ability to translate a sentence into an equation.

2.14 Prior Academic Ability and Students' Mathematics Performance.

Bandura (1997) attributes a very important role to prior achievement and its effect on students' subsequent performance. He also emphasises the inclusion of prior achievement in causal analyses. Pajares (1995) found out that previous attainments in Mathematics are strong predictors of subsequent Mathematics performance. Successive successes and failures are influential in the formation of self-efficacy. Bandura (1997) stated that prior achievement influences a person's perceived self-efficacy: however, its effect is less than that of factors such as cognitive styles, preferences and arousal. Lopez and Lent (1992) opined that prior achievement is the strongest predictor of self-efficacy beliefs. In addition, they demonstrated that general academic self-concept does not account for the self-efficacy variation without prior achievement. Furthermore, according to the findings of Lopez and Lent (1992) self-efficacy is influenced directly by previous achievement and it mediates the effects of prior achievement on following attainments.

Controversy also exists among various researchers concerning the degree to which testwiseness correlates with general cognitive ability. Several studies have found support for the notion that testwiseness and cognitive ability are separate issues. Miguel (1997) found that even when the effects of general mental ability were controlled for, testwiseness was still a significant predictor of performance on reading comprehension questions without the passages. Dunn and Goldstein (1986) asserted that certain aspects of testwiseness were actually related to some general characteristics of individuals such as general mental ability or intelligence.

Dunn and Goldstein (1986) found zero correlations between cognitive ability and testwiseness. Corroborating this view, Diamond and Evan (1972) found moderate positive correlations between intelligence and some specific testwiseness cues. Moderate positive correlations were obtained between intelligence and three testwiseness cues (stem options, specific determiners and grammatical clues), while other flaws (longer length options and similar options) were not found to be related to intelligence. The intelligence scores were obtained from the Longe-Thorndike intelligence Form AA while the testwiseness scores were obtained from a testwiseness scale. These studies lend support to the idea that test-wiseness and general mental ability are two separate constructs. In addition, Crehan, Gross, Koehler, and Slakter (1978) reported that test-wiseness is not highly related to cognitive ability. Others have reported that test-wise individuals often score higher than those low in testwiseness who are equal in terms of cognitive ability (Gross, 1977; Wahlstrom and Boersma, 1968). Sarnaki (1979) argued that testwiseness and cognitive ability are moderately correlated at best. Scruggs and Lifson (1985) opined that test-wiseness and cognitive ability are more closely related than others have argued.

Scruggs and Lifson (1985) contended that there is a lack of substantial evidence to support that cognitive ability and testwiseness are separate constructs, and state that it would defy credibility to assert that 'deductive reasoning' strategies are not related to general mental ability. In their argument, Scruggs and Lifson (1985) cited findings by Anderson (1973) which found a significant yet moderate correlation between testwiseness and general mental ability, as did Diamond and Evans (1972). Based on these findings, Scruggs and Lifson (1985) claimed that testwiseness is not a construct that students happen to acquire by chance or serendipity, which is unrelated to intelligence, and which results in substantial fluctuations of scores in achievement tests. Kreit (1998) hypothesized that the intelligence of pupils was related to acquisition of test-taking skills and that more intelligence children would improve from session to session on test-taking practice than the less intelligent ones. The results of the study revealed a gain in the mean scores in the predicted direction. The high intelligent quotient group gained the most, while the low intelligent quotient group recorded the least between their first and third session although both groups recorded significant gains.

2.15 Summary of Literature Review

The researcher has review literature about the nature of mathematics, concept of mathematics anxiety, factors that influence responses to test items and the declining performance in mathematics examinations. Some factors were identified as being responsible. The review also included theoretical approaches to the study of testwiseness and outlines of the strategies and principles that underlies testwiseness. From the literature reviewed, it has been discovered that there seems to be a consensus on the content of testwiseness training which includes: guessing, time-using, error-avoidance, cue-using and deductive reasoning strategies.

Furthermore, from the literature it was discovered that, training in testwiseness increases test scores positively and reduces test anxiety. In addition, the literature has also suggested that the following relationship appears to exist, that is:

(i) training in teswiseness and academic achievement

(ii) testwiseness, gender, abililty and academic achievement

(iii) testwiseness, gender, ability and test anxiety.

The identified relationships formed the practical and imaginary bases for the hypotheses postulated for the study. Moreover, all available literature reviewed by researcher showed that earlier researchers especially in Nigeria have not satisfactorily ventured into training in testwiseness as a means of improving students' performance and a way of reducing mathematics anxiety. A good number of studies reflected the preponderance of using traditional teaching method for the teaching and learning of mathematics in secondary schools. In this traditional method, students are subjected to mastery of facts or concepts and other learning strategies with no attempt at training students on testwiseness strategies. The present study has made effort to bridge the gap.

CHAPTER THREE

METHODOLOGY

This section presents the research process. It is presented under the following sub-headings: research design, area of study, population, sample and sampling technique, research instruments, procedures for data collection and method of data analysis.

3.1 Research Design

The research design used for this study was quasi-experimental pre-test post-test control group design (Campbell and Stanley, 1966). Quasi-experimental design refers to the application of an experimental mode of analysis and interpretation to the bodies of data not meeting the full requirements of experimental control. It is a factorial design represented graphically below.

O_1 X O_2 – Treatment Group

O_3 C O_4 – Control Group

The first row represents the treatment group. The second row is the control group. O_1 and O_3 represent pre-test scores; O_2 and O_4 represent post-test scores, X represents experimental treatment (Testwiseness Training) while C represents no treatment (control intervention). Intact classes were randomly assigned to treatment and control groups.

3.2 The Study Area

The study was carried out in Ado in Ekiti central senatorial district of Ekiti State of Nigeria. Ekiti central senatorial district was chosen because it is the only senatorial district in Ekiti-State that has all the characteristics of schools needed (that is, Co-educational, boys only and girls' only schools) for the study. Ekiti is a state in South Western Nigeria with three senatorial districts and sixteen local government areas. The state, created on 1st of October 1996 out of the territory of former Ondo state with Ado Ekiti as the state capital. It covers the former twelve local government areas that made up the Ekiti zone of old Ondo state. The state has a land mass coverage of 6,353 square kilometers and has a population of about 2,737,186 inhabitants as estimated in the 2005 population census. It is mainly an upland zone, rising over 250 meters above the sea level. The state is dotted with rugged hills, notable ones being Ikere-Ekiti hills in the south, Efon-Alaaye hills on the western boundary and Ado-Ekiti hills at the centre. The state is essentially a Yoruba speaking environment. It has 541 public primary schools and 74 registered private primary schools. Also, the State has 141 public secondary schools and 18 registered private secondary schools while there are 4 technical secondary schools in the state, the majority of which are concentrated in Ado metropolis.

3.3 Population

The target population for this study comprised all Senior Secondary School Students in all the three Senatorial Districts in Ekiti-State. The accessible population consisted of all the Senior Secondary 2 students (SS2) in Ado in Ekiti Central Senatorial District.

3.4 Sample and Sampling Procedure

In selecting the schools, all the Senior Secondary schools in Ado-Ekiti were first stratified into three groups- co-educational, boys only and girls' only. This yielded eighteen co-educational, two boys only and two girls' only schools. From the list of eighteen co-educational schools, two schools were randomly chosen using the hat and draw method, while the only two single sex(girls) and two single sex(boys) schools automatically qualified because they are the only four single sex schools in Ado-Ekiti. These made up the six public Senior Secondary Schools that were selected from the list of public Schools in Ado in Ekiti Central Senatorial District. The sample for the study was made up of four hundred and twenty-five (425) SS2 students consisting of two hundred and nineteen (219) male, and two hundred and six (206) female drawn from twelve intact classes such that two intact classes were randomly chosen from each of the six schools.

The schools used were:

1. Christ's School, Ado-Ekiti, Ekiti State.
2. Mary Immaculate Grammar School, Ado-Ekiti.
3. C.A.C Comprehensive Senior High School, Ado-Ekiti.
4. Ola Oluwa Muslim Secondary School, Ado-Ekiti.
5. Mary Hill Grammar School, Ado-Ekiti.
6. Christ Girls School, Ado-Ekiti.

SS2 students were chosen because they have spent a minimum of four years in the Secondary School and therefore must have covered reasonable content area in Mathematics and acquired some basic mathematical skills. Furthermore, it was assumed that they will served the researcher better especially in terms of their cooperation and commitment since they are the category of students that would be preparing for the Senior Secondary Certificate Examinations in less than two years and therefore were better motivated to receive any novel procedure aimed at assisting them to improve their performance. SS2 were also more stable than SS3 who are preparing for public examinations.

Three schools were used as treatment group and another three schools served as the control group. Two arms of SS2 were used in each school that served as the treatment group and the same was the case for the control group. These characteristics of the sample are summarized in Tables 2 and 3.

Table 2: Description of the Study Sample

Schools	Male	Female	Mean Age	Total
C.A.C Comprehensive (Mixed School) Testwiseness Training	44	39	15.94	83
Christ Girls (Girls Only) Testwiseness Training	-	64	15.44	64
Mary Hill (Boys Only) Testwiseness Training	86	-	15.98	86
Ola-Oluwa Muslim (Mixed School) Control Group	28	41	15.41	69
Mary Immaculate (Girls Only) Control Group	-	62	15.73	62
Christ's School (Boys Only) Control Group	61	-	15.45	61
Total	219	206	15.66	425

Table 3: Distribution of Participants by Gender and Treatment Groups

Groups	Male	Female	Total
Schools (1-3) Testwiseness Training	130	103	233
Schools (4-6) Control Group	89	103	192
Total	219	206	425

It should be noted that there was a preponderance of male than female participants in the treatment group while there were more female than male participants in the control group. Gender parity could not be achieved because intact classes were used as constituted in the various schools and it was beyond the researcher to alter them. The implications of this for the interpretation of results relating to gender should therefore not be lost sight of.

3.5 Research Instruments

Three major instruments were used for this study. These were:

1. Socio- Demographic Questionnaire (SDQ).
2. Mathematics Achievement Test (MAT)
3. Mathematics Anxiety Rating Scale – Revised (MARS – R)

1. **Socio-Demographic Questionnaire (SDQ)**.

This questionnaire was designed by the researcher to generate the participants' bio-data. Students were asked to provide information about their age, class, class attendance register number and gender. This was administered during the first phase of the study to obtain the baseline data.

2. **Mathematics Achievement Test (MAT)**: The MAT is a multiple choice test developed by the researcher. It consisted of 50-items drawn from past WASSCE question papers for periods (2005-2010) with 5 response options. The items covered the prescribed syllabus for SS2 and only the topics studied during the experimental

period. The Mathematics achievement test was constructed using test blueprint (or table of specification). Test blueprint is a 2-way table that relates the units of lesson or content area to the levels of cognitive domain objectives at which these contents have been learnt. It is to define as clearly as possible the scope and emphasis of the test and to relate the objectives to the content. Test blueprint helps to achieve content validity and provides groundwork for building achievement tests (Okoli, 2000).

Table 4: Test Blueprint for Mathematics Achievement Test

S/N	Content	Weight (%)	Knowledge	Comprehension	Application/ Problem Solving	Analysis	Total no. of item
1	**Probability and Statistics**	20	4	3	2	1	10
2	**Geometry and Mensuration**	22	2	5	3	1	11
3	**Simultaneous Equation**	18	3	2	3	1	9
4	**Number and Operation**	30	5	3	4	3	15
5	**Inequalities**	10	2	1	1	1	5
	Total	100%	16	14	13	7	50

Although the test has already been validated, the test yielded high stability co-efficient of 0.96 at the 0.05 level of significance when tested during the trial testing. It was used as pre-test to measure the entry ability of the students before exposing them to training and the MAT was also used as a predictive tool for determining students' ability levels (low, moderate and high). It was used to classify the participants accordingly. Students who scored from 0 to 49 were classified as low ability students, 50 to 69 as moderate ability students and those who scored from 70 and above were classified as high ability students. Some samples of the item are presented here:

Instruction: Answer all questions, each question is followed by five options letter A-E. Find out the correct option for each question and write only the answer to each question.

1. The probabilities that John and James pass an examination are ¾ and 3/5 respectively. Find the probability of both boys failing the examination.

   A. 1/10 B. 3/10 C. 9/20 D. 11/20 E. 2/10

Solution: The question requires students' knowledge of subtraction, multiplication fraction and probability theory (Dimensional item)

P (John) passing = ¾, P (James) passing = 3/5

P (John) failing = 1-3/4 =1/4, P (James) failing = 1-3/5 = 2/5

Both failing = P (John) failing & P (James) failing = ¼ x 2/5 = 2/20 = 1/10

Key = A (1/10) is the correct answer.

2. Correct 0.04954 to two significant figures.

   A. 0.040 B. 0.049 C. 0.050 D. 0.0491 E. 0.0495

Solution: Significant figures are counted from the first non zero numeral encounter starting from the left of the number (Uni-dimensional item)

0.04945 = 0.050

Key = C (0.050) is the correct answer.

3. **Mathematics Anxiety Rating Scale – Revised (MARS – R)**

The Mathematics Anxiety Rating Scale – Revised (MARS – R) was designed by Plake and Parker (1982). It is a 24- item scale designed to measure anxiety related to involvement in Statistics and Mathematics topics. It consists of two subscales. These are:

(a) The Learning Mathematics Anxiety (LMA) subscale which pertains to the process of learning Statistics and Mathematics.

(b) Mathematics Evaluation Anxiety (MEA) subscale which measures anxiety over being tested in Mathematics.

A sample of the items in MARS-R is presented here:

To answer each item, simply tick (√) one of the choices on the right hand column, the most appropriate to you from each of the statements. The numbers written against each statement is interpreted as follows:

1 = Low anxiety

2 = some anxiety

3 = Moderate anxiety

4 = Quite a bit of anxiety

5 = High anxiety

S/N	ITEMS	1	2	3	4	5
1	Watching a teacher work an algebraic equation on the black board.					
2	Listening to a teaching in Mathematics class					
3	Thinking about an incoming Mathematics test one day before.					
4	Taking final examination in Mathematics.					

3.6 Validation of Instruments

A pilot study was carried out by the researcher before the main study to have a tryout of the instruments and to determine their psychometric properties. The Mathematics achievement test was validated in two phases. During the first phase, a draft consisting of one hundred and twenty multiple choice objective type items that were relevant to the topics to be taught were selected from standardized objective tests in Mathematics from past question papers of WASSCE for the period 2005 – 2010 and compiled by the researcher. The draft was given to three Mathematics Education lecturers and also experts in Measurement and Evaluation to critique before final submission to the researcher's supervisors for approval. Their terms of reference included:

(i) Coverage of content.

(ii) Relevance of items to stated objectives.

(iii) Clarity of language, whether suitable or not suitable for the target population.

The outcomes of these assessments were used to re-define the items. The second phase was a tryout of the good items in a school located outside the Senatorial district under study. The conditions were similar as much as possible to those expected in the actual study. Fifty students (25 boys and 25 girls) were randomly selected among SS11 students of United High School (Ilawe) in Ekiti South Senatorial district of Ekiti-State and the instruments (MAT and MARS-R) were administered on the participants. To establish the stability of the instruments, the test-retest method was used. The interval between the first and second administration was three weeks. The results of the two administrations of the instruments were collated and based on this, Pearson product moment correlation co-efficient was used to estimate the test re-test reliability coefficient. The results are presented in Table 5.

Table 5: Test-retest reliability of the instruments

Instruments	**N**	**Test Position**	**Mean**	**S.D**	**r_{cal}**
Mathematics Achievement Test (MAT)	25	1st 2nd	33.71 64.55	12.84 5.97	0.96
Mathematics Anxiety Rating Scale-Revised (MARS-R)	25	1st 2nd	38.64 56.38	6.46 5.71	0.82

The result presented in table 5 indicates that the test-retest reliability index of Mathematics Achievement Test and Mathematics Anxiety Rating Scale-Revised were 0.96 and 0.82 respectively. These values were adjudged to be positively high, hence proved the suitability and reliability of the instruments. Furthermore, the participants' responses were used for item analysis.

3.6.1 Item Analysis of Mathematics Achievement Test (MAT): According to Baiyelo (2009), test refinement is the analysis carried out to determine the fitness of each item in a test. It is the process where a test is critically examined to determine how good it is and in that process the bad items are identified. Once a bad item is identified, the teacher can review it to determine if it is possible to refine it or discard it. In order word, Item analysis is the statistical technique for reviewing every item on the test with a view to refining the whole test (Obe, 1980). Item analyses were done by the researcher using the knowledge of the indices of item difficulty and item discrimination as well as distractor analysis.

3.6.2 Item Difficulty (Difficulty Index): The difficulty index measures the degree to which a test can be regarded as easy or difficult. The difficulty index of an item is the proportion of the testees who got the item right. It is expressed as a percentage and this ranges from 0% to 100%. The formula for estimating item difficulty is given by:

$$P = \frac{U + L}{N} \times 100$$

Where, P = the difficulty index for a given item

U = Number of students in the upper group who got the item right

L = Number of students in the lower group who got the item right

N = Number of students that took the test.

Items whose difficulty index ranges from 20% to 80% are acceptable; however the best difficulty index is 50%.

3.6.3 Item Discrimination (Discrimination Index):

According to Okoli (2000), the discriminating power of an item is the extent to which each item distinguishes between those who score low or high in the test. It measures how well a test item contributes to separating the upper and lower group. A good discriminating item is one in which a greater number of students in the upper group get the item right. The discriminating index (D) can take values ranging from -1.00 to +1.00. The higher the D values, the better the item discrimination. Test item that has a D value of + 0.40 and above is considered very effective. However, D values that range between +0.20 and 0.39 are considered satisfactory. Any item that has negative D value should be discarded. The formula for calculating discriminating index is given by:

$$D = \frac{U - L}{1/2N}$$

Where, D = Item discrimination power

U = Number of students in the upper group who got the item right

L = Number of students in the lower group who got the item right

N = Number of students in the item analysis group.

3.6.4 Distractor Analysis: The distractor analysis shows the extent to which the options are able to distract the lower group of students from choosing the right option.

Okoli (2000) opines that after identifying poor test items, such as items that are too easy, too difficult, or those with zero or negative discrimination, there are needs to ascertain what is wrong with these items. Analyzing the effectiveness of distracters entails a comparison of the responses of students in upper and lower groups.

Step-wise Procedure for Item Analysis

(i) Administer the test, score the items and arrange the students' scores in order of merit (highest to lowest)

(ii) Select the item analysis group (N). This is made up of: The upper group (best 30% or so) and the lower group (last 30% or so)

(iii) Beginning with item number one, count how many students in the upper group (U) that got it right. Thereafter, count how many students in the lower group (L) that got the item right

(iv) Repeat step 3 for other items

(v) For each item, compute the item discrimination power

(vi) Identify the poor items and analyze their item choices or the effectiveness of the distracters.

This is illustrated in the worksheet for item analysis in Table 6

Table 6: Item Analysis for the Mathematics Achievement Test

Item No.	Upper who got Item right U	Lower who got Item right L	Difficulty index (P) $\frac{U + L}{N} \times 100$	Discriminating index (D) $\frac{U - L}{1/2N}$
1	21	10	$\frac{31}{50} \times \frac{100}{1} = 62\%$	$\frac{11}{25} = 0.44$
2	22	5	$\frac{27}{50} \times \frac{100}{1} = 54\%$	$\frac{17}{25} = 0.68$
*3	6	8	$\frac{14}{50} \times \frac{100}{1} = 28\%$	$\frac{-2}{25} = -0.08$
4	23	10	$\frac{33}{50} \times \frac{100}{1} = 66\%$	$\frac{13}{25} = 0.52$
5	20	8	$\frac{31}{50} \times \frac{100}{1} = 62\%$	$\frac{12}{25} = 0.48$
6	23	19	$\frac{42}{50} \times \frac{100}{1} = 84\%$	$\frac{4}{25} = 0.16$
7	24	12	$\frac{36}{50} \times \frac{100}{1} = 72\%$	$\frac{12}{25} = 0.48$
8	22	13	$\frac{35}{50} \times \frac{100}{1} = 70\%$	$\frac{9}{25} = 0.36$
*9	14	14	$\frac{28}{50} \times \frac{100}{1} = 56\%$	$\frac{0}{25} = 0.0$
10	23	20	$\frac{43}{50} \times \frac{100}{1} = 86\%$	$\frac{3}{25} = 0.12$

Results from the analysis shows that items number 1, 2, 4, 5, 7, and 8 are acceptable and effective. The test items discriminate only positively and also not too difficult because their difficulty index ranges between 0.54 – 0.72. Considering item number 3 and 9 on the test worksheet above, these items have negative (-0.08) and zero (0.0) discriminations but both items 3 and 9 recorded positive difficulty index respectively, the researcher undertook item choice analysis to determine why item 3 and 9 recorded negative and zero discrimination power respectively. Furthermore, almost all the testees got item number 6 and 10 right. This implies that the items are too easy and therefore item number 6 and 10 should be discarded. In this study however, the item-choices analysis cannot be carried out for all the items on the achievement test in Mathematics, only two examples were illustrated here hypothetically.

Hypothetical Illustration

In the achievement test, each item has five options or choices labeled A – E, only one of which is correct.

Positive discriminating item 2

Question: Simplify: $5/\sqrt{3} - 3/\sqrt{2}$

A. $1/6(5\sqrt{3} - 3\sqrt{2})$ C. $1/6(15\sqrt{3} - 6\sqrt{2})$

B. $1/6(3\sqrt{2} - \sqrt{3})$ D. $1/6(10\sqrt{3} - 9\sqrt{2})$ E. $1/6(5\sqrt{3} - 2\sqrt{3})$

Result:	A	B	C	D*	E
Upper 25	1	0	1	22	1
Lower 25	7	5	2	5	6

Key = D

$$P = \frac{U + L}{N} \times 100 = \frac{27}{50} \times \frac{100}{1} = 54\%$$

$$D = \frac{U - L}{1/2 N} = \frac{17}{25} = 0.68$$

Comment: This question is good because distractor analysis shows that substantial number of students in the lower group responded to the distractor and large number of students in the upper group selected the correct alternative. It implies that item number 2 distinguishes between those who scored low or high marks in the test.

Negatively discriminating item Number 3

Question: A man bought 220 mathematicses at ₦5x. He sold each for 3xkobo and made a gain of ₦8. Find the value of x.

A. 2 B. 5 C. 6 D. 10 E. 4

Result:	A	B	C*	D	E
Upper 25	3	13	6	2	1
Lower 25	7	4	8	3	3

Key = C

$$P = \frac{U + L}{N} \times 100 = \frac{14}{50} \times \frac{100}{1} = 28\%$$

$$D = \frac{U - L}{1/2N} = \frac{-2}{25} = -0.08$$

Comment: This question is bad because of wrong key used in scoring the item by the examiner. It is observed from this analysis of choice that the most frequently selected option by the upper group is B. A closer look at the solution to the question shows that option B is actually the right answer. This choice results in moderate difficulty and positive discrimination.

Based on the above procedures of item analysis, items that had D discriminating index of 0.4 to 0.8 and were option distracting were selected. From this, one form of Mathematics Achievement Test was assembled. The test consisted of fifty items of five response options each. The same form was used for the pre test and post test.

The face and content validity of SDQ and MARS-R were ascertained by expert opinion. Test-retest method was used to determine the reliability of the MAT and MARS-R. The concurrent validity of MARS-R was obtained by correlating it with Richardson and Suinn (1972) Mathematics Anxiety Rating Scale (MARS). The MARS-R which yielded a coefficient alpha reliability estimate of .98 yielded a coefficient value of .97 when it was correlated with MARS.

3.6.4 Treatment Package: The testwiseness training module (TTM) was developed by the researcher and it was an adaptation of the "Taxonomy of test-taking strategies" by Nitko (2001), Sarnaki (1979) and Millman (1965). Nitko (2001) developed taxonomy of test taking strategies that will make students to be testwise and are useful on all types of tests. The test training module focused on training for test taking skills and it was treated in three parts as follows:

(iv) The test – rationale, types and purposes

(v) Testwiseness – definition and five test-taking strategies or principles which include: Time using strategies, error avoidance, guessing strategies, deductive reasoning strategies and cue-using strategies.

(vi) Test conduct – Composure for a test and test conduct.

3.7 Procedures for Data Collection

An introductory letter was collected from the Department of Educational Foundations, University of Lagos to seek permission from the Honorable Commissioner, Ekiti State Ministry of Education to use the schools. Approval was granted and the letter of permission was taken by the researcher to each of the principals of the selected Schools that were used for the study. The pre and post test instruments were personally administered by the researcher and assisted by six research assistants in group settings. The return rate was therefore one hundred percent. Similarly, all the training sessions were conducted by the researcher in conjunction with the six research assistants.

3.8 Recruitment and Training of Research Assistants

Six research assistants were appointed to assist in the collection and recording of data for the study. The Mathematics teachers for the participating classes were appointed as research assistants. This was necessary because the cooperation of the subject teachers was needed to achieve a successful data collection in each of the schools. They were trained for a period of 2 days on the role they were to play in the administration of test, questionnaire and other duties expected of them during the period of the study. The research assistants were appropriately remunerated for their efforts at the end of the study.

3.9 Procedure

This study was carried out in three phases.

Phase one (1) – Pre-treatment Assessment: The researcher administered pre-test using the three instruments (SDQ, MAT and MARS-R). The MAT was used to determine the entry ability and status of the participants before exposing them to treatments while the SDQ and MARS-R were used to collect baseline data for assigning participants to groups.

Phase two (2) – Treatment: The treatment groups had the testwiseness training module every time they had Mathematics class for six weeks and the researcher spent the last fifteen minutes of each forty-minute period training participants on testwiseness using the testwiseness training module. The participants in the control group did not receive any treatment rather they were taught the same mathematics topics for the same duration as the treatment groups by the researcher using the same lesson notes and scheme of work.

Phase three (3) – Post assessment: In the eighth week, the instruments (MAT and MARS-R) were administered again to the treatment and control groups. This was done to find out if treatment had any impact on the participants.

3.10 Treatment for the Experimental Group

Session one: Introduction of researcher as the new Mathematics teacher to the participating classes was done by the Vice principals (Academic) of the respective schools. The researcher then established rapport and stressed the need for the students to feel free to ask questions during the period of treatment. This was followed by administration of SDQ, MAT and MARS-R.

Session two: The researcher assumed the role of a teacher. The topic for the week was taught and test-taking strategies were embedded in each lesson so that students could become knowledgeable and confident test-takers. The researcher focused on: Time-Using Strategy. It involves guidelines that help to avoid loss of marks for reasons other than lack of knowledge of the test item. The points discussed under this strategy included:

(i) How to work quickly and efficiently, solving the problems and answering items you know and saving the more difficult item for the last.

(ii) Setting up a schedule for progress through the test.

(iii) Omitting or guessing at items which you cannot quickly answer.

(iv) Marking omitted items which need further consideration, to assure easy relocation.

(v) How to make use of the time remaining after the completion of the test.

Participants were allowed to ask questions at every stage of the session and class work and assignment were given at the end of the lesson.

Third and fourth Sessions: The researcher repeated steps stated in session two in teaching the students other topics using a variety of procedures, useful application of mathematical concepts, jokes, humour, deep breathing and relaxation technique in order to alleviate anxieties and motivate the participants to develop positive attitude towards learning of Mathematics. In addition, the students were also exposed to test-taking strategies which are: Error avoidance and Deductive reasoning strategies. Error avoidance strategies centered on:

(i) How to avoid minor mistakes

(ii) Pay careful attention to directions, determining clearly the nature of the task and the intended basis of response

(iii) Examine items carefully and determine the nature of the question before response

The deductive reasoning strategy allowed examinees to gain marks beyond that which they would have obtained through direct knowledge of the subject matter. Here, it is assumed that the examinee already has some knowledge of the subject matter but he/she is unsure of the answer. The researcher explained to the participants how to apply a variety of strategies including eliminating options known to be incorrect, using content information from the stem (question) or other test information. At the end of the lesson, the researcher gave class work and assignment to the students and marked the class work with the help of research assistants. Corrections were done afterwards.

Fifth Session: The focus of this session was to expose participants to guessing strategy as well as making effective use of guessing when it is likely to benefit the testee. To achieve this, questions were set from the topics that had been covered during the training session by the researcher. The researcher gave a practical illustration of how to guess for correct answers. The areas of discussion under guessing strategy included:

(i) How to eliminate most or all of the foils before guessing. That is, using partial knowledge;

(ii) Guess if right answers only are scored;

(iii) Always guess even if the usual correction or a more severe penalty for guessing is employed, whenever elimination of option provides sufficient chance of profiting;

(iv) Guess if you can do so intelligently. Do not guess if you know nothing about the question.

At the end of the session, class test was administered.

Sixth Session: This session aimed at exposing students to the use of cues and intent consideration strategies. The discussion focussed on:

(i) Use of known idiosyncrasies of the test-maker. That is, using content clues to determine answers.

(ii) Understanding the purpose of the test

(iii) Test conduct – Composure for a test and test conduct.

At the end of this session, an achievement test was administered to identify the types of questions the students needed to master and their areas of weaknesses in answering multiple choice objective questions. The same type of achievement test questions were modeled for students and the process for choosing a correct answer was discussed.

Seventh Session: Students were guided through authentic practice in a timed testing environment using the entire test-taking strategies which included: Time using strategies, error avoidance, guessing strategies, deductive reasoning and cue using strategies.

Session Eight: Summary of the training, feedback from the students and administration of post-test MAT and MARS-R.

3.11 Treatment for the Control Group

The control group was chosen from a different location that is far from the experimental schools to avoid experimental contamination. During the first session the participants were administered the Socio-Demographic Questionnaire (SDQ), Mathematics Achievement Test (MAT) and Mathematics Anxiety Rating Scale-Revised (MARS-R). The participants were taught the same topics for the same duration as the experimental group by the researcher but did not receive the testwiseness training module. In addition, normal weekly class tests were conducted and in the eighth week, post tests were administered. The control group was later exposed to testwiseness training after the eighth week so as to benefit them from the training.

3.12 Method of Data Analysis

The data that were collected from the participants using the various instruments were coded and subjected to statistical treatment. The data were subjected to both descriptive and inferential statistics. All the hypotheses were tested at the 0.05 level of significance. The means and standard deviations for pre and post treatment assessment measures were computed. Hypotheses one and three were tested using One-way Analysis of Covariance. Hypotheses two, four, five, six, seven and eight were tested using the two-way Analysis of Covariance (ANCOVA).

CHAPTER FOUR

RESULTS OF DATA ANALYSIS

4.0 Introduction

The data collected from the various research instruments were treated statistically using both descriptive and inferential statistics appropriate for each hypothesis. All the hypotheses were tested at the 0.05 level of significance.

4.1 Test of Hypothesis One: The first hypothesis states that there is no significant difference in post-test mathematics achievement between students exposed to testwiseness training and those in the control group.

To test hypothesis one, One-way Analysis of Covariance was utilized. Post-test mathematics achievement scores of the participants were entered as the dependent variable scores while their pre-test mathematics achievement scores were entered as the covariate. Experimental condition served as the independent factor. The results are presented in Tables 7 and 8.

Table 7: Descriptive Data of Pre and Post test Scores of the Participants Across the Experimental Conditions.

		Pretest Scores		Post test Scores		Mean
Group	**N**	**Mean**	**S.d**	**Mean**	**S.d**	**Difference**
Testwise Training	233	46.38	14.21	68.28	12.80	21.90
Control Group	192	46.97	12.31	49.14	15.02	2.17
Total	425	46.64	13.37	59.63	16.80	12.99

Evidence from Table 7 shows that before the training intervention, the Mathematics performance of the students, irrespective of the experimental condition to which they were assigned, was generally below average as indicated in their respective mean scores of 46.97 (Sd = 12.31) for the control group and 46.38 (Sd = 14.21) for the treatment group. The grand mean score of the two groups was 46.64 (Sd = 13.37).

At post-test, the average performance of students in the control group slightly improved from 46.97 recorded at pre-test to 49.14 (Sd = 15.02) thus yielding a gain score of 2.17. For those students who received training in test-taking skills, their Mathematics performance greatly improved from a below average performance of 46.38 obtained before the training intervention to an outstanding performance as evidenced from a mean score of 68.28 (Sd = 12.80) recorded after the treatment intervention. The pre and post test mean difference was therefore 21.90

To determine if the differences in post-test Mathematics performance between the treatment and control groups were statistically significant, ANCOVA was carried out and results are presented in Table 8.

Table 8: ANCOVA Test of Difference in Post-test Mathematics Performance between Treatment and Control Groups.

Source	Sum of Squares	Df	Mean Squares	F	Partial Eta Squared
Model	1596745.29	3	532248.43	6557.40*	.98
Covariate(Pretest Maths Achievement)	46853.36	1	46853.36	577.24*	.58
Experimental Conditions	58517.88	2	29258.94	360.48*	.63
Error	34252.71	422	81.17		
Total	1630998.00	425			

a. R Squared = .98 (Adjusted R Squared = .98).

*Significant, $p < 0.05$, $F_{critical}$ (1/422) = 3.85

$p < 0.05$, $F_{critical}$ (2/422) = 3.00

$p < 0.05$, $F_{critical}$ (3/422) = 2.61

Evidence from the ANCOVA result presented in Table 8 shows that for the Experimental condition, the F–value obtained was 360.48 as against a theoretical F–value of 3.00 given 2 and 422 degrees of freedom at the .05 level of significance. This therefore suggests that training was effective in improving the Mathematics performance of the students. A closer look at the mean scores of the treatment and control groups shows that although the two groups were generally poor in Mathematics before the training intervention, at post test, the students who received training in testwiseness improved their performance significantly better than their control group counterparts. The independent contribution of experimental condition to the explained variance in post-test Mathematics Achievement was generally high and about 63% as indicated by the partial Eta squared of 0.63

The analyses presented in Tables 7 and 8 therefore led to the rejection of the null hypothesis which states that there is no significant difference in post-test Mathematics Achievement between the treatment and control groups. On the contrary, the findings showed that students who received training in testwiseness significantly improved in the Mathematics performance more than their control group counterparts.

4.2 Test of Hypothesis Two: The second hypothesis states that there is no significant difference in post-test mathematics achievement of students in the two experimental groups due to their gender.

In testing the second hypothesis, the two levels of experimental condition (treatment and control) and gender (male and female) were compared on their post-test Mathematics achievement using a 2 x 2 Analysis of Covariance. The results are presented in Tables 9 and 10.

Table 9: Descriptive Data of the Effects of Experimental Condition and Gender on Post-test Mathematics Performance of Students.

Groups		Pretest Scores Mean	Pretest Scores S.d	N	Posttest Scores Mean	Posttest Scores S.d	Mean Difference
Testwiseness	**Male**	49.53	15.57	130	69.93	12.75	20.40
	Female	42.41	11.15	103	66.19	12.63	23.78
	Total	46.38	14.21	233	68.28	12.80	21.90
Control	**Male**	47.17	12.54	89	50.20	14.90	3.03
	Female	46.80	12.16	103	48.22	15.13	1.42
	Total	46.97	12.31	192	49.14	15.02	2.17
Total	**Male**	48.57	14.43	219	61.91	16.74	13.34
	Female	44.60	11.85	206	57.21	16.56	12.61
	Total	46.65	13.37	425	59.63	16.80	12.98

Table 9 shows that on the whole, the mean Mathematics achievement of the female students was 44.60 with a standard deviation of 11.85 as against 48.57 (Sd = 14.43) obtained by the male students before the treatment intervention. These performance scores were generally low but similar to those obtained by each gender in each of the two experimental conditions. It was therefore evident that at pre-test, the male and the female students in the two experimental groups performed poorly in Mathematics.

Table 9 also reveals that after the treatment intervention, the performance of both the male and female students greatly improved. For the male students in the control group, their mean performance slightly increased from 47.17 to 50.20 (Sd = 14.90) while the female students in the same group also improved their group performance marginally from 46.8 to 48.22 (Sd = 15.13). The mean difference between pre and post-test performance for the female students in the control group was therefore 1.42 as against 3.03 recorded by the male students in the same group. As for the male students who received training in testwiseness, their average performance in Mathematics greatly improved from 49.53 (Sd = 15.57) obtained before the training to 69.93 after the intervention, thus yielding a gain score of 20.40. Similarly, the female students in the treatment group also improved their mean performance from 42.41 at pretest to 66.19 at post-test thus yielding a mean difference of 23.78. Table 10 presents the 2 x 2 ANCOVA summary statistics.

Table 10: 2 x 2 ANCOVA Tests of the Effects of Experimental Condition and Gender on Post-test Mathematics Achievement of Students

Source	Sum of Squares	Df	Mean Square	F_{cal}	Partial Eta Squared
Model	85750.66	4	21437.66	265.52*	.72
Intercept	14609.07	1	14609.07	180.94*	.30
Covariate(Pretest Mathematics Achievement)	46206.64	1	46206.64	572.30*	.58
Experimental Conditions	40244.81	1	40244.81	498.46*	.54
Gender	1.63	1	1.63	0.02	.00
Interaction(Experimental Condition X Gender)	335.76	1	335.76	4.16*	.01
Error	40189.95	420	95.69		
Total	1630998.00	425			

a. R Squared = .72 (Adjusted R Squared = .71).

*Significant, $p < 0.05$, $F_{critical}$ (1/420) = 3.85

$p < 0.05$, $F_{critical}$ (4/420) = 2.38

Table 10 shows that the effect of gender (F = 0 .02) was not statistically significant at the 0.05 level while the interaction of gender and experimental condition (F_{cal} = 4.16) was statistically significant at 0.05 level of significance with 1 and 420 degrees of freedom. The independent contributions of gender and the interaction term (Gender by Experimental condition) to explained variance in post-test Mathematics Achievement were 0% and 1% respectively. Hypothesis two was therefore accepted. It was concluded that the post-test Mathematics Achievement of male and female students in the treatment and control groups did not significantly differ.

4.3 Test of Hypothesis Three: The third hypothesis states that there is no significant difference in post-test Mathematics anxiety of students exposed to training in testwiseness and those in the control group.

Hypothesis three was tested using a one-way Analysis of Covariance, the results of which are presented in Tables 11 and 12.

Table 11: Description of Pre and Post-test Mathematics Anxiety Scores of Students in the Treatment and Control Groups.

Group	N	Pretest Scores		Post test Scores		Mean
		Mean	S.d	Mean	S.d	Difference
Testwiseness Training	233	90.17	18.54	61.86	13.70	28.31
Control Group	192	92.14	13.11	91.70	12.48	0.44
Total	425	91.06	16.32	75.34	19.84	15.72

Table 11 indicates that before the treatment intervention, the Mathematics anxiety scores of students in both the treatment and control groups were generally high, ranging from a mean of 90.17 (Sd = 18.54) for the treatment group to 92.14 (Sd = 13.11) for the control group participants. This suggests that both groups were homogenous and high on Mathematics Anxiety.

Table 11 also reveals that although the control group participants recorded a slight reduction in their Mathematics Anxiety at post-test, the change was a negligible 0.44. For the testwise training group, a drastic reduction in Mathematics Anxiety was reported that is, from a high score of 90.17 at pretest to a low score of 61.86 at post test (with respective standard deviations of 18.54 and 13.70) thus yielding a mean difference of 28.31.

To test for significant between group differences in post-test Mathematics anxiety, a one way ANCOVA was utilized and the results are reported in Table 12

Table 12: Effects of Experimental Condition on Post-test Mathematics Anxiety of Students

Source	Sum of Squares	Df	Mean Square	F_{cal}	Partial Eta Squared
Corrected Model	112207.88[a]	2	56103.94	432.28*	.67
Intercept	20836.85	1	20836.85	160.55*	.28
Covariate(Pretest Mathematics Anxiety	18483.48	1	18483.48	142.42*	.25
Experimental Conditions	88446.95	1	88446.95	681.49*	.62
Error	54769.33	422	129.79		
Total	2579251.00	425			
Corrected Total	166977.21	424			

a. R Squared = .67 (Adjusted R Squared = .67).

*Significant, $p < 0.05$, $F_{critical}$ (1/422) = 3.85

$p < 0.05$, $F_{critical}$ (2/422) = 3.00

Table 12 indicates that for experimental condition, the obtained F-value of 681.49 is statistically significant at 0.05 level of significance ($F_{.05}$ 1/422 = 3.85). The obtained Partial Eta squared = .62 thus suggesting that the independent contribution of Experimental condition to explained variance in post-test Mathematics Anxiety was very high, about 62%.

Hypothesis three was therefore rejected based on the results in Tables 11 and 12. It was concluded that students who received training in testwiseness recorded significant reduction in their post training anxiety than students who did not participate in the training. It was therefore concluded that training in test-taking strategies significantly benefitted the participants in terms of reducing their test anxiety level.

4.4 Test of Hypothesis Four: Hypothesis four sought to determine if male and female participants in the treatment and control groups did not significantly differ in their post-test Mathematics Anxiety.

The results of the analysis of data using a 2 x 2 ANCOVA are summarized in Tables 13 and 14.

Table 13: Pre and Post test Mathematics Anxiety Scores of Male and Female Students in the Treatment and Control Groups.

		Pretest Scores			Posttest Scores		Mean
Group		**Mean**	**S.d**	**N**	**Mean**	**S.d**	**Difference**
Testwiseness	**Male**	89.58	19.10	130	60.74	13.26	28.84
	Female	90.91	17.88	103	63.27	14.16	27.64
	Total	90.17	18.54	233	61.86	13.70	28.31
Control	**Male**	91.51	14.11	89	91.28	13.08	0.23
	Female	92.69	12.22	103	92.06	11.98	0.63
	Total	92.14	13.11	192	91.70	12.48	0.44
Total	**Male**	90.36	17.24	219	73.15	19.98	17.21
	Female	91.80	15.30	206	77.67	19.48	14.13
	Total	91.06	16.32	425	75.34	19.84	15.72

The results presented in Table 13 indicate that overall, the mean Mathematics anxiety of the entire sample (N = 425) was 91.06 (Sd = 16.32) which is very high considering that the minimum and maximum scores obtainable were 24 and 120 respectively. The female participants were 0.74 above this grand mean while the male participants were 0.70 below the grand mean. The results in Table 10 also show that at post-test, the mean Mathematics anxiety scores of the male and female participants were much lower than the pretest for both groups as reflected in their respective mean scores of 77.67 (Sd = 19.48) for female and 73.15 (Sd = 19.98) for the male participants.

A categorization by experimental condition and gender indicates that the male participants in the testwiseness training group reported a post-test Mathematics anxiety mean score of 60.74 (Sd = 13.26) as against 91.28 (Sd = 13.08) reported by males in the control group. The mean difference between the males in the treatment group and their counterparts in the control group was therefore 28.61. As regards the female participants, those in the treatment group reported a post-test Mathematics anxiety mean score of 63.27 (Sd = 14.16) as against 92.06 (Sd = 11.98) obtained by those in the control group thus yielding a mean difference of 27.01 between the female participants in the two groups.

Table 14 presents the ANCOVA summary statistics of the effects of experimental condition and gender on post-test Mathematics anxiety of the students.

Table 14: ANCOVA Test of the Effects of Experimental Condition and Gender on Post-test Mathematics Anxiety of Students

Source	Sum of Squares	Df	Mean Square	F_{cal}	Partial Eta Squared
Corrected Model	112440.44[a]	4	28110.11	216.48*	.67
Intercept	20991.77	1	20991.77	161.66*	.28
Covariate(Pretest Mathematics Anxiety	18318.36	1	18318.36	141.07*	.25
Experimental Condition	86946.75	1	86946.75	669.6*	.62
Gender	137.0	1	137.0	1.06	.00
Interaction (Experimental Condition X Gender	74.9	1	74.9	.58	.00
Error	54536.77	420	129.85		
Total	2579251.00	425			
Corrected Total	166977.21	424			

a. R Squared = .67 (Adjusted R Squared = .67)

*Significant, $p < 0.05$, $F_{critical}$ (1/420) = 3.85

$p < 0.05$, $F_{critical}$ (4/420) = 2.38

Table 14 shows that a calculated F-value of 1.06 resulting as the effect of gender on post-test anxiety scores of the participants. This was lower than the critical F-value of 3.85 given 1 and 420 degrees of freedom at the .05 level of significance. For the interaction effect of experimental condition and gender on post-test Mathematics anxiety, the obtained F-value that resulted (F = 0.58) was also lower than the theoretical F-value of 3.85. Since the effects of gender and the interaction of experimental condition and gender on post-test Mathematics Anxiety were not statistically significant, hypothesis four was not rejected. It was therefore concluded that male and female students in the treatment and control groups did not significantly differ in their post-test Mathematics Anxiety. Thus, there was no interaction effect of gender and treatment on the students' post test mathematics anxiety.

4.5 Test of Hypothesis Five: Hypothesis five states that there will be no significant difference in Mathematics post-test achievement of high, moderate and low ability students who received training in testwiseness and those who did not receive training.

In testing hypothesis five, the two levels of experimental condition (treatment and control) and three levels of ability group (high, moderate and low) were compared on their post-test Mathematics achievement with pre-test Mathematics achievement as covariate, using a 2 x 3 Analysis of Covariance, the results of which are summarized in Tables 15 and 16.

Table 15: Descriptive Data of the Effects of Experimental Condition and Ability level on Post-test Mathematics Performance of Students.

Experimental Condition Ability Group		Pretest Scores Mean	Pretest Scores S.d	N	Posttest Scores Mean	Posttest Scores S.d	Mean Difference
Testwiseness	**Low**	37.01	8.33	139	62.45	12.25	25.44
	Moderate	57.04	5.56	77	75.99	8.20	18.95
	High	74.71	4.78	17	81.00	3.41	6.29
	Total	46.38	14.21	233	68.28	12.80	21.90
Control	**Low**	38.64	6.46	112	40.28	10.11	1.64
	Moderate	56.38	5.71	71	59.21	9.44	2.83
	High	76.33	5.15	9	80.00	10.71	3.67
	Total	46.97	12.31	192	49.14	15.02	2.17
Total	**Low**	37.74	7.58	251	52.56	15.82	14.82
	Moderate	56.72	5.62	148	67.94	12.16	11.22
	High	75.27	4.87	26	80.65	6.66	5.38
	Total	46.65	13.37	425	59.63	16.80	12.98

The result of the study presented in Table 15 shows that the mean Mathematics achievement of low ability students in the treatment group was 37.01 with a standard deviation of 8.33 as against 38.64 (Sd = 6.46) obtained by the low ability students in the control group before the treatment intervention. The results revealed that after the treatment intervention, the low ability students in the treatment group greatly improved their mean score to 62.45 (Sd = 12.25) yielding a gain of 25.44 as against a mean score of 40.28 obtained by the low ability students in the control group at post-test showing a slight improvement of 1.64 compared with their pre-test scores.

Table 15 also reveals that after the treatment intervention, the performance of moderate ability students greatly improved. For the moderate ability students in the control group, their mean performance slightly increased from 56.38 at pre-test to 59.21 (Sd = 9.44) at post-test. The mean difference between pre and post-test performance for the moderate ability students in the control group was therefore 2.83 as against 18.95 recorded by the moderate ability students in the treatment group. As for the high ability students in the treatment group, their mean performance in Mathematics improved from 74.71(Sd = 4.78) obtained before the training to 81.00 after the intervention, resulting in a gain score of 6.29. The high ability students in the control group also slightly improved their average performance from 76.33 at pre-test to 80.00 at post-test thus resulting in a mean difference of 3.67.

Table 16 presents the summary of results of ANCOVA of the effects of experimental condition and ability level on post-test Mathematics achievement of the students.

Table 16: ANCOVA tests of the Effects of Experimental Condition and Ability Level on Post-test Mathematics Achievement of Students

Source	Sum of Squares	Df	Mean Square	F_{cal}	Partial Eta Squared
Model	1600378.85	7	228625.55	3121.10^{*}	.98
Covariate(Pretest Mathematics Achievement)	13872.50	1	13872.50	189.38^{*}	.31
Experimental Conditions	8321.45	1	8321.45	113.60^{*}	.21
Ability Groups	156.08	2	78.04	1.07	.01
Interaction(Experimental Condition X Ability Groups)	3129.27	2	1564.63	21.36^{*}	.09
Error	30619.18	418	73.25		
Total	1630998.00	425			

a. R Squared = .98 (Adjusted R Squared = .97)

*Significant, $p < 0.05$, $F_{.05}$ (1/418) = 3.85

$p < 0.05$, $F_{critical}$ (2/418) = 3.00

$p < 0.05$, $F_{critical}$ (7/418) = 2.02

Table 19 indicates that calculated F-value of 1.07 resulted as the effect of ability level on post-test Mathematics achievement of the participants. The interaction effect of ability and experimental condition was F_{cal} = 21.36. These F-values were statistically significant at the 0.05 level of significance ($F_{.05}$ 2/ 418 =3.00). Since the obtained F values were greater than the theoretical F value, hypothesis five was rejected. It was therefore concluded that there exists a significant difference in Mathematics post-test achievement of high, moderate and low ability students exposed to training in testwiseness and those not exposed to training in testwiseness.

To determine which groups significantly differed, fifteen pairwise comparisons were performed using Fisher's protected t-test. The results of which are presented in Table 17.

Table 17: Pairwise Comparison of Post-test Mathematics Achievement between High, Moderate and Low Ability Students in the Treatment and Control Groups.

Group	S.d	CL	CM	CH	TL	TM	TH
CL	10.12	**40.28**	-12.97*	-11.09*	-15.18*	-24.45*	-14.92*
CM	9.44	18.93	**59.21**	-5.81*	-2.22*	-11.49*	-7.98*
CH	10.71	39.72	20.79	**80.00**	4.92*	1.12ns	0.24ns
TL	12.25	22.17	3.24	17.55	**62.45**	-9.27*	-6.79*
TM	8.20	35.71	16.78	4.01	13.54	**75.99**	-1.84ns
TH	3.41	40.72	21.79	1.00	18.55	5.01	**81.00**

***** = Significant at 0.05 level

ns = not significant

Respective Mean Scores are in the diagonal. Mean Differences are below the diagonal and calculated t-values are above the diagonal.

KEY: CL – Control Low Ability

CM – Control Moderate Ability

CH – Control High Ability

TL – Testwise Low Ability

TM – Testwise Moderate Ability

TH – Testwise High Ability

Results presented in Table 17 indicate that of the fifteen pairwise comparisons computed, twelve were statistically significant while three were not. The comparisons that were not statistically significant were those between:

i. High ability students in the treatment group and their control group counterparts with respective mean difference and calculated t-values of 1.00 and 0.24.

ii. High and moderate ability students in the treatment group with a mean difference of 5.01 and a theoretical t-value of 1.84.

iii. Moderate ability students in the treatment group and high ability students in the control group with respective mean scores of 75.99 and 80.00 which yielded a calculated t-value of 1.12

From these results, it was evident that training in test-taking skills was most efficacious for students with low ability (pre and post-test mean difference of 22.17) followed by those with moderate ability (M.D = 16.78) while the effect of training on the high ability students was very negligible (M.D = 1.00).

4.6 Test of Hypothesis Six: Hypothesis six states that there will be no significant difference in Mathematics post-test anxiety of high, moderate and low ability students who received training in testwiseness and those who did not receive training testwiseness.

In testing hypothesis six, the two levels of experimental condition (treatment and control) and three levels of ability group (high, moderate and low) were compared on their post-test Mathematics anxiety with pre-test Mathematics anxiety as covariate, using a 2 x 3 Analysis of Covariance, the results of which are summarized in Tables 18 and 19.

Table 18: Descriptive Data of the Effects of Experimental Condition and Ability level on Post-test Mathematics Anxiety of Students.

Experimental Condition Ability Group		Pretest Scores Mean	Pretest Scores S.d	N	Posttest Scores Mean	Posttest Scores S.d	Mean Difference
Testwiseness	**Low**	89.45	17.27	139	60.09	12.91	29.36
	Moderate	90.64	20.31	77	64.27	14.68	26.37
	High	93.94	20.80	17	65.35	13.77	28.59
	Total	90.17	18.54	233	61.86	13.70	28.31
Control	**Low**	93.88	12.52	112	93.29	10.90	0.59
	Moderate	90.59	13.89	71	90.54	14.58	0.05
	High	82.67	8.54	9	81.00	5.68	1.67
	Total	92.14	13.11	192	91.70	12.48	0.44
Total	**Low**	91.43	15.47	251	74.91	20.45	16.52
	Moderate	90.61	17.47	148	76.87	19.64	13.74
	High	90.04	18.17	26	70.77	13.76	19.27
	Total	91.06	16.32	425	75.34	19.84	15.72

The result of the study presented in Table 18 shows that the mean Mathematics anxiety of low ability students in the treatment group was 89.45 with a standard deviation of 17.27 as against 93.88 (Sd = 12.52) obtained by the low ability students in the control group before the treatment intervention. The results revealed that after the treatment intervention, the low ability students in the treatment group greatly reduced their mean score to 60.09 (Sd = 12.91) yielding a reduction of 29.36 as against a mean score of 93.29 obtained by the low ability students in the control group at post-test showing a slight reduction of 0.59 compared with their pre-test scores.

Table 18 also reveals that after the treatment intervention, the anxiety level of moderate ability students greatly reduced. For the moderate ability students in the control group, their mean anxiety scores slightly reduced from 90.59 at pre-test to 90.54 (Sd = 14.58) at post-test. The mean difference between pre and post-test mathematics anxiety scores for the moderate ability students in the control group was therefore 0.05 as against 26.37 recorded by the moderate ability students in the treatment group. As for the high ability students in the treatment group, their mean mathematics anxiety scores reduced from 93.94 (Sd = 20.80) obtained before the training to 65.35 after the intervention, resulting in a reduce score of 28.59. The high ability students in the control group also slightly reduced their mean mathematics anxiety score from 82.67 at pre-test to 81.00 at post-test thus resulting in a mean difference of 1.67.

Table 19 presents the summary of results of ANCOVA of the effects of experimental condition and ability level on post-test Mathematics anxiety of the students.

Table 19: ANCOVA tests of the Effects of Experimental Condition and Ability Level on Post-test Mathematics Anxiety of Students

Source	Sum of Squares	Df	Mean Square	F_{cal}	Partial Eta Squared
Model	2525774.62	7	360824.95	2820.40*	.98
Covariate(Pretest Mathematics Anxiety)	17275.50	1	17275.50	135.04*	.24
Experimental Conditions	28362.32	1	28362.32	221.70*	.35
Ability Groups	268.56	2	134.28	1.05	.01
Interaction(Experimental Conditions X Ability Groups)	1097.60	2	548.80	4.29*	.02
Error	53476.38	418	127.93		
Total	2579251.00	425			

R Squared = .98 (Adjusted R Squared = .97)

*Significant, $p < 0.05$, $F_{critical}$ (1/418) = 3.85

$p < 0.05$, $F_{critical}$ (2/418) = 3.00

$p < 0.05$, $F_{critical}$ (7/418) = 2.02

Table 19 indicates that calculated F-value of 1.05 resulted as the effect of ability level on post-test Mathematics anxiety of the participants. The interaction effect of ability and experimental condition was F_{cal} = 4.29. These F-values were statistically significant at the 0.05 level of significance ($F_{.05}$ 2/ 418 =3.00). Since the obtained F values were greater than the theoretical F value, hypothesis six was rejected. It was therefore concluded that there exists a significant difference in mathematics post-test anxiety of high, moderate and low ability students exposed to training in testwiseness and those not exposed to training in testwiseness.

To determine which groups significantly differed, fifteen pairwise comparisons were performed using Fisher's protected t-test. The results of which are presented in Table 20.

Table 20: Pairwise Comparison of Post-test Mathematics Anxiety between High, Moderate and Low Ability Students in the Treatment and Control Groups.

Group	S.d	CL	CM	CH	TL	TM	TH
CL	10.90	**93.29**	1.72^{ns}	3.14^{*}	20.75^{*}	18.14^{*}	9.41^{*}
CM	14.58	2.75	**90.54**	2.43^{*}	19.03^{*}	16.42^{*}	8.48^{*}
CH	5.68	12.29	9.54	**81.00**	5.33^{*}	4.27^{*}	38.17^{*}
TL	12.91	33.2	30.45	20.91	**60.09**	2.61^{*}	1.77^{ns}
TM	14.68	29.02	26.27	16.73	4.18	**64.27**	0.81^{ns}
TH	13.77	27.94	25.19	15.65	5.26	1.08	**65.35**

***** = Significant at 0.05 level

ns = not significant

Respective Mean scores are in the diagonal. Mean differences are below the diagonal and calculated t-values are above the diagonal. Results presented in Table 20 indicate that of the fifteen pairwise comparisons computed, twelve were statistically significant while three were not. The comparisons that were not statistically significant were those between:

i. Low and moderate ability students in the control group with respective mean difference and calculated t-values of 2.75 and 1.72.
ii. Low and high ability students in the treatment group with a mean difference of 5.26 and a theoretical t-value of 1.77.
iii. Moderate and high ability students in the treatment group with respective mean scores of 64.27 and 65.35 which yielded a calculated t-value of 0.81

From these results, it was evident that training in test-taking skills was most efficacious in reducing the mathematics anxiety of students with low ability (pre and post-test mean difference of 33.2) followed by those with moderate ability with mean difference of 26.27 while the effect of training on the high ability students yielded the lowest mean difference of 15.65.

4.7 Test of Hypothesis Seven: There will be no significance difference in post-test Mathematics achievement between male and female students of low, moderate and high ability exposed to training in testwiseness and those not exposed to training in testwiseness.

In testing of the seventh hypothesis, the two levels of experimental condition, gender (males and females) and three levels of ability group (high, moderate and low) were compared on their post-test Mathematics achievement with pre-test Mathematics achievement as covariate, using a 2 x 3 Analysis of Covariance, the results of which are presented in Tables 21 and 22.

Table 21: Descriptive Data of the Effects of Gender and Ability on Post-test Mathematics Achievement of Students.

			Pretest Scores			Posttest Scores		
Experimental Condition	**Gender**	**Ability Group**	**Mean**	**S.d**	**N**	**Mean**	**S.d**	**Mean Difference**
Testwiseness	**Male**	**Low**	37.27	9.25	66	61.95	12.06	24.68
		Moderate	57.94	6.10	48	77.21	7.46	19.27
		High	74.88	4.88	16	81.00	3.52	6.12
		Total	49.53	15.57	130	69.93	12.75	20.40
	Female	**Low**	36.78	7.45	73	62.90	12.47	26.12
		Moderate	55.55	4.21	29	73.97	9.08	18.42
		High	72.00	0.00	1	81.00	0.00	9
		Total	42.41	11.15	103	66.19	12.63	23.78
	Total	**Low**	37.01	8.33	139	62.45	12.25	25.44
		Moderate	57.04	5.56	77	75.99	8.20	18.95
		High	74.71	4.78	17	81.00	3.41	6.29
		Total	46.38	14.21	233	68.28	12.80	21.90
Control	**Male**	**Low**	38.64	6.60	52	41.58	9.94	2.94
		Moderate	56.75	5.80	32	59.38	9.29	2.63
		High	74.60	4.93	5	81.20	10.73	6.6
		Total	47.17	12.54	89	50.20	14.90	3.03
	Female	**Low**	38.65	6.40	60	39.15	10.20	0.5
		Moderate	56.08	5.70	39	59.08	9.67	3
		High	78.50	5.20	4	78.50	12.12	0
		Total	46.80	12.16	103	48.22	15.12	1.42
	Total	**Low**	38.64	6.46	112	40.28	10.11	1.64
		Moderate	56.38	5.71	71	59.21	9.44	2.83
		High	76.33	5.15	9	80.00	10.71	3.67
		Total	46.97	12.31	192	49.14	15.02	2.17
Total	**Male**	**Low**	37.87	8.18	118	52.97	15.07	15.1
		Moderate	57.46	5.97	80	70.08	12.01	12.62
		High	74.81	4.77	21	81.05	5.69	6.24
		Total	48.57	14.43	219	61.91	16.74	13.34
	Female	**Low**	37.62	7.03	133	52.19	16.50	14.57
		Moderate	55.85	5.09	68	65.43	11.94	9.58
		High	77.20	5.36	5	79.00	10.56	1.8
		Total	44.60	11.85	205	57.21	16.56	12.61
	Total	**Low**	37.74	7.58	251	52.56	15.82	14.82
		Moderate	56.72	5.62	148	67.94	12.16	11.22
		High	75.27	4.87	26	80.65	6.66	5.38
		Total	46.65	13.37	425	59.63	16.80	12.98

Table 21 indicates that on the whole, at post-test the high ability students, irrespective of their gender performed better in Mathematics than the moderate ability students who also performed better than the low ability students with respective mean scores of 80.65 (Sd = 6.66), 67.94 (12.16) and 52.56 (15.82). A decomposition of the ability groups by gender shows very negligible mean differences ranging from 4.44 between male and female students in the high ability group to 0.53 for those in the low ability group.

To determine if the differences between the groups were statistically significant, the results in Table 22 are presented

Table 22: 2 x 3 ANCOVA test of the Effects of Ability and Gender on Post-test Mathematics Achievement of Students

Source	Sum of Squares	df	Mean Squares	F_{cal}	Partial Eta Squares
Corrected Model	89386.01	12	7448.83	101.37*	.75
Intercept	1945.55	1	1945.55	26.48*	.06
Covariate(Pretest Mathematics Achievement	13813.76	1	13813.76	187.99*	.31
Experimental Condition	4428.78	1	4428.78	60.27*	.13
Gender	18.50	1	18.50	.25	.00
Ability Group	60.66	2	30.33	.41	.00
Experimental Condition X Gender	68.25	1	68.25	.93	.00
Experimental Condition X Ability Group	1960.13	2	980.06	13.34*	.06
Interaction (Gender X Ability Group)	4.24	2	2.12	.03	.00
Interaction(Experimental Condition X Gender X Ability)	186.55	2	93.27	1.27	.01
Error	30274.73	412	73.48		
Total	1630998.00	425			
Corrected Total	119660.74	424			

a. R Squared = .75 (Adjusted R Squared = .74).

*Significant, $p<0.05$, $F_{.05}$ (1/412) = 3.85

$p < 0.05$, $F_{critical}$ (2/412) = 3.00

$p < 0.05$, $F_{critical}$ (12/412) = 1.75

Table 22 reveals that calculated F-value of 0.25 and 0.41 resulted as the effect of gender and ability group respectively on post-test Mathematics achievement of the students. These were lower than the critical F-value of 3.85 given 1 and 412 degrees of freedom at the .05 level of significance. For the interaction effect of gender and ability on post-test Mathematics performance, the obtained F-value of 0.03 was lower than the theoretical F-value of 3.85. Furthermore, the interaction effect of experimental condition, gender and ability on post-test mathematics performance, the obtained F-value of 1.27 was also lower than the theoretical F-value of 3.85. Therefore, since the effects of gender and ability, and the interaction of gender and ability, and the three way interaction of experimental condition, gender and ability on post-test Mathematics performance were not statistically significant, hypothesis seven was not rejected. It was therefore concluded that male and female students of low, moderate and high ability exposed to training in testwiseness and those not exposed to training in testwiseness were not significantly differ in their post-test mathematics achievement scores.

4.8 Test of Hypothesis Eight: There will be no significance difference in post-test mathematics anxiety between male and female students of low, moderate and high ability exposed to training in testwiseness and those not exposed to training in testwiseness.

In testing of hypothesis eight, the two levels of experimental condition, gender (males and females) and three levels of ability group (high, moderate and low) were compared on their post-test mathematics anxiety with pre-test mathematics anxiety scores as covariate, using a 2 x 3 Analysis of Covariance, the results of which are presented in Tables 23 and 24.

Table 23: Descriptive Data of the Effects of Gender and Ability on Post-test Mathematics Anxiety of Students.

Experimental Condition	Gender	Ability Group	Pretest Scores Mean	Pretest Scores S.d	N	Posttest Scores Mean	Posttest Scores S.d	Mean Difference
Testwiseness	Male	Low	88.82	18.30	66	57.73	12.09	31.09
		Moderate	89.13	19.56	48	63.33	13.75	25.8
		High	94.06	21.47	16	65.38	14.23	28.68
		Total	89.58	19.10	130	60.74	13.26	28.84
	Female	Low	90.01	16.39	73	62.23	13.34	27.78
		Moderate	93.14	21.60	29	65.83	16.24	27.31
		High	92.00	00.00	1	65.00	00.00	27.00
		Total	90.91	17.88	103	63.27	14.16	27.64
	Total	Low	89.45	17.27	139	60.09	12.91	29.36
		Moderate	90.64	20.31	77	64.27	14.68	26.37
		High	93.94	20.80	17	65.35	13.77	28.59
		Total	90.17	18.54	233	61.86	13.70	28.31
Control	Male	Low	92.56	12.95	52	92.52	11.16	0.04
		Moderate	90.97	16.37	32	90.75	16.13	0.22
		High	84.00	8.77	5	81.80	5.17	2.2
		Total	91.51	14.11	89	91.28	13.08	0.23
	Female	Low	95.03	12.13	60	93.97	10.73	1.06
		Moderate	90.28	11.68	39	90.36	13.38	-0.08
		High	81.00	9.24	4	80.00	6.93	1.00
		Total	92.69	12.22	103	92.06	11.98	0.63
	Total	Low	93.88	12.52	112	93.29	10.90	0.59
		Moderate	90.59	13.89	71	90.54	14.58	0.05
		High	82.67	8.54	9	81.00	5.68	1.67
		Total	92.14	13.11	192	91.70	12.48	0.44
Total	Male	Low	90.47	16.21	118	73.06	20.89	17.41
		Moderate	89.86	18.27	80	74.30	19.93	15.56
		High	91.67	19.51	21	69.29	14.44	22.38
		Total	90.36	17.24	219	73.15	19.98	17.21
	Female	Low	92.28	14.79	133	76.55	19.99	15.73
		Moderate	91.50	16.57	68	79.90	19.00	11.60
		High	83.20	9.39	5	77.00	9.00	6.20
		Total	91.80	15.30	206	77.67	19.48	14.13
	Total	Low	91.43	15.47	251	74.91	20.45	16.52
		Moderate	90.61	17.47	148	76.87	19.64	13.74
		High	90.04	18.17	26	70.77	13.76	19.27
		Total	91.06	16.32	425	75.34	19.84	15.72

The results presented in Table 23 indicate that a categorization by experimental condition and gender indicates that the male participants in the testwiseness training group reported a post-test Mathematics anxiety mean score of 60.74 (Sd = 13.26) as against 91.28 (Sd = 13.08) reported by males in the control group. The mean difference between the males in the treatment group and their counterparts in the control group was therefore 28.61. As regards the female participants, those in the treatment group reported a post-test Mathematics anxiety mean score of 63.27 (Sd = 14.16) as against 92.06 (Sd = 11.98) obtained by those in the control group thus yielding a mean difference of 27.01 between the female participants in the two groups.

In addition, Table 23 indicates that on the whole, at post-test the high ability students, irrespective of their gender recorded the lowest mathematics anxiety followed by the low ability students who also recorded low mathematics anxiety than the moderate ability students with respective mean scores of 70.77 (S.d = 13.76), 74.91 (20.45) and 76.87 (19.64). A decomposition of the ability groups by gender shows a mean differences ranging from 16.18 between male and female students in the high ability group to 1.68 for those in the low ability group. To determine if the differences between the groups were statistically significant, Table 24 presents the ANCOVA summary statistics of the effects of experimental condition, gender and ability on post-test Mathematics anxiety of the students.

Table 24: 2 x 3 ANCOVA tests of the Effects of Ability and Gender on Post-test Mathematics Anxiety of Students

Source	Sum of Squares	df	Mean Squares	F_{cal}	Partial Eta Squares
Corrected Model	114087.94	12	9507.33	74.06*	.68
Intercept	19156.32	1	19156.32	149.23*	.27
Covariate(Pretest Mathematics Anxiety	16978.10	1	16978.10	132.28*	.24
Experimental Condition	14229.25	1	14229.25	110.84*	.21
Gender	15.53	1	15.53	.12	.00
Ability Group	204.48	2	102.24	.80	.00
Experimental Condition X Gender	18.96	1	18.96	.15	.00
Experimental Condition X Ability Group	888.97	2	444.48	3.46*	.02
Interaction (Gender X Ability Group)	85.16	2	42.58	.33	.00
Interaction(Experimental Condition X Gender X Ability)	37.38	2	18.69	.15	.00
Error	52889.28	412	128.37		
Total	2579251.00	425			
Corrected Total	166977.21	424			

a. R Squared = .68 (Adjusted R Squared = .67).

*Significant, $p < 0.05$, $F_{critical}$ (1/412) = 3.85

$p < 0.05$, $F_{critical}$ (2/412) = 3.00

$p < 0.05$, $F_{critical}$ (12/412) = 1.75

Table 24 reveals that calculated F-value of 0.12 and 0.80 resulting as the effect of gender and ability group respectively on post-test Mathematics anxiety of the students. These were lower than the critical F-value of 3.85 given 1 and 412 degrees of freedom at the .05 level of significance. For the interaction effect of gender and ability on post-test Mathematics anxiety, the obtained F-value of 0.33 was lower than the theoretical F-value of 3.85. Furthermore, the three way interaction effect of experimental condition, gender and ability on post-test mathematics anxiety, the obtained F-value of 0.15 was also lower than the theoretical F-value of 3.85. Therefore, since the effects of gender and ability, the two way interaction effect of gender and ability, and the three way interaction of experimental condition, gender and ability on post-test mathematics anxiety were not statistically significant, hypothesis eight was not rejected. It was therefore concluded that male and female students of low, moderate and high ability exposed to training in testwiseness and those not exposed to training in testwiseness were not significantly differ in their post-test mathematics anxiety scores.

4.9 Summary of Findings

Based on this study, the following are the summary of findings:

1. The mathematics performance of students who participated in the study was generally low, about 46.64%. Training in test taking strategies generally improved the Mathematics performance of the students to an average of 59.63%.

2. There was no significant gender difference in the students' performance in mathematics. Training in test-taking skills was equally effective for both male and female participants.

3. The mathematics anxiety of the participants was generally high. Training in testwiseness assisted the participants to manage their mathematics anxiety levels.

4. The male and female participants did not significantly differ in their mathematics anxiety and testwiseness training was equally effective in helping both male and female participants to manage their Mathematics Anxiety.

5. High, moderate and low ability students in the treatment and control groups significantly differed in their post-test mathematics achievement. Training in testwiseness was significantly most effective for low ability students, followed by those with moderate ability, while the effect of training in testwiseness on the high ability students was very negligible.

6. There exists a significant difference in mathematics post-test anxiety of high, moderate and low ability students exposed to training in testwiseness and those not exposed to training in testwiseness. Training in testwiseness was most efficacious in reducing the mathematics anxiety of students with low ability.

7. The male and female students of low, moderate and high ability exposed to training in testwiseness and those not exposed to training in testwiseness were not significantly differ in their post-test mathematics achievement scores.

8. The male and female students of low, moderate and high ability exposed to training in testwiseness and those not exposed to training in testwiseness were not significantly differ in their post-test mathematics anxiety scores.

CHAPTER FIVE

DISCUSSION OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

5.0 Introduction

This study investigated the effects of testwiseness training on test anxiety and achievement in mathematics among some selected senior secondary school students. This chapter discusses the results of the statistical analysis relating to the research questions postulated and the hypotheses tested. The discussion of findings tries to place the study findings in perspective vis-à-vis other related findings. It highlights the implications of the findings to test developers, evaluators and educational psychologists in Nigeria and provides some specific recommendations on the finding.

5.1 Discussion of Findings

Hypothesis one stated that there is no significant difference in post test mathematics achievement between students exposed to testwiseness training and those in the control group. The findings showed that there was a significant difference in post test Mathematics achievement between the treatment and control group.

The result revealed that testwiseness training enhanced greater academic achievement in students. This finding supports the research literature on the relationship between training in testwiseness and test performance. Many researchers (Gibbs, 1964; Rowley, 1974; Sapp, 1999; Yien, 2001) had shown that students who received training in testwiseness significantly improved in their performance higher than those not trained in testwiseness. One issue raised by this finding is that knowledge in test-taking strategies plays a mediating role between test takers' characteristics and test performance.

The results of this study have therefore shown that testwiseness can be effectively taught within the classroom setting in secondary schools and a number of methods may be successfully used. The methods include embedded instruction, terminal instruction and self-instruction. Many schools and private organizations organize "extra or coaching lessons" for students when major examinations such as Senior Secondary Certificate Examination (SSCE) and Unified Tertiary Matriculation Examination (UTME) are approaching. Even when schools do not make such arrangements, parents tend to believe in the efficacy of the "coaching lesson" in order for their wards to pass major examinations. The fundamental issue about this "extra or coaching lessons" is the extent to which testwiseness principles are taught and the duration of teaching. The lapses in the way testwiseness is taught leaves room for extraneous influences.

The study result confirmed that if students, through embedded instruction were appropriately exposed to the five test-taking strategies which are time using strategies, error avoidance, guessing strategies, deductive reasoning and cue-using strategies, then their test scores in multiple choice questions have a high probability of improving significantly than those of students not exposed to training in testwiseness.

Hypothesis two stated that there is no significant difference in post-test mathematics achievement of students in the two experimental groups due to their gender. The result of the statistical analysis of data showed that the post-test mathematics achievement of male and female students in the treatment and control groups did not significantly differ. This implies that gender as a single factor did not produce variance in Mathematics achievement scores of participants. This does not agree with the findings of earlier studies that the effect of sex on Mathematics performance among students was significant (Mazzero, 1994; Knol and Berger, 1991; Fakuade, 1993; Yen, 1993).

It was noted that after the training intervention, the performance of both male and female students greatly improved. In situating our findings on the effect of gender on mathematics achievement, it was observed that findings regarding gender effect on performance in mathematics are contradictory and inconclusive. While some studies reported significant gender differences in mathematics achievement with male students performing significantly better than their female counterparts for example (Knol and Berger, 1991), others found no such gender differences (Kalejaiye, 1995) and claim that gender effects on performance are illusionary and keep popping up because researchers keep looking for them until they find them . In one such study, Kalejaiye (1995) reports that the grades of male and female students in a given Mathematics course generally show no gender differences. Our finding that gender as a single factor did not produce variance in achievement scores of male and female students therefore corroborates this finding. However, studies by Mazzero (1994) and Fakuade (1993) suggest that the effect of gender on students' performance is significant. Why findings regarding gender effects on mathematics achievement are contradictory is difficult to explain. A plausible reason could lie in the nature of the Mathematics tests used by different researchers, some of which may lack adequate content sampling and with questionable psychometric properties. Also, the differences in findings may be the outcome of differences in research methodology, age or educational level of the respondents or some other personal-social attributes of respondents that may have a confounding effect.

Hypothesis three stated that there is no significant difference in post-test mathematics anxiety of students exposed to training in testwiseness and those in the control group. The findings of this study show that at post-test, the testwise trained group reported the greatest reduction in mathematics anxiety while the control group only reported a slight reduction in their mathematics anxiety.

It was evident that testwiseness training was efficacious in reducing the anxiety level of students in mathematics. The result supports the findings of Sapp (1999) who reported that testwiseness is an important correlate of test anxiety. Sapp (1999) opined that testwise students tend to perceive tests as less threatening than test-naïve students. Collaborating this finding, Garner (1990) and Yien (2001) found a statistically significant relationship between testwiseness training and mathematics anxiety. It therefore follows that since testwiseness training is effective in reducing anxiety level of students, it could be inferred that it can similarly help in increasing the students' academic performance in mathematics since a student who has less phobia for a particular subject is likely to do better in that subject.

Hypothesis four stated that male and female students in the treatment and control groups will not significantly differ in their post-test score of mathematics anxiety. The findings showed that male and female participants in the two experimental groups did not significantly differ in their post-test mathematics anxiety. It was evident from the results of the analysis of data that both male and female participants recorded a very high level of Mathematics anxiety at pre-test. At post-test, the findings showed that effects of gender and the interaction of experimental condition and gender on post-test were not statistically significant. It could be inferred from the findings that testwiseness training was equally effective in assisting both male and female participants in the treatment group to manage their mathematics anxiety better.

This implies that students, irrespective of their gender, exhibited the same level of anxiety when dealing with problems in mathematical situations. The finding in this study agrees with that of Richardson and Suinn (1972) who found no significant difference between the mean total Mathematics Anxiety Rating Scale (MARS) scores of men and women college students in a large sample of freshmen and undergraduate education major. The finding is also consistent with the earlier findings of Lussier (1996) that although male students in his study indicated a higher mean score than female students in their Mathematics anxiety, the differences were negligible and not statistically significant.

It should be noted that the narrowing of the gender gap in all spheres of human endeavor and the changing role of the female in society and the movement towards equal opportunity for all (Aksu and Sagayu, 1988) might explain these findings. Consequently, the traditional belief that Mathematics is a male dominated area of study may no longer be true. The current trend shows that male and female students are now competing on an equal basis for their future success.

Hypothesis five stated that there will be no significant difference in Mathematics post-test achievement of high, moderate and low ability students who received training in testwiseness and those who did not receive training.

The finding showed that there was a significant difference in Mathematics post-test achievement of high, moderate and low ability students exposed to training in testwiseness and those not exposed to training in testwiseness. Results from Table 15 revealed that the main effect of ability level was significant. The low ability group recorded the highest gain score, followed by the moderate ability group thus implying that these two groups benefitted most from the testwiseness training. Why the high ability students did not benefit maximally from the training in test-taking skills is not clear.

However, it is plausible that high ability students may be low risk takers and therefore may not utilize guessing strategy unlike the low ability students who may be high risk takers. It is also possible that the high ability students have already developed effective study skills and test-taking techniques that are responsible for their high performance. This finding is however in a different direction from the literature. Scruggs and Lifson (1985) claimed that test-wiseness is not a construct that students happen to acquire by chance or serendipity, which is unrelated to intelligence, and which results in substantial fluctuations of scores in achievement tests. Kreit (1998) hypothesized that high ability students would benefit more than average and low ability students. In line with the hypothesis, Kreit (1998) found gain mean scores in the predicted direction while results of this study were in the reverse order.

However, the findings of Crehan, Gross, Koehler, and Slakter (1978) suggest that test-wiseness is not highly related to cognitive ability. The researchers found that low ability students recorded greater mean gain than the high ability students. In the real sense, if the gain means scores had been as predicted, it may then be argued that testwiseness training may not be necessary since it would neither change the trend of students' performances nor improve the lot of low ability students. It is evident from this study that testwiseness training significantly improved the mathematics achievement of low ability students.

Hypothesis six stated that there will be no significant difference in mathematics post-test anxiety of high, moderate and low ability students who received training in testwiseness and those who did not receive training testwiseness. The findings of this study show that at post-test, the testwise trained group reported the greatest reduction in mathematics anxiety while the control group only reported a slight reduction in their mathematics anxiety.

It was also evident that testwiseness training was more efficacious in reducing the mathematics anxiety of low ability students, followed by those with moderate ability. The result supports the findings of Sapp (1999) who reported that testwiseness is an important correlate of test anxiety. Sapp (1999) opined that testwise students tend to perceive tests as less threatening than test-naïve students. This result may be justified by the fact that the low ability students were test naïve and always have phobia for mathematics test before the training intervention unlike the high ability students who were confident test-takers with high reliance on cognitive ability, that come what may, they will perform better tests. This fact may result in the high ability students in not making judicious use of testwiseness principles. Collaborating this finding, Garner (1990) and Yien (2001) found a statistically significant relationship between testwiseness training and mathematics anxiety. It therefore follows that, since testwiseness training is effective in reducing mathematics anxiety of low ability students, testwiseness training may be adopted by teachers, counsellors and psychologists in assisting low performing students in schools.

Hypothesis Seven stated that there will be no significance difference in post-test mathematics achievement between male and female students of low, moderate and high ability exposed to training in testwiseness and those not exposed to training in testwiseness.

The findings showed that at post-test, the high ability students, irrespective of their gender performed better in Mathematics than both moderate ability and low ability students' participants. The data analysis result from Table 22 indicates that the effects of gender and ability, the interaction of gender and ability, and the three way interactions of experimental condition, gender and ability on post-test Mathematics performance were not statistically significant. This implies that male and female students exposed to testwiseness training and those not exposed to testwiseness training in different ability groups did not significantly differ in their mathematics achievement. The hypothesis was therefore not rejected. This result disagrees with Tobia (1976) opinion which claimed that mathematics results from a culture that makes Mathematics ability a masculine attribute.

The result corroborates the findings of Mac Cann-Roberto (1995) and Fennama (1979) which were that there are no gender related differences in mathematics achievement. Some of the reasons for the no gender difference in mathematics achievement could be due to common aspirations in careers by both male and female secondary school students in Nigeria today. In addition, the influence of peer groups in solving mathematics problems together motivates students and eliminates gender bias.

Hypothesis Eight stated that there will be no significance difference in post-test mathematics anxiety between male and female students of low, moderate and high ability exposed to training in testwiseness and those not exposed to training in testwiseness.

The findings showed that at post test, the high ability students, irrespective of their gender recorded the lowest mathematics anxiety and closely followed by the low ability students. The effects of gender and ability, the interaction effect of gender and ability, and the three way interaction of experimental condition, gender and ability on post-test mathematics anxiety were not statistically significant. This implies that gender and ability as factors did not produce variance in mathematics anxiety scores of participants in the experimental conditions. This does not agree with the earlier findings that prior achievement influences a person's perceived self-efficacy and that its effect is less than that of factors such as cognitive styles, preferences and arousal. Prior achievement is the strongest predictor of self-efficacy belief (Bandura, 1997; Lopez & Lent, 1992). From the findings, it could be inferred that testwiseness training was equally effective in assisting both male and female participants of low, moderate and high ability in the treatment group to manage their mathematics anxiety better. The implication of this for the school administrators, teachers and parents is that training in teswiseness should be given priority in schools and various coaching centre. This will enable students to enter testing situations without a feeling of tension and worry that interferes with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations. If self-esteem is basically strong and there is a certain level of task related confidence, the individual may be able to control the anxiety and channel it into the task and hence, perform better.

5.2 Summary of Findings

The study was conducted primarily to determine the effect of testwiseness training on test anxiety and achievement in Mathematics of Secondary School Students, with gender and ability level as moderating variables. The study also investigated the interaction effects of gender, academic ability and experimental conditions on the dependent measures. Eight null hypotheses were tested. Based on the results of testing the null hypotheses, the following were the highlights of the findings:

1. There is a significant difference in the post-test Mathematics achievement between students exposed to testwiseness training and those in the control group. Therefore, the first hypothesis that there will be no significant difference in the post-test Mathematics achievement between students exposed to testwiseness training and those in the control group was rejected.

2. There is no significant difference in post-test Mathematics achievement of students in the two experimental groups in the two gender groups. The hypothesis was not rejected. There was no significant difference in post-test Mathematics achievement of students in the two experimental groups due to their gender.
3. There is a significant difference in the post-test Mathematics anxiety of students exposed to training in testwiseness and those in the control group. Therefore, the third hypothesis that there will be no significant difference in the post-test Mathematics anxiety of students exposed to training in testwiseness and those in the control group was rejected.
4. Male and female participants in the treatment and control groups did not significantly differ in their post-test Mathematics Anxiety. Hypothesis four, which stated that Male and female participants in the treatment and control groups will not significantly differ in their post-test Mathematics Anxiety was not rejected. And there was no interaction effect of gender and treatment on the students' post test Mathematics anxiety.
5. There is a significant difference in Mathematics post-test achievement of high, moderate and low ability students who received training in testwiseness and those who did not. Therefore, the fifth hypothesis that there will be no significant difference in Mathematics post-test achievement of high, moderate and low ability students who receive training in testwiseness and those who do not was rejected. There was an interaction effect of ability level and treatment on students' Mathematics achievement.

6. There exists a significant difference in mathematics post-test anxiety of high, moderate and low ability students exposed to training in testwiseness and those not exposed to training in testwiseness. Training in testwiseness was most efficacious in reducing the mathematics anxiety of students with low ability.

7. The male and female students of low, moderate and high ability exposed to training in testwiseness and those not exposed to training in testwiseness were not significantly differ in their post-test mathematics achievement scores.

8. The male and female students of low, moderate and high ability exposed to training in testwiseness and those not exposed to training in testwiseness were not significantly differ in their post-test mathematics anxiety scores.

5.3 Contributions to Knowledge

The study contributed to knowledge in the following ways:

1. The study has exposed the fact that testwiseness can be taught in the classroom environment to enhance students' performance in Mathematics and that such is feasible in Ekiti State of Nigeria, just as it is in other parts of the world.

2. The study has also demonstrated that training in testwiseness can assist the students in managing their Mathematics anxiety also in Ekiti State of Nigeria.

3. The study revealed that testwiseness, as a test-taking strategy, can be incorporated into the school curriculum with the intent of improving the academic success of students.

4. Critical to the study is a novel revelation that testwiseness training can be used as a viable strategy to improve the academic performance of low ability students in Mathematics.

5. The study has illuminated the cloudy relationship among gender, cognitive ability and performance in Mathematics by revealing no gender differences in Mathematics across the various ability levels in the study area being Ekiti State of Nigeria.

5.4 Recommendations

Based on the findings of this study, the following specific recommendations are put forward for consideration:

1. Teachers should lead students to solve Mathematical problems using different strategies and ensure that the topics are well comprehended by the students.

2. Training in testwiseness as confirmed by this study is a practicable means to positively improve students' test scores. This therefore implies that testwiseness training may serve as a viable means of improving students' poor performance in Mathematics. Based on this, frantic effort should be made to formally teach students different strategies needed for test-taking.

3. Teachers should use embedded instructional methods in the training of students on testwiseness in order to enhance students' mastery and retention of knowledge and skills gained during the lessons.

4. It is recommended that teachers in training and practicing teachers should be taught the principles of test construction in general and testwiseness in particular. It may be necessary to organize orientation programmes, seminars and workshops on principles of test construction in general and testwiseness in particular at local, state and national levels.

5. Training in testwiseness as confirmed by this study is more efficacious in improving the test scores of low ability students. As such, conserted efforts should be made by teachers to identify the low abilty students in the classrooms and constantly teach them requisite principles needed for test-taking.

6. Training in testwiseness as confirmed by this study is an efficacious means of reducing students' test anxiety. Based on this, frantic effort should be made to formally teach students different strategies needed for test-taking in order to overcome the debilitating effects of test anxiety on classroom performance.

5.5 Suggestions for Further Research

Study of testwiseness is relatively new and unexplored in Nigeria schools and so the findings of this study have opened up several areas of future research. Directions for future research include:

1. The replication of this study in other state of the federation.
2. This study only focused on teaching of testwiseness in Mathematics. It would be worthwhile to explore the effects of replicating the study for other science subjects in particular and all other school subjects in general in Nigeria.
3. The study could be carried out using other methods of training in testwiseness.
4. This study only focused on multiple-choice questions as it is used for West Africa Senior Certificate Examination (WASCE) and Unified Tertiary Matriculation Examination (UTME). It could be worthwhile to explore the differential and comparative effects of testwiseness training on the different types of tests (essay and objective).
5. The study could be replicated in the Junior Secondary School (JSS) since the performance of students in Senior Secondary Certificate Examination (SSCE) builds on Junior Secondary School.

5.6 Conclusions

In view of the findings of this study, the following conclusions were made.

1. Testwiseness training takes into consideration both the low, moderate and high ability students in enhancing meaningful learning of Mathematics. It allows the teacher to pay attention to individual student's area of weaknesses in answering

test questions as well as proffering relevant strategies in tackling examination questions.

2. Testwiseness training has been found to improve the problem solving skills of students. That is, in order to improve students' performance in Mathematics, testwiseness principles were taught at the secondary school level. The training is likely to reduce the test-taking impediment of test-naïve students and those low in testwiseness and place students at relatively equal levels of testwiseness knowledge.

3. Enthusiasm is contiguous and teachers of Mathematics should bring this attitude to their teaching by thorough preparation of each lesson and applying holistic approach to it. Teachers have a sensitive role to play in building up confident test-takers by encouraging active participation of students in the teaching and learning process so as to discover things by themselves. This is important because when the students are directly involved and they discover the principle underlying the task, the tendency to remember quickly is high and hence, improve academic achievement.

4. Finally, from available interactive review, there has been paucity of reports or studies on effects of testwiseness training on test-anxiety and achievement in Mathematics in Nigeria Secondary Schools. Hence, this study tended to fill this gap.

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APPENDIX 1

UNIVERSITY OF LAGOS

SCHOOL OF POST GRADUATE STUDIES

DEPARTMENT OF EDUCATIONAL FOUNDATIONS

Mathematics Achievement Test (**MAT**)

Section A

Sex______ School Code ______Student Class Attendance Register Number ______ Age____

Section B

INSTRUCTION: Answer all questions, each question is followed by five options letter A-E. Find out the correct option for each question and write only the answer to each question.

Time Allowed: 1hr 30min.

1. Correct 0.04954 to two significant figures.

   B. 0.040 B. 0.049 C. 0.0495 D. 0.0491 E. 0.050

2. Simplify: 5/√3 - 3/√2

   C. 1/6(5√3 -3√2) C. 1/6(15√3 - 6√2)

   D. 1/6(3√2 - √3) D. 1/6(10√3 - 9√2) E. 1/6(5√3 -2√3)

3. A man bought 220 mathematicses at ₦5x. He sold each for 3xkobo and made a gain of ₦8. Find the value of x.

   B. 2 B. 5 C. 6 D. 10 E. 4

4. From a point P, R is 5km due west and 12km due south. Find the distance between P and R.

   A. 5km B. 12km C. 13km D. 17km E. 7km

5. A fair die is tossed once, what is the probability of obtaining neither 5 nor 2?

   A. 5/6 B. 2/3 C. ½ D. 1/6 E. 1/4

6. Convert 101101_{two} to a number in base ten.

   A. 61 B. 46 C. 45 D. 44 E. 62

7. Solve the equation $2^7 = 8^{5-x}$

A. 5/8 B. 8/3 C. 3/2 D. 15/4 E. 4/15

8. Expand (2x – 3y)(x – 5y)

A. $2x^2 + 13xy - 15y^2$ B. $2x^2 - 13xy - 15y^2$ C. $2x^2 + 13xy + 15y^2$ D. $2x^2 - 15xy + 13$ E. $2x^2 - 13xy + 15y^2$

9. The probabilities that John and James pass an examination are ¾ and 3/5 respectively. Find the probability of both boys failing the examination.

B. 1/10 B. 3/10 C. 9/20 D. 11/20 E. 7/10

10. Find the mean of the numbers 1, 3, 4, 8, 8, 4 and 7.

A. 4 B. 5. C. 6 D. 7 E. 3

11. The length of the adjacent side of a right-angled triangle is x cm. If the length of the hypotenuse is √13cm, find the value of x.

A. 2 B. 3 C. 4 D. 5 E. 6

12. An arc of a circle of radius 14cm subtends angle 300 at the centre. Find the perimeter of the sector formed by the arc. (Take ƛ = 22/7)

A. 14.67cm B. 42.67cm C. 101.33cm D. 513.33cm E. 42.76

13. For what value of y is the expression $(6x - 1)/(y^2 - y - 6)$

A. 1/6, ¼ B. 3, -2 C. -3, 2 D. 0, 1 E. -2, -3

14. A train moving at a uniform speed covers 36km in 21 minutes. How long does it take to cover 60km?

A. 35minutes B. 40minutes C. 45minutes D. 90minutes. E. 85minutes

15. P = {3, 9, 11, 13} and Q = {3, 7, 9, 15} are subsets of the universal set Ʊ = {1, 3, 7, 9, 11, 13, 15}. Find $P^1 \cap Q^1$.

A. {3, 9} B. {5, 7, 15} C. {15} D. {1, 11} E. {1}

16. Express 1213_4 in base 10.

A. 105_{10} B. 106_{10} C. 206_{10} D. 203_{10} E. 103_{10}

17. If the height of a cylinder is 18cm and the curved surface area is $486cm^2$, find the radius of the cylinder using the value 3 for ƛ.

A. 3.7cm B. 3.8cm C. 4.9cm D. 1.7cm E. 3.6cm

18. If $(x+3)^2 = 4$. Find the value of x.

A. 5, 1 B. 5, 3 C. 7, 2 D. 6, 1 E. 6, 3

19. Calculate the volume of a cone of height 20cm and base radius 9cm. (Take ƛ =3).

A. $520cm^3$ B. $1520cm^3$ C. $7600cm^3$ D. $1620cm^3$ E. $7620cm^3$

20. If $123_n = 215_6$, find the values of n.

A. 3,8 B. 8, 6 C. 8,-10 D. -8,-10 E. 6, 8

21. If the probability of an event occurring is y. what is the probability of the event not occurring.

A. 0 B. 1+ y C. y-1 D. 1/y E. 1-y

22.The volume of a cylinder is $120cm^3$ and area of its base is $150cm^2$. Find the height of the cylinder.

A. 80cm B. 8cm C. 0.8cm D. 0.08cm E. 0.88cm

23. A bag contains 2 red, 3 blue and 4 green identical balls. If two balls are picked at random one after the other without replacement. What is the probability that both are green?

A. 1/6 B. ¼ C. 1/3 D. 3/8 E. 2

24. A fair coin is tossed three times. Find the probability of getting two heads and one tail.

A. ½ B. ¼ C. 3/8 D. 3/5 E. 1/3

25. A sector of a circle of radius 14cm containing an angle 60^0 is folded to form a cone. Calculate the radius of the base of the cone.

A. 5.5cm B. 4.67cm C. 3.5cm D. 2.38cm E. 2.33cm

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

A. 6 B. 8 C. 4 D. 9

27. In the equation (2x -9) (x +8) = 0.What are the values of x.

A. 9/2, -8 B. 8, -9/2 C. 4, 4 D. 7/2, 9

28. Convert 1200.21_3 to base ten.

A. 44 7/9 B. 45 C. 45 7/8 D. 45 7/9. E. 7/8

29. Express 0.000025 in standard form.

A. 25×10^5 B. 2.5×10^{-5} C. 205×10^{-2} D. 2500×10^5 E. 250×10^5

30. Use tables to calculate the value of 391 x 7925.

A. 3098000 B. 309800 C. 398000 D. 309800000 E. 3980000

31. Taking ƛ to be 3.14, calculate ƛ $(7.6)^2$ to an appropriate degree of accuracy.

A. 190 B. 170 C. 180 D. 188 E. 160

32. The ratio of boys to girls in a class is 5:3. Find the probability of selecting at random a girl from the class.

A. 1/8 B. 1/3 C. 3/8 D. 3/5 E. 5/8

The table below shows the scores of a group of 40 students in physics test.

Score	1	2	3	4	5	6	7	8	9
Frequency	2	3	6	7	9	6	2	2	3

Use the information to answer question **33** and **34**

33. If the mode is m and the median is n, then (m, n) is

A. (5, 5) B. (5, 6) C. (6, 5) D. (9, 4) E. (6, 6)

34. What is the mean of the distribution?

A. 4.2 B. 4.5 C. 4.8 D. 5.0 E. 5.2

35. Find the median of the set of numbers 12, 15, 13, 14, 12, 12

A. 12 B. 12.5 C. 13 D. 13.5 E. 11.5

36. If $43_x = 1110_3$ find the value of x.

A. 7 B. 8 C. 6 D. 5 E. 9

37. Solve the equation $x^2 - 7x + 10 = 0$

A. (5, 2) B. (7, 3) C. (5, 3) D. (6, 2) E. (6, 3)

38. What must be added to $d^2 - 5d$ to make the expression a perfect square? Factorize the result.

A. 5/2 B. 25/2 C. 5/4 D. 25/4 E. 25/3

39. Calculate the total surface area of a cone of height 12cm and base radius 5cm (take ƛ = 22/7)

A. $180cm^2$ B. $282(6/7)cm^2$ C. $235(5/7)cm^2$ D. $381cm^2$ E. $282(5/7)cm^2$

40. If the product of two real numbers is 0. What is the value of one of the numbers (or both of them).

A. 1 B. 2 C. 3 D. 0 E. 4

41. Simplify 0.000215 x 0.000028 and express your answer in standard form.

A. 6.03×10^9 B. 6.02×10^9 C. 6.03×10^{-9} D. 6.02×10^{-9}

E. 6.01×10^{-9}

42. Factorise: x + y – ax – ay

A. (x – y) (1 – a) B. (x + y) (1+ a) C. (x + y) (1 – a)

D. (x – y) (1 + a) E. (1 – x) (x + y)

43. A car uses one litre of petrol for every 14km. If one litre of petrol costs #63.00, how far can the car go with #900.00 worth of petrol?

A. 420km B. 405km C. 210km D. 200km E. 300km

44. Correct 0.002473 to 3 significant figures

A. 0.002 B. 0.0024 C. 0.00247 D. 0.0025 E. 0.002473

45. Simplify 1 ½ + 2 1/3 x ¾ - ½

A. –2 ½ B. -2 ¼ C. 2 1/8 D. 2 ¾ E. 3/4

46. The sum of 2 consecutive whole numbers is 5/6 of their product. Find the numbers.

A. 3, 4 B. 1, 2 C. 2, 3 D. 0, 1 E. 2, 4

47. Given that P = {x: $1 \leq x \leq 6$}, and Q = {x: $2 < x < 10$} where x is an integer. Find n (P∩Q)

A. 4 B. 6 C. 8 D. 10 E. 7

48. The sum of 6 and one-third of x is one more than twice x. Find x.

A. X = 7 B. X = 5 C. X = 3 D X = 2, E. X =6

49. Given that T = { x : $-2 < x \leq 9$}, where x is an integer. What is n(T)?

A. 9 B. 10 C. 11 D. 12 E. 7

50. Solve the inequality: $3(x + 1) \leq 5(x + 2) + 15$.

A. $X \geq -14$ B. $X \leq -14$ C. $X \leq -11$ D. $X \geq 11$ E. $X \geq -11$

APPENDIX 2

UNIVERSITY OF LAGOS

SCHOOL OF POST GRADUATE STUDIES

DEPARTMENT OF EDUCATIONAL FOUNDATIONS

(WITH EDUCATIONAL PSYCHOLOGY)

Mathematics Anxiety Rating Scale – Revised (MARS-R)

SECTION A

Sex_______________ Male/Female (delete one) Class_________________

Student Class Attendance Register No_________ School Code __________

Time Allowed: 10 Minutes

SECTION B

Instructions: You are expected to answer the questionnaire as correctly and honestly as you possibly can. The following statements which indicate how students feel when they are learning Mathematics and how they feel over being tested about Mathematics. It is not a test, so there are no rights or wrong answers. Please rate each item in terms of how anxious you feel during the event specified by simply tick ( ) one of the choices, the most appropriate to you from the right of each statement.

The numbers: **1 = Low anxiety**
2 = some anxiety
3 = Moderate anxiety
4 = Quite a bit of anxiety
5 = High anxiety

S/N	ITEMS	1	2	3	4	5
	Subscale: Learning Mathematics Anxiety (LMA)					
1	Watching a teacher work an algebraic equation on the black board.					
2	Buying a Mathematics text book.					
3	Reading and interpreting graphs or charts					
4	Signing up for a course in Statistics.					
5	Listening to another student explain a Mathematics formulae.					
6	Walking into a Mathematics class					
7	Looking through the pages in a Mathematics text					
8	Starting a new chapter in a Mathematics book					
9	Walking in school and thinking about a Mathematics topic.					
10	Picking up a Mathematics textbook to begin working on a homework / assignment.					
11	Reading the word statistic / probability					
12	Working on abstract / difficult mathematical problems.					
13	Reading a formula in Chemistry					
14	Listening to a teaching in Mathematics class					
15	Having to use table in the back of a Mathematics book					
16	Being told how to interpret probability statements.					

	Subscale: Mathematics Evaluation Anxiety (MEA)					
17	Being given home work / assignment of many difficult problems which is due the next class meeting.					
18	Thinking about an incoming Mathematics test one day before.					
19	Solving square root problem.					
20	Taking an examination (quiz) in a Mathematics class					
21	Getting ready to study for a Mathematics test.					
22	Being given a "pop" quiz in a Mathematics class.					
23	Waiting to get a Mathematics test returned in which you are expected to do well.					
24	Taking final examination in Mathematics.					

Developed by Plake, B. S and Parker, C. S (1982)

APPENDIX 3

UNIVERSITY OF LAGOS

SCHOOL OF POST GRADUATE STUDIES

DEPARTMENT OF EDUCATIONAL FOUNDATIONS

(WITH EDUCATIONAL PSYCHOLOGY)

Socio-Demographic Questionnaire (SDQ)

Section A

Sex_______________ Male/Female (delete one) Class_________________

Student Class Attendance Register No_________ School Code _________

Time Allowed: 5 Minutes

Section B

Instruction: You are expected to complete the questionnaire as correctly and honestly as you possibly can.

I attend Coaching Class _______Yes / No

If Yes, Nature of Coaching:

1. Individual (_)
2. Group (_)
3. Home Tutoring (_)

Numbers of Times per week _________________

Number of Hours/Minutes per coaching_______

Subjects for which Coaching Occurred ___________________________________

Reason for being Coached____

APPENDIX 4

KEYS TO MATHEMATICS ACHIEVEMENT TEST (MAT)

QUESTION	KEY
1	E
2	D
3	C
4	C
5	B
6	C
7	B
8	E
9	A
10	B
11	B
12	C
13	B
14	A
15	E
16	E
17	A
18	A
19	D
20	C
21	E
22	C
23	D
24	C
25	E
26	D
27	A
28	D

29	B
30	A
31	C
32	C
33	A
34	C
35	B
36	E
37	A
38	D
39	B
40	D
41	D
42	C
43	D
44	C
45	D
46	C
47	A
48	C
49	C
50	E

Total Occurrence of answers: A (9), B (8), C (16), D (9) E (8)

APPENDIX 5

DEPARTMENT OF EDUCATIONAL FOUNDATIONS
(WITH EDUCATIONAL PSYCHOLOGY)
FACULTY OF EDUCATION
UNIVERSITY OF LAGOS, NIGERIA

Head of Department
Prof. (Mrs.) Ayoka Mopelola Olusakin,
B.Ed, M.Ed; Ph.D (Ibadan) FCASSON

UNIVERSITY OF LAGOS
IN DEED AND IN TRUTH

Tel: 2341-1- 4932660-1
Ext. 1969, 2260

16th December, 2010.

TO WHOM IT MAY CONCERN

LETTER OF INTRODUCTION

This is to confirm that **FAKOREDE, JOHNSON OLAGOKE** with Matriculation **No.039034022** is a Ph. D student of Measurement and Evaluation. He is conducting a research on his project "**Effects Of Item Dimensionality And Testwiseness Training On Anxiety And Students' Achievement In Mathematics Among Senior Secondary School Students In Ekiti State".**

It shall be greatly appreciated if you could give him the necessary assistance based on the information above.

Thank you.

HEAD
DEPT. OF EDUCATIONAL FOUNDATION
UNIVERSITY OF LAGOS

Prof. (Mrs.) A.M. Olusakin

APPENDIX 6

C.A.C COMPREHENSIVE SENIOR HIGH SCHOOL,

ADO-EKITI, EKITI STATE, NIGERIA.

C.A.C COMPREHENSIVE SENIOR HIGH SCHOOL
CACCHS
ADO-EKITI
FOUNDED 1980
GOD FIRST

FROM THE PRINCIPAL

P.M.B 5332
ADO-EKITI.

Our Ref: CACCHS..............................

Your Ref:..............................

Date: 03-03-11

The Head of Department,

Faculty of Educational Foundations,

University of Lagos, Nigeria.

Ma,

RE – MR. FAKOREDE, JOHNSON OLAGOKE

With reference to your letter of introduction of **Mr. FAKOREDE, JOHNSON OLAGOKE** with matriculation No. 039034022, dated 16th December 2010, this letter is written to confirm that he was here for the conduct of his research titled **"Effects of Item Dimensionality and testwiseness training on Anxiety And Students' Achievement in Mathematics Among Senior Secondary School Students in Ekiti State"** for eight weeks.

He had satisfactorily carried out the research and he compulted himself during the period of his stay here.

Thank you.

Yours faithfully,

VICE PRINCIPAL
C.A.C. COMP. HIGH SC
ADO-EKITI

03-03-11

Mrs. G.M Ibikunle
Principal

APPENDIX 7

UNITED HIGH SCHOOL

ILAWE - EKITI, EKITI STATE.

Motto: Unity, Industry & Progress

Year Founded Sept. 26, 1975

Private Mail Bag 1.
Ilawe - Ekiti,
Ekiti State, Nigeria.

Principal..

Our Ref:..

Your Ref:..

Date: 3rd March, 2011

The Head of Department,
Department of Education Foundations,
Faculty of Education,
University of Lagos,
Lagos.

Dear Sir,

ACKNOWLEDGEMENT LETTER

This is to confirm that FAKOREDE JOHNSON OLAGOKE a Ph. D. Student with Matriculation No. 039034022 visited the above named school to carry out his research work titled "Effects Of Item Dimensionality And Testwiseness Training On Anxiety And Students' Achievement In Mathematics Among Senior Secondary School Students In Ekiti State".

Thank you.

Yours faithfully,

Mrs. F. W. Anifowose,
PRINCIPAL.

03/03/2011

APPENDIX 8

MARY IMMACULATE GRAMMAR SCHOOL
ADO - EKITI

From the Principal

P.M.B. 5361,
Ado - Ekiti,
Ekiti State,
Nigeria.
Tel: Ado 030-250124

Our Ref..................... *Your Ref.*.................... *Date.* 2/3/2011

The Dean,
School of Post Graduate Studies,
University of Lagos,
Lagos.

Dear Sir,

ACKNOWLEGDEMENT LETTER

This is to confirm that FAKOREDE JOHNSON OLAGOKE a Ph. D. Student with Matriculation No. 039034022 visited the above named school to carry out his research work for the period of 8 weeks.

Yours faithfully,

Principal
MARY IMMACULATE
GRAMMAR SCHOOL
ADO - EKITI 2-3-2011

MRS C.M. FAGBEYIRO
(Principal.

APPENDIX 9

CHRIST'S SCHOOL

ADO-EKITI
Founded 1933 A.D.

CHRISTUS . VICTOR

OFFICE OF THE PRINCIPAL
08032731716, 08085549272
E-mail: christschool33@yahoo.com.
E-mail: woleakinyede@yahoo.com.

Our Ref:...

Your Ref:...

03 / 03 / 20 11

The Head of Department,
Department of Education Foundations,
Faculty of Education,
University of Lagos,
Lagos State.

Sir/Ma,

ACKNOWLEDGEMENT LETTER

This is to confirm that Mr. Fakorede Johnson, Ph.D. Student of your Institution with Matric No. 039034022 came to Christ's School, Ado – Ekiti to conduct research on the Thesis title "Effects Of Item Dimensionality And Testwiseness Training On Anxiety And Students' Achievement In Mathematics Among Senior Secondary School Students in Ekiti State.

Yours faithfully,

CHRIST'S SCHOOL ADO – EKITI

03/03/2011

VICE PRINCIPAL

Mrs. B. K. Ajayi,
V.P. ACADEMICS.