EFFECT OF SIMPLIFIED NON-TECHNICAL LANGUAGE OF PHYSICS MULTIPLE-CHOICE TEST ITEMS USED BY WEST AFRICAN EXAMINATIONS COUNCIL ON STUDENTS ACHIEVEMENT

BY

CHIKA, BENEDICTA IFEYINWA

DEPARTMENT OF GUIDANCE AND COUNSELLING
DELTA STATE UNIVERSITY, ABRAKA

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CHIKA, BENEDICTA IFEYINWA
PG/07/08/139571
B.Sc. (Ed.) (ESUT) 2005

Dissertation Submitted to the Postgraduate School in Partial Fulfillment of the Requirements for the Award of Master of Education (M.Ed.) Degree in Measurement and Evaluation of the Delta State University, Abraka.

DEPARTMENT OF GUIDANCE AND COUNSELLING
DELTA STATE UNIVERSITY, ABRAKA

MARCH, 2014

DECLARATION

I hereby declare that the study is my original work in the Department of Guidance and Counselling, Delta State University, Abraka.

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CHIKA, Benedicta Ifeyinwa
Student

_____

Date

_____

Dr. J.N. Odili
Supervisor

_____

Date

CERTIFICATION

We the undersigned certify that this work was carried out by CHIKA, Benedicta Ifeyinwa, in partial fulfillment of the requirements for the award of Master of Education (M.Ed.) Degree in Measurement and Evaluation of the Delta State University, Abraka.

_____ _____

Dr. J.N. Odili **Date**
Supervisor

_____ _____

Dr. (Mrs.) G.O. Akpochafo **Date**
Ag. Head of Department

_____ _____

Prof. P.O. Ikoya **Date**
Dean, Faculty of Education

_____ _____

Prof. (Mrs.) Dicta Ogisi **Date**
Dean, Postgraduate School

DEDICATION

This work is dedicated to the families of Mr. and Mrs. Jude I. Chika and Mr. Donatus C. Fejokwu, for making this work a reality.

ACKNOWLEDGEMENTS

With a heart full of joy, I wish to sincerely appreciate my supervisor, Dr. J.N. Odili, for his directive and audience during the course of this study. A special thanks also go to Dr. J.O. Oji of the College of Education, Agbor, for his encouragement and support. I also wish to appreciate my siblings, Chike, Emeke and Chijioke Chika for their love and encouragement.

My sincere thanks go Dr. (Mrs.) F.N. Ugoji. You have shown great interest to seeing the success of this work. I will not end without appreciating Prof. R.I. Okorodudu, Dr. P.U. Osadebe, Late Dr. J.F. Egbule for their audience and encouragement during the course of this study. To all lecturers of the Department of Guidance and Counselling, I wish to say thank you and God bless you.

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ABSTRACT

This study investigates the effects of simplified non-technical language of Physics multiple choice test items used by the West African Examinations Council (WAEC) on students' achievement. To guide this investigation, seven research questions and seven hypotheses were formulated. The research questions and hypotheses bordered the simplification of non-technical words in Physics and how simplifying language influences the performance of students with different background such as location, gender and socio-economic status. The population comprised senior secondary III students who study Physics. The instruments for data collection were WAEC questions from 2007, 2008 and 2009 examination years which have the qualities identified by Cassel and Johnston as being complex. Physics test form A was made up of 30 multiple choice test items that were phrased in original language while test form B was made up of same 30 multiple choice test items in a simplified language form. Stratified random sampling technique was employed. A post test only control group experimental design was used to collect data from 250 students. T-test was used to test the significance of the difference on the mean value of test forms A and B. This was carried out at 0.05 level of significance. It was found that simplifying the non-technical language of Physics test items has no effect on the performance of students offering Physics. This finding was the same for both male and female, students from urban and rural location, and those from high and low socio-economic status. Recommendations were made based on the findings.

CHAPTER ONE

INTRODUCTION

Background of the study

Scientific skills are very important to the present world and national development. Without the study of Physics, some scientific skills would be invalid. Physics is the basic science that treats matter and energy and the laws governing their reciprocal interplay under the condition of precise observation and exact measurement.

The importance of Physics shows the necessity of the subject in the area of science and technology. The growing awareness and contribution of Physics education is meaningful to economic, social and political development. Physics is offered by students in senior secondary classes aspiring to study science related courses such as medicine, engineering, surveying, geology, etc as prescribed by the Joint Admission and Matriculation Board (JAMB) in their brochure. A credit pass in Physics is needed for admission into the various courses of study. Physics is an integral part of science education. There are records of poor performance by many students who offer the subject at external examinations such as the West African Senior School Certificate Examination (WASSCE), National Senior School Certificate Examination (NSSCE), and the Unified Tertiary Matriculation Examination (UTME). This relative poor performance

of students in Physics, when compared with other science subjects such as Biology and Chemistry, is evident from the statistics of students' performance at the Senior School Certificate Examination. The statistics of performance by students offering Physics at the West African Senior School Certificate Examination for five years is presented in appendix 1.

From appendix 1, it was observed that less than 40% of the students passed in Physics at credit level. For instance, in 2005, only 18.15% of the students passed Physics at credit level. The figure was less than 40% from 2001 – 2005. This implies that more than 50% of students who enrolled for Physics during the West African Senior School Certificate Examination were unable to gain admission into institutions of higher learning to study science related courses of their choice. This scenario has many other attendant problems. Firstly, the students are likely to re-write Physics at the Senior School Certificate Examination. This is because of the emotional imbalance of students. Moreover, students who have attempted the examination a number of times are likely to indulge in examination malpractice in their desperate bid to pass the subject. This examination malpractice could be in the form of students either been found with materials related to

Physics or being impersonated (that is, asking someone else to sit for the examination on their behalf).

Secondly, it creates additional financial burden on parents in terms of reenrollment, buying books repeatedly and maintaining the students during the extra time in school. Some educators and researchers share their ideas on the poor performance of students in Physics at the Senior School Certificate Examination.

Johnston and Mugol (2009) and Oluka (2005) observed that students find Physics concepts difficult to learn. This is because the concepts, at times, are abstract. They also observed that certain terminologies used in Physics such as retardation, acceleration, resistance, velocity and so on without proper explanation are responsible for the poor performance of students at the Senior School Certificate Examination. Because students find it difficult to understand these terms and what they mean, they further find it difficult to solve mathematical test items given to them. This suggests that the level of study of Physics in Nigeria is largely unsatisfactory. Hence there should be research in this area that will help to improve students' performance and acquire quality education in Physics.

In recent times, research in the field of testing have shown a causal relationship between achievement in science subjects

(Physics and biology) and ability in English Language. For instance, Cassel and Johnston (1984), found that the language of a test item can affect students performance in Chemistry. Statistics from West African Examination Council also revealed a relationship between those who passed science subjects and English language. The data is presented in appendix 2.

According to the statistics, 26.09% passed English Language at credit level while that of Biology and Physics were 23.26% and 33.97% respectively in 2001. The same trend was observed from 2002 to 2005. In 2001, 41.13% failed English Language while those of Biology and Physics were 45.44% and51.03% respectively. This shows that there is a relationship between the performance of students in English Language, Physics and Biology. From the data presented, it was observed that the percentage of students who passed English Language was close to those who passed Physics and Chemistry respectively.

Research studies by Cassel and Johnston (1984) revealed that simplifying non-technical words in Chemistry multiple-choice test brought about significant improvement in number of students who passed the items. Non-technical words are specifically used or attributed to a particular object. For instance, when Chemistry multiple-choice test was simplified by replacing complex words in

key positions with simpler synonyms, the number of students who passed such items increased from 53% to 63%. Changing terms of quantity as, for example, “less abundant” to “most abundant” increased the percentage passes from 51% to 85%. Similarly, replacing negative worded sentences to positive worded sentences increased the percentage passes from 24% to 80%. Reducing the length of sentences in stimulus tasks also increased the percentage passes from 47% to 67%. Task presentation in this way is common in Physics multiple choice test items used in WAEC and NECO examinations. Physics as a subject possesses non-technical words such as acceleration, momentum, velocity, friction and so on. These non-technical words are mostly used by examination bodies like the West African Examination Council (WAEC), National Examination Council (NECO), and Joint Admission and Matriculation Board (JAMB) when examining students. These forms of test items have posed additional tasks on the students.

Simplifying the English language of test items in a subject like Physics will help improve students’ performance at WAEC and NECO examinations. Nigeria communities have two major media of communication, the mother tongue (L1) and English language (L2). The use of the student’s mother tongue as a medium of communication/teaching enhances their understanding of the

subject. This is because of the inherent difficulty at understanding the concepts of the subject as used in English language. The continuing increase in the number of students who prefer the use of their mother tongue (L1) as a medium of teaching in classroom nation-wide has forced the issue of the importance of language in assessment to the forefront. In an attempt to respond to the growing national concern on language backgrounds of students and its effect on performance, the researcher is undergoing a study on examining the effect of language on students' performance at the West African Senior School Certificate Examination (WASSCE) Physics test items and investigating the significance of language related variable from WAEC'S assessment in Physics content area. Test items given by WAEC are in complex form. For example, a very sensitive spring balance is used to determine the weight of an object at the North pole. When the same spring balance was used to measure the weight of the same object at the equator, it was found to have reduced. The explanation for this observation is that ... (WAEC 2008). They could be simplified so as to reduce the stress on both teachers and students. For example, the same spring used to measure the weight of an object at the equator was also used to determine the weight of the North pole. What does the explanation define? Since the West African Examinations Council (WAEC) is

involved in direct sampling of language for students in its move to open-ended and extended open-open questions, there is an increasing need for studies on the effects of simplifying technical background and the linguistic characteristics of test items on students performance in Physics at the Senior School Certificate Examination. The assessment strategies being developed for the purpose, however, down play the role of simplifying non-technical language for students. Language and classroom culture are areas that need attention if all students are to be provided opportunity to learn. The amount of variation in test performance due to language background can be determined.

Linguistic ability refers to the knowledge and principles of sentence formation. Linguistic ability tends to influence students in their academic performance. Linguistic ability is influenced by factors like socio-economic status, gender and location of testees.

Socio-economic status refers to students from different socio-economic status viz: high and low class students. The environment where the student resides is capable of influencing the student in mastery and the use of English language. In this case, the location is considered with kin interest. This has to do with those in the urban areas and those in the rural areas. Research indicates that children from low socio-economic status homes develop academic

skills more slowly than children from high socio-economic status home. (Morgan, Farkas, Hillemeier & Maczuga 2009). Aikens and Barbarin (2008) show that the school system in low socio-economic status communities is often under resourced, and therefore negatively affect students' academics. Inadequate resources and increased dropout rates affect the children's academic achievement, therefore perpetuating the low socio-economic status of the community. Improving the school system to help reduce the risk factor of socio-economic status is essential.

Gender and achievement in English language is considered a factor. In terms of gender (male and female), it is observed that females have more interest at reading comprehensions than their male counterparts. This study will investigate if the language of Physics test item at WASSCE presents difficulty to male and female candidate who are of the same ability.

Statement of the Problem

Research have revealed that there is relationship between the number of students who pass English and the number of students who pass science subjects like Biology, Chemistry and Mathematics. Also, statistics of performance of students at West African Senior School Examination show that there is relationship

between the number of students who passed English and Physics. In 2001, 26.09% passed English while 33.97% passed Physics. These are presented in appendix 2.

Also, it was found that simplifying language of test items reduce the index of differential items functioning in Biology. The problems outlined in this study are; first, what is the effect of simplifying the non technical language of Physics multiple-choice test items on Senior Secondary School students' performance in Physics? Secondly, how does students' background characteristic like gender, socio-economic status and location influence the effects of simplifying the language of test item on students' performance?

Research Questions

To guide this study, the following research questions were posed;

1. What is the effect in the mean performance of students in Physics' multiple-choice test with simplified language and those of original language form?
2. What is the effect in the mean performance of male and female Physics students on a language simplified multiple-choice test items?

3. What is the effect in the mean performance of testees from urban and rural locations on test items with simplified English language?
4. What is the effect in the mean performance of testees from high and low socio- economic status on test items with simplified English language?
5. What is the effect in the mean performance of testees in test items with simplified words in key position compared to their counterpart with original words in key position?
6. What is the effect in the mean performance of testees in test items with negative phrase change to the positive phrase?
7. What is the effect in the mean performance of testees in test items simplified by reducing the number of words compared to those with large number and complex words?

Hypotheses

1. There is no significant difference between the performance of Physics students in test items with simplified language and those with original language.
2. There is no significant difference between the performance of male and female Physics students in test items with simplified language.

3. There is no significant difference between the performance of Physics students of urban and rural locations in test items with simplified language.
4. There is no significant difference between the performance of Physics students from high and low socio economic status in test items with simplified language.
5. There is no significant difference between the performance of Physics students tested in test items with simplified words in key positions and those with original words in key positions.
6. There is no significant difference between the performance of Physics students tested with items that are negative by phrased and items that are changed to positively phrased.
7. There is no significant difference between the performance of Physics students tested in items with simplified reduced number of words and those with many and complex words.

Purpose of the Study

The purpose of this study is to ascertain the effect of simplifying the non-technical English language of Physics multiple-choice test items used by West African Examinations Council which were originally phrased in complex language on students' achievement in multiple choice test items in the original language

form. Secondly, it intends to establish the effect of such simplification on the achievement of students from different backgrounds such as location, gender and socio- economic status, items as well as simplified by rewarding items with complex words in key position, long and complex words, and item phrased in the negative.

Significance of the Study

The study is significant in the following ways;

The simplified test items would motivate the students to study the subject (Physics) like any other subject and there will be a better understanding of the subject.

Public examination bodies like the West Africa Examinations Council and National Examinations Council would use the outcome of the research to formulate guidelines to edit the language of the test items constructed for use in public examinations. These have a tendency to improve students' performance and understanding of test items.

Physics teachers would be guided by the outcome of this study to develop teacher-made tests and improve on the teaching of Physics. The teachers' language structure would be simplified to the understanding of students and make the subject more interesting. Unambiguous sentences, complex words, and terms, and so on would be avoided by the teacher in order to improve the teaching learning condition of Physics as a subject. Psychometricians could have the opportunity to use the outcome of this study to improve the reliability and validity of tests.

Scope/Delimitation of the study

The study covered Physics multiple choice test items, which were identified using Cassel and Johnston model, to be complex at the WAEC SSCE of 2007, 2008 and 2009. The language of test items was simplified by reducing the length of sentences, changing negative phrases to positive, and using simple synonyms in key positions. Only non-technical words of the multiple choice test items were simplified.

CHAPTER TWO
REVIEW OF RELATED LITERATURE

This chapter reviewed some related literature. It is organized under the following subheadings;

a) Theoretical framework
b) Item response theory and classical test theory
c) Empirical studies on simplified language
d) Test validity and reliability
e) Gender
f) Location
g) Socio-economic status
h) Changing negative to positive
i) Simplifying words in key position
j) Rewording long and complex words
k) Appraisal to literature review

Theoretical Framework

Testing is an important aspect in the teaching-learning process. According to Kaplan and Saccuzzo (2001), test is a measurement device used to qualify behavior or aid understanding and predict behavior. Crombach (2003) defines test as a systematic procedure for observing a person's behavior and describing it with the aid of numerical scale or a category system.

During the process of testing, cognitive domains are measured. Test, according to Ali, Ezeachi and Ogbazi (2004), is an

instrument administrated to someone or something to determine the presence or absence of a phenomenon being measured. There are different forms of test. They include:

1. Aptitude test
2. Personality test
3. Interest inventories
4. Achievement.

During the course of this work, emphasis is laid on achievement test and the effect of simplified word on achievement of students in Physics.

Item Response Theory

The effectiveness of the item response theory (IRT) in the field of measurement offers some idea on mechanics of theoretical assumption that aid construction of test items.

Test forms should be assembled to meet specifications for both psychometric properties and non-psychometric properties of the test. Psychometric attributes of items may refer to classical item statistics, IRT- based item parameters, (that is a^-, b^-, c^- parameters estimates), item response function or item information function. The test level psychometric properties are often functions of the item attributes; for example, the test information function equals the sum of the item information functions, and the test mean

equals the sum of item difficulty (that is p-value). Non-psychometric specifications for test assembly refers to attributes that are not related to statistical characteristics of test and include factors such as test length, test content, number of test forms to be constructed, item format, item exposure rate, item sets and item exclusion. Exponents in item response theory postulate the latent traits or mental traits that are responsible for an individuals' performance in a given test (Warn, 1978). The items are usually designed to answer questions such as;

1. How adequately does the test plan describe the instructional objectives and the content measured?
2. How does each test item have an answer that would be agreed upon by experts?
3. Is the answer space clearly indicated and is each answer space related to its corresponding test item?

Timothy (1999) defines item analysis as the process of examining a student's responses to each test item of uni-dimensional assumption in IRT. A test should be constructed such that performance in the item is sustained only by the subject matter ability demand.

Vander Linden and Luecht (1998) proposed an "IRT-based method for constructing strongly parallel test by matching items on item response functions. They noted that "test forms with pair wise identical response functions have equal true scores and observed score variance for each examinee in the population for which the IRT model holds and are therefore parallel. Since the IRT definition of strongly parallel forms refers to equivalence in item response function across forms, the criterion, that parallel test forms have identical distributions of item response functions conditional on θ is an appropriate standard to evaluate the degree parallelism of alternate test forms.

With the IRT definition of strong parallelism, if the item response function, P_i (Θ), represents the conditional difficulty of the i- item for a person with latent traits (Θ), then the parallel test forms would refer to test forms that satisfy the requirement that the distribution of P_i (Θ) is the same for each (Θ) value across forms that can be used to indicate the degree of test parallelism. Macdonald defined two test forms as item parallel if they consist of paired items with identical item parameters.

The resultant score (X) for an individual from the above consists of the following component of Physics ability Θ. The

influence of extraneous ability component is represented by Ladah (λ) and the measurement error component is represented by epsilon (Σ).

The presence of λ represents a shift form from the mode of characterization of score on the classical test theory (CTT). In the classical mode, a test score X is made up of true score component (X_t) and an error score component (X_e). The classical test theory is based on decomposition of observed scores into true scores and error scores. This is mathematically represented as

$$X = X_t - X_e$$

According to Dowine and Health (1974), X_e is held to be random and is related to the reliability of any measuring device. The identification of X in IRT model helps to identify a source of error which is systematic and could distort the result of testing when not taken care off. This leads to one of the assumptions of uni-dimensionality which states that a test is uni-dimensional when the item measures one and only one area of knowledge or ability. It also tests the bits of knowledge which are logically and sequentially related. Nenty (1998) states that in order to achieve specific objectives in psychological measurement in IRT, a test must

be designed, administered, and scored in a way that one and only one ability accounts for an examiner's score on it.

Knowledge of this finding will bring challenges to test writers of developing test items which are uni-dimensional in terms of the ability they are meant to measure. A good Physics test can be said to be valid if it measures only Physics ability. The demand for validity is that extraneous variables such as communication skills, illustrations whose familiarity does not cut across group of examinees should be eliminated. Studies on language using CTT compare the item P-value for one group with the P-value of another group. (Warn 1978).

Empirical Studies on Language of Test Items and Students Achievement.

The achievement of the student in classroom learning of Physics varies according to certain factors which results into the tendency of a test to yield different scores. Individuals who have the same efficiency from different subgroups of population of test takers have been taken into consideration as their performance differs. This could be possibly analyzed from the non-technical words in Physics achievement.

Effects of Language of Physics Test Items on Students Performance

There is increasing decline in Physics achievement and enrollment. Ezeife (1996) says that there are increasing conditions for under achievement and slow learning of Physics. This portrays possible failures of previous efforts of science educators to improve the learner situation. The achievement momentum of study of Physics varies according to factors such as students background and learners' environment and development level in terms of cognitive maturity. Ali (1998), Ogunleye (1999), Ivowi (1999), and Okebukola (2002) present major problem areas of Physics teaching and learning to include: student related problems, problems of acquisition or supply of instructional materials, problems arising from the technical and abstract nature of Physics teaching and learning concepts and inferiority complex of girl children in Physics learning.

The problems of underachievement and slow learning that attend Physics learning are attributed by Ikwa (1997) to students' ineffective grasp of concepts due to the difficulty of constructing understanding of these concepts. Peace and Roux (2006) are worried that the decline in Physics achievement is below the conceptual threshold and is indicative of lack of problem solving competence. Effiong (1999) carefully observed examination records. He said that the West Africa Senior School Certificate Examination

students' enrollment in Physics never attained 20% of the total entry in any given year for the past decades while Chemistry and Biology have at certain times exceeded 40% and 70% of the total entry respectively within the same period. This, perhaps, arises from both students' and teachers' inability to construct understanding of most Physics concepts called "difficult" concepts defined by Ivowi (1999) as concepts difficult to teach and learn.

Test Validity

Validity is an important part of testing. The quality of test as a psychological measurement is judged on the basis of its validity. A test that does not measure the subject matter cannot be said to be valid. The definition of test validity has undergone change over the years.

Thorndike (1918) states that validity is a rational judgment in which test items represent the content and objective of a course that it is concerned with. The test assembled provides efficient test construction such as the equivalence of the test forms based on a certain test blue print. Validity is divided into four components; content, criterion, concurrent and constructs validity.

Content Validity

As the name implies, it is the extent to which a test samples the domain which are to be covered. It was to this effect Lennon (1956) cited by Mehrens and Lehman (1978) defined validity as the extent to which a subject's responses to the items of a test may be considered to be a representative sample of his responses to a real situation which together constitute the area of concern to the person interpreting the test. From Lennon's, content validity is ascribed to the subject's responses rather than the test items themselves.

Criterion Validity

Criterion-related validity refers to the empirical techniques of studying the relationship between test scores and some independent external measures. It involves computing a correlation coefficient between test scores and criterion measurement. Validity is measured by the magnitude of correlation coefficient between test scores and criterion measurement. According to Gronlund (1976), predictive validity is when prediction occurs between two measures over a period of time. Alternatively, it is an estimate of the performance of a student in subsequent criterion task.

Construct Validity

Construct validity, according to Gronlund (1976), could be defined as the extent to which test performance can be interpreted in terms of certain psychological constructs. Constructs are psychological qualities which are assumed to exist in order to explain some aspect of behavior. Examples are intelligence, reading, critical thinking. Construct validity covers all the other types of validity. Gerdner (2005) sees construct validity as embracing all the other types of validity. Validation in this sense is the level of confidence with which an examinee's test score can be used to make inferences concerning the ability under measure.

Gronlund (1976) identified some factors that influence the validity of a test item. They are vocabulary and sentence structure which are too difficult and ambiguous test items. A Physics achievement test with content validity would become invalid where, in the light of construct validity, scores in the test can be accounted for by abilities such as reading, comprehension, technical skills. The basis of the level of confidence that can be made from the test is required for the score to be valid.

Factors Affecting Language Competence:

Language can be viewed as a metaphor for more general skills that facilitate economic activities. For example, Lazear (1996) used

the term 'language' to refer broadly to a set of cultural values. In this study, the researcher focuses on language in the simplifying form. It is observed that language is repository of cultural and literary values.

The effects of language to students' achievement in Physics are affected by some variables. Such variables have led to under achievement of students in the subject of. Research in IRT have identified extraneous variables capable of influencing students performance in tests. These extraneous variables include language to socio-economic status, language to gender and language to location.

Socio Economic Status

English language competence on test construction in Physics achievement test the possibility of an examinee in group A (high English language competence) with ability of answering an item correctly as equal to the probability of an examinee B (low English language competence) with ability of answering an item correctly.

Students with a high level of spoken English are assumed to ascertain cultural level. This cultural level has to do with one who obeys rules and principles of the usage of English language. The relationship between children from high socio-economic status and

those from low socio-economic status is evenly differentiated by their level of competence in language. The difference in their language is in the non-interference of their pronunciation of words by the mother tongue. A study by Bernstein identified the use of two different kinds of languages known as the elaborate and restricted language.

Elaborated language code is mostly found among children from the middle socio-economic status. Children in this category are more knowledgeable in language use and exhibit a clear understanding of language structure. He explained this with the story of a woman who cautioned her child. Unknown to her, the child learnt the use of complex vocabulary and their meanings. These kinds of language structures are mostly used in the classroom, textbook and examination rooms, (Eggleston, 1992).

The restricted code is commonly used among people of low socio-economic status. This was also illustrated with the story of a woman who prevented her son from learning by restricting the child to specific conditions; unknowingly to her she was introducing the restricted code. This is commonly used among unskilled labours of the society. It was observed that children from middle socio-economic status tend to perform better in the use of English language and in a more simplified form. They adhere more to

competence in communication, reading and spoken English. On the other hand, those of low socio-economic status tend to perform more poorly in English language in terms of communication, reading and spoken English.

Since communication skills contribute to the value of extraneous variables, item response theory model is used to test validity. Since this skill is socio-economic status dependent, it is therefore reasonable to investigate the influence of factors such as speaking, listening and writing proficiency, the frequency at which language is used, the ability to alternate between language and the ability to keep the language structure separate.

The structure of English used by children in rural areas tend to be poor because their mother tongue seems to dominate and inhibit the English language. On the other hand, those in urban areas learn English language and have opportunity of listening and learning from more experienced users thereby listening to conversations that improve their mastery and competence of the language. From the above analysis, it can be inferred that Physics students in urban areas will perform better than their counterparts in rural areas because of the former's better hold on English.

Gender

Oxford (1993), Oxford, Young, Ito and Sumrall (1993), Young and Oxford (1997), observed that gender is an issue with important theoretical and pedagogical implication in English language learning; it has some attention in language strategy research. It was observed that gender has a significant impact on how students learn language. Sheory (1999) observed gender difference when he said that sometimes males surpass females in the use of particular strategies effectively. Oxford and Nyikos (1989) looked at the strategies used by some universities and concluded that gender difference has a profound influence "on strategy use, and that females used strategy more frequently than males. In the same vein, Thompson and Galisky (2001) observed that people believe that men have advantage in negotiation; that is, men actually outperform women when negotiation is perceived as diagnostic, whereas no such difference was found when the task was framed as a learning tool.

A study carried out by Green and Oxford (1995), found that females use learning strategies significantly more often than males while Eakins and Eakins (2003), and Mulac (1998), found that men and women exhibit different stylistic features and communication patterns in their various subject areas. However, a study carried out by Egenge (1998), on gender issues and student achievement

on reading comprehension did not support the observation reported above but found that male students achieve better in reading comprehension than their female counterparts. Also Pickergills and Lock (1991) found that there is no difference between verbal reasoning ability of male and female students. This study investigates the language used in Physics test items at senior secondary three and administered differently to male and female students of the same ability.

Test comprehension is a step in the problem-solving process. This step has to do with understanding simple English, conversion of word problem and of special vocabulary and language structures of Physics problems. According to Spencer and Russell (2003), the difficulty with reading Physics is due to its specialized language and terminologies. If children fail to solve them, one would not expect minor wording changes to improve solution performance, yet this is precisely what is observed. Results suggest that children find these problems difficult because they could not interpret keywords and phrases in the problem text.

De Corte (1985) points out that words problem given to school children are often stated briefly and sometimes ambiguously because of supposition in the test. He also hypothesized that rewording verbal problem so that the somatic relationship are

made more explicit without affecting the underlying somatic structural facility by constructing proper problem representation and by extension, finding the correct solution. A major cause of performance error in English is dialect difference across communities (Orr, 1987). This is inspite of the fact that language plays a ritual role in the performance of pupils (Odili and Nworgu, 2004). Statistics on Biology WASSCE questions showed that 37% of the questions were affected by language. It was also observed that the percentage of pupils that failed was on the high side.

Although Various researches have been done in subject areas like English Language, Biology, Chemistry, none has significantly been carried out in the area of Physics. That is why this research is on the area of Physics performance as it relates to English.

Location

The environment a child lives has either a positive or negative effect on his use of English language (spoken, reading or writing). In Nigeria, there are urban and rural areas. Obaya (2005) observed that the environment of a child affects the use of English language and its mastery. He further observed that the problem of language interference affect the learning and competence of the second language. The first language here is known as the mother tongue while the second language is English. There are major differences

between speech sounds and patterns of the mother tongue (L1) and English language (L2). They occur in the learner's inability to understand certain speech sounds of English especially those sounds not found in the mother tongue. Secondly, the learner runs the risk of spelling English words wrongly because of interference from the mother tongue. Obaye (2005) observed that this problem is more in a child who is learning English language in an environment where the mother tongue is predominantly spoken. Hence this study investigates if the language of Physics test items administered on senior secondary 3 students pose serious problems.

Test Item Facility

Language is an important aspect of student's achievement. A study by Cassel and Johnston (1984) produced results that showed that extraneous variables are capable of influencing students' performance in a test. For instance, Cassel and Johnston found that language of test questions in Chemistry multiple choice items affected the performance of examinees. This implies that the language of test items can be a very significant factor in students' performance.

According to Cassel and Johnston (1984), management of language could introduce additional task and increase the difficulty index of Chemistry multiple choice test.

Changing from Negative to Positive

The use of negative words in test questions increases the difficulty of the questions. It creates more problems when negative words are used in both stem and option. The use of double negative introduces additional thinking and thus increases the difficulty index. Examples of changing from positive to negative are found in appendix 3.1.

From appendix 3.1 we can see that when original questions were simplified, correct response rose from 24% to 80% in the first item.

Simplifying Words in Key Position

The simpler the keywords in a stem the more responses given by students. This leads to improvement in the performance of the testee. Example of keyword is in appendix 3.2.

From appendix 3.2, we could see that changing key words from pungent gas to choking gas increased the correct response from 56% to 63% in the first item.

Changing Terms of Quantity

The use of complicated terms of quantity in the stem or option of multiple choice questions increases the difficulty of the question when compared with when the same term of quantity is used. The explanation given by Cassel and Johnston is that "the language change is influencing the thinking rather necessary to answer the question" Example for these is in appendix 3.3.

From appendix 3.3, we could see that changing terms of quantity in the simplified form increased the correct responses from 75% to 84%.

Rewording Long Complex Questions

Many testees tend to prefer fewer words. Many worded questions with co-bedded clauses present greater problem of intellectual organization before the answer could be attained. Presenting the information in a more simplified sentence, however, reduce internal intellectual organization necessary to answer questions. Examples of these are in appendix 3.4

Appendix 3.4 showed that long complex questions increase the performance of examinees from 40% to 70% when shortened.

The p-value is reactive to the ability level of the examinee. The same item given to high ability group and low ability group of the same population give two different p-value.

Appraisal of Literature

A test is a systematic procedure of assembling test items or preparation of a test by drawing and compiling series of questions which constitute a task to a testee. In this study, the researcher discussed the classical test theory. It is a theory which postulates that test items can be valid measurement of learning outcomes if they measures only one latent trait of the subject matter. In item response theory, there are two sources of error in a test score. These are random error and extraneous error. Sources of extraneous variable error include language of test items, illustration which may be culture specific, and so on. It was observed that language influences the performance of testees. Those from high socio-economic status perform better than those from low socio-economic status. Language is influenced by the environment and gender.

Certain research findings were the focus of this study. Studies found that for longer Biology items, students took longer time to answer them and answered few correctly. The range of language

factor relevant in Physics assessment is very broad. A common theme across many of the studies is that of the complexity of logistic features in Physics. Items must be considered as a separate issue from Physics.

Some researchers worked on the problems associated with Physics achievement in Secondary Schools. They are problems relating to the abstract and technical nature of the subject. But none has dealt on the effect of language of Physics multiple choice test items used by the West African Examinations Council on students' performance, particularly in Aniocha North Local Government Area and Oshimili South Local Government Area of Delta State. This is the gap which this research work intends to fill.

CHAPTER THREE

RESEARCH METHODS AND PROCEDURE

This chapter was carried out under the following sub-headings:

- Design of the study
- Population of the study
- Sample and sampling techniques
- Research instruments
- Validity of the instrument
- Reliability of the instrument

- Method of data collection
- Experimental procedures
- Control of threat to internal and external validity
- Data analysis

Design of the Study

The study employed experimental research design. Specifically, pre-test - post test control group experimental design was employed to investigate the effects of simplifying English language of Physics multiple – choice test items on students' performance in Physics. The independent variable is the language of Physics multiple choice test items which is presented in two forms viz.

1. The original English language form used by the West Africa Examinations Council for phrasing Physics multiple choice test items.
2. The same Physics multiple choice test items presented in simplified English language without change in task being measured.

The dependent variable was students' performance in Physics.

The treatment was the presentation of test items in original language form to a control group and the same items in a simplified language form to an experimental group. The idea was to determine

if presenting test items in the two language forms will differentially affect the performance of testees in Physics test.

Population of the Study

The population of the study was made up of all Senior Secondary Three (SS III) Physics students of public secondary schools in Aniocha North and Oshimili North Local Government Areas of Delta State. They were 500 students.

Sample and Sampling Techniques

A total of 250 students were sampled for the study through stratified random sampling technique from the two Local Government Areas in Delta North Senatorial District (Aniocha North and Oshimili North). The sample size was from the urban and the rural areas.

Research Instrument

The instrument was administered by the researcher with the assistance of the Physics teachers in the schools. Test forms A and B were interspaced among the students in the same classroom at the same time. Responses were collected after the test. Test form A comprised original test items by WAEC with thirty multiple choice

test items. Test form B comprising simplified test-items had thirty test-items.

Validity of the Instrument

A test-blue print was prepared from topics and instructional objectives of the Physics to establish a face validity and content validity. They were carefully examined by experts of measurement and evaluation and, based on their comments, amendments were made. The content validity showed the extent to which the test-items sampled the domain which were covered.

Reliability of Research Instrument

The parallel form method was used to establish the reliability of the test administered on the testee. The two test forms, "A" and "B", were said to be equivalent since they contained similar items. The two tests were correlated using Pearson R formula to establish the coefficient of equivalence. The reliability of the test was 0.92.

Method of Data Collection

Physics achievement scores were used to collect data. The instrument was of original language form used by WAEC (form A) and a simplified language form (form B).

Experimental Procedure

The first step was distribution of the students in the sampled schools into experimental and control groups. The independent variable was language of Physics achievement test which was presented in two form: A and B. Form A contained 30 multiple choice test items with original language used by West African Examinations Council (WAEC) drawn from SSCE questions of 2007, 2008 and 2009. The questions were manipulated in form B by simplifying the language of the non technical words. They retained their original meaning in the sense that they measured the same content and behavior process. The test lasted for a period of three months bearing in mind the fact that the testees are senior secondary school III students who were preparing for their external examination. The method of simplifying the multiple choice test items suggested by Cassel and Johnston (1984) was used. The dependent variable was students' responses which were either right or wrong. The idea was to find out if the mean performance of the students will be higher in the simplified test items than in the original test form.

Control of Threat to Internal and External Validity

The following threat to internal validity that was identified in the study was experimental mortality. This is the tendency for students who have been sampled for the study to be absent during

the period of treatment. This problem will be handled by administering the treatment on a day that coincided with the schools' continuous assessment test.

The threats to external validity in the design were the measuring instrument and artificiality of experimental treatment. Instrument was multiple choice test items. Generalizability cannot be extended to practical test and essay. This will be stated as limitation to the study. Artificiality of experimental treatment was handled by making sure that all the students in the class were involved.

Data Analysis

The data collected were students' performance in the test. They were btained by adding the items the students got right. T-test computation was used to compare the mean performance of students of the two groups.

CHAPTER FOUR

PRESENTATION AND DISCUSSION OF RESULTS

The results of this study are presented and discussed in this chapter. They are presented in tables according to the research questions and hypotheses.

Research Question I

What is the performance mean difference between Physics who were examined students with simplified language in physics multiple – choice test items and those examined in original language form?

Table 4.1: Comparison of performance mean of students in simplified language and original language forms

Test Form	N	$\bar{X}$	SD	SE
Simplified form	250	12.40	1.2753	0.057
Original form	250	12.41	1.5084	0.068

From the table, it is observed that the mean performance of students with simplified language is 12.40 with standard deviation of 1.2753 while that of original language form is 12.41 with standard deviation of 1.5084.

Research Question II

What is the performance mean difference between male and female Physics students in simplified language multiple choice test items?

Table 4.2: Performance mean of male and female students in simplified language test form.

Gender with simplified test form	N	$\bar{X}$	SD	SE
Male	110	12.0182	0.5982	0.0381
Female	140	12.3214	4.9432	0.3145

The table shows that male students had a mean of 12.0182 and standard deviation of 0.5982, while their female counterpart had a mean of 12.3214 with a standard deviation of 4.9432.

Research Question III

What is the performance mean difference between testees from urban and rural locations in test items with simplified English language?

Table 4.3: Performance mean of urban and rural students in simplified language form

Location with simplified form	N	$\bar{X}$	SD	SE
Rural	124	12.048	2.2118	0.1407
Urban	126	12.261	2.2828	0.1452

In the table above, the mean of students in urban area is 12.261 with standard deviation of 2.828, while those from rural area have a mean of 12.048 and standard deviation of 2.2118.

Research Question IV

What is the performance mean difference of testees from high and low socio-economic status in test items with simplified English language?

Table 4.4: Comparison of the performance mean of students of high socio-economic and low socio-economic status in simplified language form

Socio-economic status	N	$\bar{X}$	SD	SE
High	138	12.36	1.1469	0.0988

Low	112	12.68	1.5541	0.0729

The table shows that the mean and standard deviation are 12.36 and 1.1469 respectively while that of low socio-economic status are 12.68 and 1.5541 respectively.

Research Question V

What is the performance mean difference of testees in test items with simplified word in key positions and items with complex key positions?

Table 4.5: Comparison of the performance mean of students in simplified key positions and those in original language

Items with complex word in key positions	**N**	$\bar{X}$	**SD**	**SE**
Simplified test form	250	3.616	1.2010	0.0774
Original test form	250	3.792	0.9100	0.0579

Results in this table shows that the mean of simplified test form is 3.616 and standard deviation, 0.2010, while the mean of original test form is 3.792 and standard deviation, 0.9100.

Research Question VI

What is the performance mean difference of students in test item in long and complex words test items and simplified reduced number of words?

Table 4.6: Comparison of the performance mean of test items in long and complex words and the simplified

Items in long and complex words	N	$\bar{X}$	SD	SE
Original test form	250	3.048	0.9258	0.0589
Simplified test form	250	3.564	0.7617	0.0484

In the table above, the mean performance of testees in long and complex test items is 3.048 and standard deviation, 0.9258 while those in simplified test form had a mean of 3.564 and standard deviation, 0.7617.

Research Question VII

What is the performance mean difference of positively phrased test items and negatively phrased test items?

Table 4.7: Comparison of the performance mean of negatively phrased to positively phrased test items

Items with negative phrase	N	$\bar{X}$	SD	SE
Simplified	250	3.072	1.1748	0.0747
Simplified test form	250	3.208	1.3756	0.0875

In the table above, the mean performance of testees with negatively phrased test items is 3.208 and standard deviation is

1.3756 while that of simplified form is 3.072 and standard deviation, 1.1748.

Hypothesis I

There is no significant difference between the performance of Physics students in test items with simplified language and those with original language.

Table 4.8: Effect of simplified and original language of Physics test items on students' performance.

Test forms	N	$\bar{X}$	SD	df	t-cal	t-crit.
Simplified form	250	12.40	1.275	248	0.096	1.96
Original form	250	12.41	1.508			

In the table above, the mean performance of simplified test form is 12.40 and the standard deviation is 1.275, while that of original test form has a mean of 12.41 and standard deviation of 1.508. The degree of freedom is 248, t-calculated is 0.096 and t-critical is 1.96. Since the t-calculated is less than the t-critical, the null hypothesis is accepted.

Hypothesis II

There is no significant difference between the performance of male and female Physics students in test items with simplified language.

Table 4.9: Effect of simplifying the language of test items on performance of male and female students in Physics.

Gender	N	$\bar{X}$	SD	df	t-cal	t-crit.
Male	110	12.0182	0.5982	248	0.4219	1.96
Female	140	12.0214	4.9432			

In the table above, the mean performance of male is 12.0182 as against 12.0214 for female while the standard deviation of male is 0.5982 as against 4.9432 for female. The degree of freedom is 248, t-calculated is 0.4219 and t-critical 1.96. The t-calculated is less than the t-critical. Therefore, the null hypothesis is accepted.

Hypothesis III

There is no significant difference between the performance of Physics students of urban and rural locations in test items with simplified language.

Table 4.10: Effect of location on students' performance in physics with simplified language.

Location	N	$\bar{X}$	SD	df	t-cal	t-crit.
Rural	124	12.048	2.2118	248	0.7509	1.96
Urban	126	12.261	2.2828			

In the table above, the students from urban areas had a mean score of 12.048 and standard deviation of 2.2118, while those students from rural areas had a mean score of 12.261 and standard deviation of 2.2808. It is also observed that the degree of

freedom is 248, t-calculated, 0.7509 and t-critical, 1.96. From the presentation, it is shown that the t-calculated is less than the t-critical. Therefore, the null hypothesis is accepted.

Hypothesis IV

There is no significant difference between the performance of Physics students from high and low socio-economic status in test items with simplified language.

Table 4.11: Effect of socio-economic status on students' performance in Physics with simplified language.

Socio-economic status	N	$\bar{X}$	SD	df	t-cal	t-crit.
High	138	12.36	1.1469	248	0.0729	1.96
Low SES	112	12.68	1.5541			

The table above shows that students' from high socio-economic status have a mean score of 12.36 and standard deviation 1.1469, while their counterparts from low socio-economic status have a mean score of 12.68 and standard deviation of 1.5541. The degree of freedom 248, t-calculated is 0.0729 and t-critical 1.96. The result shows that the t-calculated is less than the t-critical and as such, the null hypothesis is accepted.

Hypothesis V

There is no significant difference between the performance of Physics students tested in test items with simplified words in key positions and those with original words in key positions.

Table 4.12: Effect of test items with simplified and complex words in key positions on Physics students' performance

Items with simplified and complex words in key positions	N	$\bar{X}$	SD	df	t-cal	t-crit.
Original test forms	250	3.792	0.9100	248	1.8429	1.96
Simplified test forms	250	3.616	1.2010			

From the table above, students measured with complex words in key positions in simplified form had a mean score of 3.616 and standard deviation of 1.2010, while their counterpart measured in original test form had a mean score of 3.792 and a standard deviation of 0.9100. The degree of freedom is 248, t-calculated, 1.8429 and t-critical 1.96. Since the t-calculated is less than the t-critical, the null hypothesis is accepted.

Hypothesis VI

There is no significant difference between the performance of Physics students tested with items that are negatively phrased and items that are positively phrased.

Table 4.13: Effect of test items with long and complex language on Physics students' performance in original test forms to simplified test forms.

Item with long & complex words	N	$\bar{X}$	SD	df	t-cal	t-crit.
Simplified test forms	250	3.048	0.9258	248	6.8253	1.96
Original test forms	250	3.564	0.7617			

The table above shows that students measured with simplified test forms had a mean score of 3.048 and standard deviation of 0.9258 while those measured with original test form had a mean score of 3.564 and standard deviation of 0.7617. The degree of freedom is 248, t-calculated, 6.8253 and t-critical is 1.96. Since the t-calculated is less than the t-critical, the null hypothesis is accepted. This shows that there is no significant difference between the performance of Physics students with long and complex words and those tested with reduced number of words.

Hypothesis VII

There is no significant difference between the performance of Physics students tested in items with simplified reduced number of words and those with many and complex words.

Table 4.14: Effect of test items phrased in negative words and those phrased in positive words on students' performance in Physics

Item with negative phrase	N	$\bar{X}$	SD	df	t-cal	t-crit.
Simplified test forms	250	3.072	1.1748	248	1.1898	1.96
Original test forms	250	3.208	1.3756			

From the table, the mean score of students' performance measured in positively phrased items is 3.072 and standard deviation 1.1748, while those students measured in negatively phrased items had a mean score of 3.208 and standard deviation 1.3756. The degree of freedom 248, t-calculated, 1.1898 and t-critical, 1.96. The result shows that the t-calculated is less than the t-critical. The null hypothesis is therefore accepted. That is, there is no significant difference between the performance of Physics students tested with negatively phrased items and positively phrased items.

Findings

The following findings were made from the study:

1. There is an effect in the performance mean of students in Physics multiple choice test items with simplified language than those with original language.

2. There is an effect in the performance mean of male and female testees in simplified language.

3. There is an effect in the performance mean of testees from urban and rural locations in simplified language form.

4. There is an effect in the performance mean of testees of socio-economic status in simplified language form.

5. There is an effect in the performance mean of testees in simplified words in key positions and to those in original words in key positions.

6. There is an effect in the performance mean of testees in simplified long and complex words and those of original long and complex form.

7. There is an effect in the mean performance of testees in simplified negative phrase and those in original form.

8. There is no significant difference in the effect of simplified language of Physics test items on students' performance. The hypothesis was accepted.

9. There is no significance in the effect of simplified language of Physics test items performance of male and female students. The Hypothesis was accepted.

10. There is no significance in the effect of simplified language of Physics test items on location. The hypothesis was accepted.

11. There is no significance in the effect of simplified language of Physics test items on socio-economic status. The hypothesis was accepted.

12. There is no significance in the effect of simplified language and original complex words in key positions of Physics test items on students' performance. The hypothesis was accepted.

13. There is significance in the effect of Physics test items with many and complex words and simplified reduced number of words on students' performance. The hypothesis was rejected.

14. There is no significance in the effect of Physics test items in original negatively phrased and simplified positively phrased

forms on students' performance. The hypothesis was accepted.

Discussion of Findings

Effect of simplifying the non-technical language of Physics multiple-choice test item on students' performance

Table 4.8 reveals that performance of student in physics test with simplified language and that with original language shows no significant difference in the performance. This shows the null hypothesis was accepted. This finding is not in accordance with the study by Cassel and Johnston (2004), which reveals that simplifying non-technical words in Chemistry multiple-choice test brought about a significant improvement in the number of students who passed the test.

Effect of simplifying the non-technical language of test items on performance of male and female students in Physics

Table 4.9 reveals that there is no significant difference in the performance of male and female students in test items with simplified non-technical language. This shows that the null hypothesis was accepted. This finding is in accordance with Thompson and Galisky (2001) who observed that people believed that males are outperformed by females when negotiation is

perceived as diagnostic, whereas no such difference is found when the task is framed as a learning tool.

Egenge (1998) found that male students achieve higher in reading comprehension than their female counterparts. This, is not in accord with the finding of this study.

Effect of location on students' performance in Physics with simplified non-technical language

Table 4.10 reveals that there is no significant difference in the performance of testees in urban and rural locations in test items with simplified non-technical language. This shows that the null hypothesis was accepted. This finding, is not in accord with Obaye (1982) who observed that a child who learns English in an environment where the mother tongue is mostly spoken experiences more problem with the use of English.

Effect of socio-economic status on students' performance in Physics with simplified non-technical language

Table 4.11 reveals that there is no significant difference in the performance of testees from high and low socio-economic status on test items with simplified non-technical language. This shows that the null hypothesis was accepted.

Effect of test items with complex words in key positions and simplified non-technical language on Physics students' performance

Table 4.12 reveals that there is no significant difference in the performance of students with test items with complex language in key position and simplified language. This shows that the null hypothesis was accepted. This finding is in accord with Cassel and Johnson (2004) who found that management of language could introduce additional task and increase difficulty index in Chemistry multiple choice test items. In Cassel and Johnston model, students had 53% in test with complex words in key positions and 63% when the test items where simplified.

Effect of test items in long and complex words and those in simplified forms on Physics students' performance

Table 4.13 reveals that there is significant difference in the performance of testees in long and complex language and simplified language test items. This shows that the null hypothesis was rejected. Cassel and Johnston noted that many worded questions with co-bedded clauses presented greater problems of intellectual organization before answers could be attained while presenting the information in more simplified sentences also reduces internal intellectual organization necessary in order to answer the

questions. This shows that the finding is in accord with Cassel and Johnston's model (2004).

Effect of test items phrased in negative words and those phrased in positive words on Physics students' performance

Table 4.14 reveals that there is no significant difference in the performance of students tested with items phrased in negative words and phrase to those phrased in positive words. This shows that the null hypothesis was accepted. Cassel and Johnston said that the use of double negative words introduces addition thinking and thus increases difficulty index. The finding is not in accord with the model proposed by Cassel and Johnston as the testees tend to perform better in negatively phrased test items.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

In this chapter, the following sub – topics are discussed.

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

Summary of the Report

There is problem of poor performance of SSS students in Physics. This problem has remained inspite of efforts to improve on teaching methodology. Literature revealed that simplifying non-technical language of multiple choice test items in Physics and Biology improves the performance of students.

This study, however, shows that simplifying the language of Physics multiple choice test items used by WAEC at the SSCE does not significantly improve the performance of Physics students. The study specifically shows that reducing the length of non-technical phrases, using simple synonyms in key positions and replacing negatively phrased questions with positive form do not significantly improve the performance of students. It also shows that students

backgrounds such as gender, location and socio-economic status have no significant influence on the performance of students in language simplified non-technical words.

Conclusion

It is concluded from the finding of this study that simplifying the non-technical language of Physics multiple choice test items does not bring about significant improvement of students when compared with performance in similar test items posed in original non-technical language form.

It is further concluded that students background characteristics like location (urban-rural) gender (male-female) SES (high-low) do not significantly influence performance in the two test forms.

Recommendations

The following recommendations are made:

1. Given the findings from the study that simplifying the language of test items does not improve the performance of students, it is recommended that original non-technical language in Physics should be adhered to.

2. Public examination bodies should continue with original language in their test items because non-technical language in Physics does not significantly improve the performance of students.
3. Physics teachers should teach Physics concepts in its nature.

Suggestions for Further Research

The following suggestions are made for further research:

1. The study can be replicated by increasing the sample size. More rigorous experimental design can be applied to increase systematic variance.
2. The number of items (i.e test length) can be increased by including more items in parallel tests.

Contributions to Knowledge

The study has contributed to knowledge in the following ways:

1. The study revealed that simplifying the non-technical language of Physics multiple choice test items does not bring about improvement in the performance of senior secondary school students.

2. The effect of complexity of non-technical language of Physics multiple choice test items on performance of SSS students is not moderated by their gender, location and SES.

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APPENDIX 1

Grade	2001	2002	2003	2004	2005
Credit	33.97%	37.26%	26.66%	29.86%	18.85%
Passes	24.03%	34.85%	53.35%	20.05%	50.05%
Failures	51.10%	27.89%	19.99%	30.10%	31.10%
Total	100.00%	100.00%	100.00%	100.00%	100.00%

Source: WAEC, Office of the Senior Deputy Registrar, Head of Research Division

APPENDIX 2

Percentage performance of students in English, Biology and Physics from 2001 – 2005

Grade	**2001 %**	**2002 %**	**2003 %**	**2004 %**	**2005 %**
Credit Eng	26.09	29.57	29.03	29.03	25.65
Credit Bio	23.26	31.26	43.14	30.83	35.75
Credit Phy	33.97	37.26	26.66	29.85	18.85
Pass Eng	30.57	31.89	33.91	33.91	34.19
Pass Bio	29.18	29.88	26.96	32.28	29.86
Pass Phy	24.03	34.85	53.35	20.05	50.05
Fail Eng	41.13	40.18	32.91	35.12	53.48
Fail Bio	45.44	36.1	26.47	35.12	53.48
Fail Phy	50.10	27.89	19.99	30.10	31.10

APPENDIX 3.1

Table 1: Effect of changing from Negative to Positive

Original question	**% of correct response**	**Simplified question correct response %**	**% of correct response**
Which one of the following particles does not have the same number of electrons as calcium ion	24	Which of following particles has the same number of electrons as a calcium ion?	80
Which statement is not true?	60	Which statement is true?	80
a. Protons does not have the same mass as electron		The proton has the same mass as an electron	
b. The hydrogen molecules contains two atoms		The hydrogen molecules contains three atoms	
c. Isotopes of chlorine do not have different number of proton in their atoms		Isotopes of chlorine have different number of proton in their atoms	
d. The element with atomic number 13 is a non metal		The element with atomic number 13 is a metal	

APPENDIX 3.2

Table 2: Effect of changing keywords

Original question	**% of correct response**	**Simplified question correct response**	**% of correct response**
1. Which one of the following is pungent gas?	56	Which of the following is a choking gas?	63
2. Which one of the following requires a non-aqueous solvent to dissolve it?	34	Which one of the following requires a liquid other than water to dissolve it?	49

Source: Cassel and Johnston (1984) p. 613

APPENDIX 3.3

Table 3: Effect of Changing Terms of Quantity

Original question	**% of correct response**	**Simplified question Correct response %**	**% of correct response**
A brass contains 75% copper, 22% zinc, 2% aluminum, and 1% lead. Which is the least abundant element in this brass?	75	A brass contains 75% copper, 22% zinc, 2% aluminum, and 1% lead. Which is the most abundant element in this brass?	84

Source: Cassel & Johnston (1984) p. 614

APPENDIX 3.4

Table 4: Effect of rewording Long or Complex Question

Original question	**% of correct response**	**Simplified question correct response**	**% of correct response**
When a metal Z was added to the sulphate of a metal X, the metal X was precipitated and there was no effervescence. When the test was repeated using the metal T in place of Z no reaction occurred. Which one of the following is the correct order of decreasing activity (i.e the most reactive first) of the four metals?		Three metals Z, T and X were added to separate solution containing metal X ions. Z precipitate X; T had no effect and with Y as a gas was given off from the solution which one of the metal show the correct order of activity (the most reactive)	

Source: Cassel & Johnston (1984)

APPENDIX A

TEST FORM A

Name of School: ----------
L.G.A of School:----------
Sex of Student: ----------
Instruction: Answer the following questions. Circle the letter of the option that represents the correct answer.
Duration: 2 Hours

Item with negative phrase in W.A.SS.CE 2007

1. Which of the following statement about sound wave is not correct? Sound wave can be
   A) Reflected
   B) Refracted
   C) Diffracted
   D) Polarized

2. Which of the following operation does not represent an action of force field?
   A) Falling of a mango fruit from tree
   B) Picking of nail using bar magnet
   C) Repulsion of two like charges
   D) Pushing of wheel barrow on a level ground

3. Which of the following phenomena is not direct consequence of rectilinear propagation of light?
   A) Lunar and solar eclipse
   B) Diffraction of light
   C) Shadows of opaque objects

4. Which of the following observation is not an effect of surface tension?
   A) Droplets of water dripping slowly from a tap
   B) Mercury soiled on a clean glass plate forms small spherical droplets
   C) An insect walking across the surface of a pond
   D) Water flowing out more easily than engine oil from a container

Item with negative phrase in W.A.S.S.C.E 2008

5. Which of the following action will not increase the sensitivity of a moving coil galvanometer?
   A) Using a strocy temporary magnet
   B) Increasing the area and number of turns of the coil
   C) Using weak hair spring
   D) Using a light pointer

Item with negative phrase in W.A.S.S.C.E 2009

6. Which of the following waves is not transverse wave
   A) Light waves
   B) Sound waves
   C) Sea waves
   D) Radio waves

7. Light traveling through a small pinhole does not make a shadow with a district sharp edge because of
   A) Diffraction
   B) Interference
   C) Reflection
   D) Refraction

8. Which of the following is not part of the electro magnetic spectrum
   A) X – rays
   B) Microwaves
   C) Infrared radiation
   D) Alpha rays

9. A satellite in circular motion around the earth does not have?
   A) A gravitational force acting on it
   B) A uniform velocity
   C) An acceleration
   D) Centripetal force acting on it

Items with long and complex words in W.A.S.S.C.E 2007

10. A block of mass 4.0kg causes a spiral spring to extend by 0.16m from its outstretched position. The block is removed and another body mass 0.5kg is hung from the same spiral spring. If the spring is then stretched and relaxed, what is the angular frequency of the subsequent motion? [g = $10ms^{-2}$] (50 words)
   A) $10\sqrt{5}rads^{-5}$
   B) $5\sqrt{5}rads^{-1}$

C) $5rads^{-1}$

D) $\sqrt{5}rads^{-1}$

11. A rectangular glass of thickness d and absolute refractive index n is placed on a point object which is viewed vertically downward from above the prism. Which of the following expression correctly defenses the apparent upward displacement of the objects? (41 words)

A) $\frac{d}{n}$

B) dn

C) $\frac{d}{n-2}$

D) $\frac{d(n-1)}{n}$

12. A car of mass 800kg moves from rest on a horizontal track and travels 60m in 20s with uniform acceleration. Assuming there was no fractional force, calculate the acceleration force? (30 words)

A) 240.00N

B) 800.00N

C) 1600.00N

D) 2400.00N

Item with long and complex words in W.A.S.S.C.E 2008

13. A very sensitive spring balance was used to determine the weight of an object at the North Pole. When the same spring balance was used to measure the weight of the same object at the equator, it was found to have reduced. The explanation for this observation is that? (50 words)

A) It is very hot at the equator

B) The spring balance has expanded

C) The acceleration of freefall due to gravity varies with location

D) The mass of the body is reduced

14. An object of mass 2kg moving with a velocity of $3ms^{-1}$ collides head-on with another object of mass 11kg moving in the opposite direction with a velocity of $4ms^{-1}$. If the object sticks together after collision, calculate their common speed? (38 words).

A) 0.60 ms^{-1}

B) 0.67 ms^{-1}

C) 2.00 ms^{-1}

D) $3.33ms^{-1}$

15. A converging lens and a screen are placed 20cm and 8cm respectively from an object on a straight line so that a sharp image is formed on the screen. If the object is 3cm high, calculate the height of the image formed? (44 words).
    A) 1cm
    B) 9cm
    C) 12cm
    D) 15cm

Item with long and complex word W.A.S.S.C.E 2009

An isolated metal sphere of radius R, caring an electric charge Q, is situated in a medium of relative permittivity Σr. A test charge is placed at a point p, distance r from the surface of the sphere. Let Σo represent the permitting of free space.

16. The electric potential at p is given by the expression (10 words)
    A) $\frac{Q}{4\pi\Sigma r\Sigma r^2}$
    B) $\frac{Q}{4\pi\Sigma o\Sigma r(R+r)}$
    C) $\frac{Q}{4\pi\Sigma o\Sigma r(R-r)}$
    D) $\frac{Q}{4\pi\Sigma r\Sigma oR}$

17. The magnitude of the electric field intensity p, giving by the expression (12 words)
    A) $\frac{Q}{4\pi\Sigma r\Sigma oR}$
    B) $\frac{Q}{4\pi\Sigma o\Sigma r(R+r)^2}$
    C) $\frac{Q}{4\pi\Sigma o\Sigma r(R-r)^2}$
    D) $\frac{Q}{4\pi\Sigma o\Sigma rR^2}$

18. It takes 4 minutes to boil a quantity of water using an electric heating coil. How long will it take to boil the same quantity of water using the same heating coil if the current is doubled? (Neglect any external heat losses) (36 words).
    A) 8 minutes

B) 4 minutes
C) 2 minutes
D) 1 minute

19. A body of mass 5kg moving with a velocity of $30ms^{-1}$ due east is suddenly hit by another body and changes it's velocity to $50ms^{-1}$ in the same direction. Calculate the magnitude of impulse received? (36 words)
A) 100N
B) 150N
C) 250N
D) 400N

Items with complex words in key positions in W.A.S.S.C.E 2007

20. A body accelerates uniformly from rest at $2ms^{-2}$. Calculate the magnitude of its velocity after travelling 9m
A) $4.5ms^{-1}$
B) $6.0ms^{-1}$
C) $18.0ms^{-1}$
D) $36.0ms^{-1}$

21. A relative density bottle of volume $50cm^3$ is completely filled with a liquid at 30^0c. It is then heated to 203 such that 0.75^0 cm^3 of the liquid is expected. Calculate the apparent cubic expansivity of the liquid?
A) $0.00030k^{-1}$
B) $0.00032k^{-1}$
C) $0.01970k^{-1}$
D) $0.02030k^{-1}$

Items with complex words in key position in W.A.S.S.C.E 2009

22. A relative bottle of volume $50cm^3$ is completely filled with a liquid at 30^0c. It is then heated to 80^0c such that $0.75cm^3$ of the liquid is expelled. Calculate the apparent cubic expansivity of the liquid.
A) $0.00030k^{-1}$
B) $0.00032k^{-1}$
C) $0.01970k^{-1}$
D) $0.02030k^{-1}$

23. A body of volume $0.046m^s$ is immersed in a liquid of density $980kgm^{-3}$ with ¾ of its volume submerged. Calculate the up thrust on the body ($g = 10ms^2$)
A) 11.27N

B) 33.8N
C) 112.70N
D) 338.10N

24. If the direction of the current in a straight wire is reversed, the magnetic field ……?
A). Remain the same
B) Becomes parallel to the wire
C) Ceases to exist
D) Appositively directed

25. The isotopes of uranium are designated as 238U and 235U. The numbers 238 and 235 represent their……?
A) Atomic numbers
B) Nuclear numbers
C) Proton numbers
D) Neutron numbers

Items with long and complex words in W.A.S.S.C.E 2008

26. It takes a shorter time for a liquid to boil at the top of a mountain than at the base because at the top, the …… (26 words)
A) Temperature is higher
B) Pressure is lower
C) Humidity is higher
D) Temperature is constant

27. In the day time, it is possible to see under shady area such as under a tree, because a light have undergone …… (22 words).
A) Internal reflection
B) Refraction
C) Diffraction
D) Diffused reflection

28. A ball is dropped and it hits the floor at a point A. It rebounds upwards to a point B. While moving from A to B is …… (26 words)
A) Kinetic energy is increasing
B) Potential energy is increasing
C) Potential energy is decreasing
D) Kinetic energy remains constant

29. If the change on an object is measured as $4.0x10^{-18}c$, how many excess electrons do the object posses, given that the charge of an electron is $1\text{-}6x10^{-19}c$? (27 words)

A) 18
B) 19
C) 25
D) 37

30. A wire, 1.0m long and with cross-sectional area $2.0x10^{-7}m^2$ has resistance of 0.1Ω. Calculate the electrical conductivity of the wire. (22 words)
A) 2.0x107 $Ω^{-1}M^{-1}$
B) 5.0x107 $Ω^{-1}M^{-1}$
C) 2.0x108 $Ω^{-1}M^{-1}$
D) 5.0x108 $Ω^{-1}M^{-1}$

APPENDIX B
TEST FORM B

Name of School----------
L.G.A of School----------
Sex of Student----------
Instruction: Answer the following questions. Circle the letter of the option that represents the correct answer.
Duration: 2 Hours

Item with positive phrase

1. Which of the following statement about sound wave is correct? Sound wave can be ……
   A) Overtone
   B) Echo
   C) Diffracted
   D) Polarized

2. Which of the following operation represents an action of a force field?
   A) Motion of a car
   B) Action of eye to flowers
   C) Repulsion of two like charges
   D) Pushing of a wheel-barrow on a level ground

3. Which of the following phenomenon is a direct consequence of rectilinear propagation of light?
   A) Image on plane mirror
   B) Image in a convex mirror
   C) Diffraction of light
   D) Image of object in a pin hole camera

4. Which of the following observation is an effect of surface tension?
   A) An insect walking across the surface of a point
   B) Water flowing out more easily than engine oil from container
   C) A man swimming in a pool
   D) A fish swimming in a river

Items with positive phrase W.A.S.S.C.E 2009

5. Which of the following is transverse wave?
   A) Music waves
   B) Noise waves
   C) Radio waves

D) Longitudinal waves

6. Light travelling through a small pin hole makes a shadow with a distinct sharp edge because it is ……
   A) Differential
   B) Interference
   C) Polarization
   D) Transparent

7. Which of the following is a part of the electromagnetic spectrum?
   A) Alpha rays
   B) Microwaves
   C) Radioactive
   D) Electromagnetic wave

8. A satellite in circular motion around the earth have ……
   A) Centripetal force acting on it
   B) Gravitational force acting on it
   C) Retardation
   D) Uniform speed

Items with positive phrase 2008

9. Which of the following actions will increase sensitivity of moving coil galvanometer?
   A) Increasing area and number of turns of the coil
   B) Using strong temporary magnets
   C) Using strong spring
   D) Using a heavy pointer

Items with simplified words (2007)

10. A block of man 4kg made an extension of 0.16m in a spring. Another body of mass 0.mass 0.50kg hung in the same spring is released. What is the angular frequency of the subsequent motion? (g = $10m^5$) (36 words)
    A) $10\sqrt{5}rads^{-1}$
    B) $5\sqrt{2}rads^{-1}$
    C) $5rads^{-1}$
    D) $\sqrt{5}rads^{-1}$

11. The displacement of the rectangular glass prism whose refractive index n and thickness d is expressed as …… (16 words)

A) $\frac{d}{n}$

B) dn

C) $\frac{d}{n-2}$

D) $\frac{d(n-1)}{2}$

12. Calculate the accelerating force of a car with mass 80kg which moves from rest and travels 60m in 20s assuming frictional force is neglected. (25 words)
    A) 240.00N
    B) 800.00N
    C) 1600.00N
    D) 2400.00N

Items with simplified words (2008)

13. The same spring used to measure the weight of an object at the equator was also used to determine the weight at the north pole. What does the explanation of observation define? (31 words)
    A) It is very hot at the equator
    B) The spring balance has expanded
    C) The acceleration of freefall due to gravity varies with location
    D) The mass of the body is reduced

14. Calculate the common speed of two bodies moving in opposite direction with the first object of mass 2kg and velocity $3ms^{-1}$ and the other of mass 11kg.
    A) $0.60ms^{-1}$
    B) $0.67ms^{-1}$
    C) $2.00ms^{-1}$
    D) $3.33ms^{-1}$

15. Calculate the height of the image formed from a converging lens when placed 20cm and 8cm respectively from the object and is 3m high.
    A) 1cm
    B) 9cm
    C) 12cm
    D) 15cm

An isolated metal sphere of radius R, carrying an electric charge Q, is situated in a medium of relative permittivity Σr. A test charge is placed at a point p, distance r from the surface of the sphere. Let Σo represent the permitting of free space.

16. The magnitude of the electric field intensity at p is (10 words)

A) $\frac{Q}{4\pi\Sigma r\Sigma r^2}$

B) $\frac{Q}{4\pi\Sigma o\Sigma r(R+r)^2}$

C) $\frac{Q}{4\pi\Sigma o\Sigma r(R-r)^2}$

D) $\frac{Q}{4\pi\Sigma r\Sigma oR^2}$

17. Electric potential at p is (4 words)

A) $\frac{Q}{4\pi\Sigma 0\Sigma r\, r^2}$

B) $\frac{Q}{4\pi\Sigma o\Sigma r(R+r)^2}$

C) $\frac{Q}{4\pi\Sigma o\Sigma r(R-r)^2}$

D) $\frac{Q}{4\pi\Sigma 0\,\Sigma r\, R}$

18. It takes 4 minutes to boil a quantity of water using an electric heating coil. How long will it take to boil the same quantity if the current is doubled? (30 words).

A) 8 minutes
B) 4 minutes
C) 2 minutes
D) 1 minute

19. A body of mass 5kg moving with a velocity of 30ms^{-1} changes it's velocity to 50ms^{-1} when suddenly hit and moves in the same direction. Calculate the magnitude of impulse received? (31 words)

A) 100N
B) 150N
C) 250N
D) 400N

Items with simplified words in key position

20. A body moves from rest at $2ms^{-2}$. Calculate the magnitude of its velocity after travelling 9m
    A) $4.5ms^{-1}$
    B) $6.0ms^{-1}$
    C) $18.0ms^{-1}$
    D) $36.0ms^{-1}$
21. Which of the following surface will release heat energy best?
    A) Red surface
    B) White surface
    C) Black surface
    D) Yellow surface

Items with complex words in key position in W.A.S.S.C.E 2009

22. A relative density bottle of volume $50cm^3$ is completely filled with a liquid at 30^0c. It is then heated to 80^0c such that $0.75cm^3$ of the liquid is given up. Calculate the apparent cubic expansivity of the liquid.
    A) $0.00030k^{-1}$
    B) $0.00032k^{-1}$
    C) $0.01970k^{-1}$
    D) $0.02030k^{-1}$

23. A body of volume $0.046m^s$ is dipped in a liquid of density $980kgm^{-3}$ with ¾ of its volume displaced. Calculate the up thrust on the body ($g = 10ms^2$)
    A) 11.27N
    B) 33.81N
    C) 112.70N
    D) 338.10N

24. If the direction of the current in a straight wire is turned around, the magnetic field ……?
    A). Remains the same
    B) Becomes parallel to the wire
    C) Ceases to exist
    D) Oppositely directed

25. The isotopes of uranium are designated as ^{238}U and ^{235}U. The numbers 238 and 235 represent their……?
    A) Atomic numbers
    B) Nuclear numbers
    C) Protons numbers
    D) Neutron numbers

Items with simplified word

26. Liquid boils faster at the top of a mountain than at the base because at the top, the …… (18 words)
    A) Temperature is higher
    B) Pressure is lower
    C) Humidity is higher
    D) Temperature is constant

27. It is possible to see under shady areas during the day because a light has undergone …… (16 words).
    A) Internal reflection
    B) Refraction
    C) Diffraction
    D) Diffused reflection

28. A ball is dropped at a point A. It rebounds upwards to a point B. Movement from A to B is …… (21 words)
    A) Kinetic energy is increasing
    B) Potential energy is increasing
    C) Potential energy is decreasing
    D) Kinetic energy remains constant

29. The charge of an electron is $1{,}6x10^{-19}c$, how many electrons does the object posses if measured as $4.0x10^{-18}c$. (18 words)
    A) 18
    B) 19
    C) 25
    D) 37

30. Calculate the electric conductivity of wire 1.0m long, cross-sectional area $2.0x10^{-7}m^2$ with resistance of $0.1N^2$. (16 words)
    A) $2.0x107\ \Omega^{-1}M^{-1}$
    B) $5.0x107\ \Omega^{-1}M^{-1}$
    C) $2.0x108\ \Omega^{-1}M^{-1}$
    D) $5.0x108\ \Omega^{-1}M^{-1}$

ANSWERS ON TEST FORMS

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

NAMES OF LOCAL GOVERNMENTS IN DELTA NORTH SENATORIAL DISTRICT DIVIDED INTO URBAN AND RURAL

Urban Areas	**Rural Areas**
Ndokwa West	Ndokwa East
Ika South	Ika North – East
Oshimili North	Oshimili South
	Aniocha North
	Aniocha South

NAMES OF SECONDARY SCHOOLS IN ANIOCHA NORTH LOCAL GOVERNMENT AREA OF DELTA STATE THAT REGISTERED FOR SENIOR SCHOOL CERTIFICATE EXAMINATION

Rural School	**No. of Student Offering Physics**
Boys Model Secondary School, Onicha Olona	11
Martin's College, Issele – Uku	23
Issele – Azagba Mixed Secondary School, Issele – Azagba	17
Odiani Mixed Secondary School, Okunzu	2
Comprehensive Secondary School, Onicha – Uku	2
Martin de Poress Senior Secondary School, Onicha – Olona	10
Onicha – Ugbo Girls School, Onicha – Ugbo	4
Pilgrim Baptist Secondary School, Issele – Uku	30
Comprehensive Senior Secondary School, Idumuje – Ugboko	2
Technical College, Issele – Uku	10
Okalete Mixed Secondary School, Issele – Mkpitime	5
Olona Boys Secondary School, Onicha – olona	5
St. Pius X Grammar School, Onicha – Ugbo	5

NAMES OF SECONDARY SCHOOLS IN OSHIMILI NORTH LOCAL GOVERNMENT AREA OF DELTA STATE THAT REGISTERED STUDENTS IN PHYSICS FOR SENIOR SCHOOL CERTIFICATE EXAMINATION

Urban Schools	**No. of Student Offering Physics**
St. Patrick's College, Asaba	25
Anglican Girls Grammar School (A.G.G.S), Asaba	58
Westend Mixed Secondary School, Asaba	13
St. Brigids College, Asaba	25
Asagba Mixed Secondary School, Asaba	12
New Era College, Asaba	10
Niger Secondary School, Asaba	13
Osadenis Secondary School, Asaba	4

TEST BLUE PRINT FOR 30 TEST ITEMS ON PHYSICS MULTIPLE CHOICE TEST ITEMS

Content	**Know-ledge 30%**	**Compre-hension 30%**	**Appli-cation 20%**	**Analy-sis 10%**	**Synthe-sis 5%**	**Evalua-tion 5%**	**Total 100%**
Physical quantities 30%	3	3	1	1	-	1	9
Motion 10%	1	1	1	-	-	-	3
Work, Energy & Power 10%	1	1	1	-	-	-	3
Projectile 20%	2	2	-	1	1	-	6
Energy Ionization 10%	1	1	1	-	-	-	3
Machine 20%	1	1	2	1	1	-	6
	9	9	6	3	2	1	30

APPENDIX 4.1

TEST FORM A

X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2
13	169	10	100	14	196	14	196	14	196	14	196	14	196	14	196
12	144	11	121	13	169	13	169	13	169	13	169	13	169	10	100
13	169	13	169	15	225	13	169	10	100	12	144	12	144	12	144
14	196	12	144	12	144	14	196	14	196	10	100	14	196	15	225
11	121	10	100	13	169	10	100	13	169	11	121	12	144	13	169
10	100	12	144	15	225	13	169	15	225	12	144	14	196	14	196
12	144	11	121	10	100	10	100	13	169	15	225	13	169	10	100
14	196	14	196	11	121	13	169	12	144	13	169	11	121	11	121
13	169	15	225	13	169	14	196	12	144	11	121	10	100	15	225
11	121	10	100	14	196	10	100	15	225	10	100	15	225	13	169
15	225	13	169	13	169	15	225	10	100	12	144	13	169	14	196
14	196	14	196	10	100	10	100	11	121	14	196	14	196	13	169
10	100	13	169	11	121	11	121	10	100	13	169	12	144	15	225
11	121	12	144	13	169	14	196	13	169	12	144	10	100	14	196
13	169	11	121	12	144	13	169	12	144	14	196	11	121	13	169
12	144	10	100	15	225	10	100	14	196	11	121	10	100	12	144
15	225	11	121	14	196	11	121	13	169	15	225	15	225	10	100
13	169	14	196	11	121	12	144	15	225	10	100	12	144	11	121
14	196	13	169	12	144	14	196	13	169	13	169	13	169	12	144
12	144	12	144	11	121	15	225	12	144	11	121	15	225	13	169
10	100	15	225	10	100	10	100	10	100	10	100	11	121	15	225
13	169	10	100	13	169	13	169	11	121	11	121	10	100	14	196
12	144	10	100	12	144	12	144	14	196	14	196	13	169	10	100
14	196	13	169	14	196	14	196	12	144	13	169	11	121	11	121
12	144	12	144	13	169	10	100	13	169	10	100	12	144	11	121
14	196	11	121	12	144	10	100	13	169	10	100	15	225	11	121
13	169	11	121	10	100	10	100	11	121	11	121	15	225	13	169
10	100	15	225	13	169	13	169	15	225	12	144	13	169	15	225
14	196	13	169	11	121	11	121	13	169	14	196	12	144	10	100
15	225	11	121	12	144	15	225	10	100	15	225	11	121	13	169
14	196	15	225	12	144	10	100	12	144	11	121	13	196	11	121
14	196														

$$\text{Mean} = \frac{\Sigma X}{N}$$

$$\overline{X} = \frac{3103}{250}$$

$$\overline{X} = 12.412$$

$$S^2 = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n - 1}$$

$$S^2 = \frac{39081 - \frac{(3103)^2}{250}}{250 - 1}$$

$$S^2 = \frac{39081 - 38514.436}{249}$$

$$S^2 = \frac{566.564}{249}$$

$$S^2 = 2.2754$$

$$S = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n - 1}$$

$$S = 2.2754$$

$$S = 1.5084$$

X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2
13	169	12	144	14	196	11	121	11	121	10	100	13	169	14	196	12	144
12	144	14	196	13	169	13	169	14	196	11	121	11	121	13	169	13	169
10	100	15	225	12	144	15	225	15	225	12	144	10	100	15	225	12	144
11	121	14	196	10	100	13	169	11	121	14	196	12	144	14	196	10	100
12	144	13	169	11	121	14	196	12	144	12	144	14	196	13	169	11	121
13	169	10	100	13	169	13	169	14	196	10	100	10	100	11	121	14	196
14	196	11	121	14	196	12	144	13	169	13	169	11	121	10	100	15	225
15	225	12	144	10	100	10	100	10	100	15	225	13	169	14	196	13	169
13	169	10	100	12	144	11	121	12	144	14	196	12	144	12	144	12	144
12	144	13	169	11	121	13	169	11	121	13	169	11	121	12	144		
10	100	14	196	13	169	14	196	10	100	12	144	11	121	14	196		
11	121	13	169	14	196	10	100	13	169	10	100	13	169	10	100		
13	169	15	225	15	225	12	144	14	196	11	121	14	196	11	121		
15	225	14	196	10	100	13	169	10	100	13	169	12	144	12	144		
14	196	10	100	11	121	12	144	11	121	14	196	15	225	10	100		
13	169	13	169	14	196	14	196	13	169	15	225	14	196	13	169		
14	196	12	144	13	169	13	169	12	144	11	121	13	169	12	144		
13	169	11	121	12	144	15	225	14	196	12	144	12	144	14	196		
11	121	10	100	10	100	14	196	15	225	13	169	12	144	12	144		
10	100	15	225	11	121	13	169	10	100	14	196	11	121	11	121		
11	121	13	169	12	144	15	225	11	121	13	169	13	169	10	100		
13	169	14	169	14	196	14	196	12	144	14	196	12	144	11	121		
12	144	12	144	13	169	10	100	12	144	12	144	10	100	14	196		
15	225	11	121	14	196	11	121	14	196	11	121	11	121	13	169		
10	100	13	169	15	225	13	169	13	169	10	100	14	196	14	196		
11	121	14	196	12	144	12	144	12	144	12	144	13	169	12	144		
14	196	12	144	10	100	14	196	11	121	10	100	12	144	15	225		
13	169	11	121	13	169	13	169	14	196	12	144	10	100	13	169		
12	144	10	100	12	144	14	196	15	225	11	121	13	169	14	196		
13	169	11	121	10	100	10	100	13	169	14	196	12	144	10	100		

$$\text{Mean} = \frac{\Sigma X}{N}$$

$$\overline{X} = \frac{3100}{250}$$

$$\overline{X} = 12.4$$

$$S^2 = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n - 1}$$

$$S^2 = \frac{38845 - \frac{(3100)^2}{250}}{250 - 1}$$

$$S^2 = \frac{38845 - 38440}{249}$$

$$S^2 = \frac{405}{249}$$

$$S^2 = 1.6265$$

$$S = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n - 1}$$

$$S = 1.6265$$

$$S = 1.2753$$

Computing t – test for finding the mean difference performance of original test form to simplified language test.

$$t = \frac{X_1 - X_2}{\sqrt{\frac{S_1^2}{n} + \frac{S_2^2}{n}}}$$

$$t = \frac{12.412 - 12.4}{\sqrt{\frac{1.5084^2}{250} + \frac{1.2753^2}{250}}}$$

$$t = \frac{12.412 - 12.4}{\sqrt{0.0091 + 0.0065}}$$

$$t = \frac{0.012}{0.1249}$$

$$t = 0.0961$$

Degree of freedom (df)

$$df = n_1 + n_2 - 2$$
$$= 250 + 250 - 2$$
$$= 500 - 2$$

= 488

Since there is no df = 488, the researcher choose the df = ∞ which is 1.645.

APPENDIX 4.2

Pilgrim Baptist Grammar School, Issele – Uku

Boys Model Secondary School, Onicha – Olona

St. Pius X Grammar School, Onicha – Ugbo

St. Patrick's College, Asaba.

Mean Distribution for male physics students in simplified language form

X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2
13	169	14	196	13	169	10	100	13	169	15	225	13	169
10	100	10	100	10	100	13	169	10	100	10	100	10	100
11	121	12	144	15	225	10	100	11	121	13	169	14	196
13	169	14	196	14	196	11	121	13	169	12	144	12	144
12	144	13	169	13	169	12	144	10	100	10	100	13	169
14	196	12	144	12	144	13	169	13	169	12	144	10	100
15	225	15	225	11	121	12	144	12	144	13	169	14	196
13	169	10	100	13	169	10	100	10	100	13	169	10	100
10	100	13	169	10	100	13	169	13	169	10	100	12	144
10	100	12	144	12	144	14	196	12	144	10	100	12	144
14	196	10	100	10	100	14	196	14	196	12	144	12	144
11	121	12	144	11	121	15	225	14	196	13	169	13	169
11	121	12	144	13	196	13	196	11	121	10	100	12	144
14	196	10	100	10	100	10	100	12	144	10	100	13	169
12	144	11	121	12	144	10	100	14	196	12	144	12	144
11	121	11	121	11	121	13	169	15	225				

Mean = $\frac{\Sigma X}{n}$

= $\frac{1322}{}$

110

= 12.0182

$$S^2 = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n-1}$$

$$= \frac{15927 - \frac{(1322)^2}{110}}{110-1}$$

$$= \frac{15927 - 15888}{109}$$

= 0.3578

$S = \sqrt{0.3578}$

= 0.5982

Distribution for Female physics students with simplified test forms are as follows:

Martins College, Issele – Uku
Onicha – Ugbo Girls Grammar School, Onicha – Ugbo
Anglican Girls Grammar School, Asaba
St. Brigids College, Asaba
Martin de Poress Secondary School, Onicha – Olona.

X	**X^2**	**X**	**X^2**	**X**	**X^2**	**X**	**X^2**	**X**	**X^2**	**X**	**X^2**	**X**	**X^2**
13	169	13	169	10	100	12	144	10	100	14	196	13	169
10	100	10	100	14	196	10	100	11	121	10	100	10	100
12	144	11	121	13	169	11	121	12	144	12	144	11	121
14	196	12	144	10	100	13	169	10	100	13	169	12	144
13	169	12	144	11	121	15	225	13	169	10	100	14	196
15	225	10	100	11	121	14	196	14	196	11	121	13	169
14	196	15	225	11	121	10	100	13	169	13	169	15	225
10	100	15	225	13	169	13	169	14	196	14	196	13	169
12	144	14	196	14	196	11	121	13	169	15	225	12	144
11	121	13	169	13	169	12	144	15	225	14	196	10	100
10	100	12	144	12	144	14	196	14	196	13	169	13	169

11	121	10	100	11	121	15	225	13	169	12	144	11	121
13	169	11	121	10	100	13	169	12	144	10	100	10	100
15	225	13	169	15	225	12	144	10	100	13	169	13	169
10	100	12	144	12	144	11	121	13	169	12	144	12	144
14	196	10	100	14	196	13	169	12	144	10	100	11	121
13	169	15	225	10	100	10	100	14	196	11	121	14	196
12	144	10	100	13	169	12	144	13	169	15	225	13	169
14	196	14	196	12	144	11	121	15	225	14	196	12	144
13	169	10	100	12	144	14	196	13	169	10	100	15	225

$$\text{Mean} = \frac{\Sigma X}{n}$$

$$= \frac{1725}{140}$$

$$= 12.3214$$

$$S^2 = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n-1}$$

$$= \frac{24651 - \frac{(1725)^2}{140}}{140 - 1}$$

$$= \frac{24651 - 21254.5}{139}$$

$$= \frac{3396.5}{139}$$

$$= 24.4353$$

$$S = \sqrt{24.4353} \quad S = 4.9432$$

$$t = \frac{X_1 - X_2}{\sqrt{\frac{S_1^2}{n} + \frac{S_2^2}{n}}}$$

$$= \frac{12.3214 - 12.0182}{\sqrt{\frac{(0.5982)^2}{110} + \frac{(4.9432)^2}{140}}}$$

$$= \frac{0.3032}{\sqrt{0.0033 + 0.1745}}$$

$$= \frac{0.3032}{\sqrt{0.1778}}$$

$t = 0.4216$

APPENDIX 4.3

Name of schools tabulated into high and low socio-economic status

High Socio-Economic Status	**Low Socio-Economic Status**
St. Patrick's College, Asaba	Comprehensive Sec. School, Onicha Uku
Anglican Girls Grammar School, Asaba	Comprehensive Sec. School, Idumuje Ugboko
Westend Mixed Secondary School, Asaba	Odani Mixed Secondary School, Okwuzu
St. Brigids Secondary School, Asaba	Onicha – Ugbo Girls Secondary School, Onicha – Ugbo
Azagba Mixed Sec. School, Asaba	St. Pius X Grammar School, Onicha – Ugbo

Students from low socio-economic status

X	**X^2**	**X**	**X^2**	**X**	**X^2**	**X**	**X^2**	**X**	**X^2**	**X**	**X^2**	**X**	**X^2**
13	169	11	121	14	196	13	169	13	169	14	196	10	100
10	100	14	196	10	100	15	225	15	225	15	225	12	144
12	144	13	169	12	144	12	144	14	196	14	196	11	121
14	196	12	144	14	196	14	196	10	100	13	169	15	225
13	169	10	100	13	169	15	225	13	169	12	144	12	144
15	225	13	169	12	144	13	169	12	144	10	100	13	169

14	196	14	196	10	100	12	144	10	100	11	121	14	196
13	169	13	169	13	169	10	100	11	121	13	169	11	121
13	169	10	100	12	144	14	196	13	169	14	196	15	225
15	225	11	121	10	100	13	169	12	144	12	144	14	196
15	225	15	225	14	196	11	121	14	196	13	169	12	144
12	144	13	169	12	144	15	225	13	169	13	169	13	169
10	100	10	100	11	121	13	169	10	100	15	225	15	225
13	169	12	144	13	169	11	121	12	144	14	196	12	144
14	196	14	196	12	144	14	196	14	196	12	144	14	196
11	121	12	144	13	169	15	225	13	169	10	100	15	225

$$\text{Mean} = \frac{\Sigma X}{n}$$

$$= \frac{1421}{112}$$

$$= 12.6875$$

$$S^2 = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n-1}$$

$$= \frac{18297 - \frac{(1421)^2}{112}}{112-1}$$

$$= \frac{18297 - 18028.9}{111}$$

$$S^2 = 2.4153$$

$$S = \sqrt{2.4153}$$

$$= 1.5541$$

Distribution for students with high socio-economic status

X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2
13	169	10	100	13	169	14	196	13	169	14	196	12	144
14	196	13	169	10	100	12	144	10	100	10	100	15	225
12	144	12	144	12	144	10	100	11	121	13	169	13	169
10	100	14	196	11	121	11	121	13	169	12	144	10	100
11	121	11	121	15	225	13	169	12	144	14	196	12	144
15	225	13	169	13	169	12	144	15	225	13	169	10	100
13	169	14	196	14	196	13	169	11	121	10	100	11	121
14	196	12	144	11	121	15	225	13	169	12	144	13	169
12	144	11	121	15	225	13	169	10	100	11	121	15	225
13	169	10	100	13	169	12	144	14	196	10	100	14	196
15	225	13	169	10	100	10	100	13	169	14	196	14	196
10	100	12	144	11	121	11	121	13	169	13	169	13	169
14	196	10	100	13	169	13	169	12	144	10	100	10	100
13	169	11	121	12	144	14	196	13	169	10	100	14	196
11	121	13	169	10	100	13	169	13	169	12	144	11	121
12	144	14	196	11	121	12	144	14	196	11	121	12	144
13	169	15	225	14	196	13	169	12	144	10	100	15	225
14	196	12	144	13	169	12	144	14	196	13	169	11	121
15	225	13	169	12	144	13	169	14	196	13	169	10	100
12	144	11	121	14	196	10	100	15	225				

$$\text{Mean} = \frac{\Sigma X}{n}$$

$$= \frac{1707}{138}$$

$$= 12.3695$$

$$S^2 = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n-1}$$

$$= \frac{21295 - \frac{(1707)^2}{138}}{}$$

$$138 - 1$$

$$= \frac{21295 - 21114.8}{137}$$

$$S^2 = 1.3153$$

$$S = \sqrt{1.3153}$$

$$= 1.1469$$

$$t = \frac{X_1 - X_2}{\sqrt{\frac{S_1^2}{n} + \frac{S_2^2}{n}}}$$

$$= \frac{12.6875 - 12.3695}{\sqrt{\frac{(1.5541)^2}{112} + \frac{(1.1469)^2}{138}}}$$

$$= \frac{0.318}{\sqrt{0.0216 + 0.0095}}$$

$$= \frac{0.318}{0.1763}$$

$$t = 18.03$$

APPENDIX 4.4

Name of schools tabulated into urban and rural areas

Urban	Rural
St. Patrick's College, Asaba	Comprehensive Sec. School, Onicha Uku
Anglican Girls Grammar School, Asaba	Comprehensive Sec. School, Idumuje Ugboko
Westend Mixed Secondary School, Asaba	Odani Mixed Secondary School, Ukwuzu
St. Brigids Secondary School, Asaba	Onicha – Ugbo Girls Secondary School, Onicha – Ugbo
Azagba Mixed Sec. School, Asaba	St. Pius X Grammar School, Onicha – Ugbo

Students from urban area

X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2
13	169	14	196	13	169	15	225	14	196	13	169	10	100
12	144	13	169	12	144	13	169	12	144	10	100	13	169
10	100	10	100	10	100	10	100	10	100	12	144	12	144
13	169	11	121	11	121	14	196	13	169	10	100	10	100
10	100	13	169	13	169	14	196	12	144	13	169	13	169
14	196	12	144	11	121	11	121	15	225	11	121	12	144
15	225	10	100	14	196	10	100	14	196	15	225	11	121
13	169	11	121	13	169	10	100	13	169	14	196	11	121
14	196	13	169	12	144	13	169	12	144	14	196	14	196
12	144	14	196	14	196	10	100	13	169	13	169	13	169
11	121	15	225	12	144	11	121	14	196	10	100	14	196
13	169	14	196	11	121	13	169	12	144	13	169	13	169
14	196	12	144	10	100	12	144	10	100	12	144	12	144
12	144	11	121	13	169	13	169	11	121	11	121	11	121
14	196	12	144	12	144	12	144	11	121	13	169	10	100
13	169	11	121	10	100	13	169	13	169	12	144	13	169
12	144	14	196	13	169	13	169	12	144	13	169	12	144

14	196	13	169	14	196	10	100	14	196	13	169	12	144

$$\text{Mean} = \frac{\Sigma X}{n}$$

$$= \frac{1545}{126}$$

$$= 12.2619$$

$$S^2 = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n-1}$$

$$= \frac{19596 - \frac{(1545)^2}{126}}{126-1}$$

$$= \frac{19596 - 18944.6}{125}$$

$$= \frac{651.4}{125}$$

$$= 5.2112$$

$$S = \sqrt{52112}$$

$$= 2.2828$$

Test Items for Rural Location

X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2
12	144	13	169	12	144	15	225	13	169	13	169	14	196	10	100
10	100	12	144	10	100	13	169	12	144	11	121	13	169	14	196
13	169	10	100	13	169	12	144	10	100	10	100	10	100	13	169
12	144	11	121	14	196	10	100	13	169	13	169	12	144	10	100
13	169	12	144	13	169	12	144	14	196	14	196	11	121	11	121
14	196	10	100	15	225	14	196	15	225	13	169	13	169	12	144
10	100	11	121	10	100	13	169	13	169	15	225	11	121	14	196
13	169	12	144	11	121	10	100	10	100	13	169	15	225	13	169
14	196	10	100	12	144	13	169	11	121	12	144	10	100	15	225
15	225	11	121	11	121	14	196	12	144	10	100	12	144	13	169
13	169	13	169	10	100	12	144	11	121	11	121	12	144	12	144
12	144	12	144	10	100	13	169	13	169	13	169	13	169	10	100
11	121	10	100	11	121	12	144	11	121	12	144	14	196	10	100
11	121	11	121	13	169	14	196	12	144	11	121	12	144	11	121
13	169	10	100	12	144	15	225	13	169	14	196	10	100	15	225
12	144	13	169	14	196	11	121								

$$\text{Mean} = \frac{\Sigma X}{n}$$

$$= \frac{1494}{124}$$

$$= 12.0484$$

$$S^2 = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n-1}$$

$$= \frac{18602 - \frac{(1494)^2}{124}}{124-1}$$

$$= \frac{18602 - 18000.3}{123}$$

$$= \frac{601.7}{123}$$

$S^2 = 4.8919$

$S = \sqrt{4.8919}$

$= 2.2118$

$$t = \frac{X_1 - X_2}{\sqrt{\frac{S_1^2}{n} + \frac{S_2^2}{n}}}$$

$$= \frac{12.2619 - 12.0484}{\sqrt{\frac{(2.2118)^2}{124} + \frac{(2.2828)^2}{126}}}$$

$$= \frac{0.2135}{\sqrt{0.0394 + 0.0414}}$$

$$= \frac{0.2135}{0.2843}$$

$t = 0.7509$

APPENDIX 4.5

Items in key position in original language

X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2
3	9	3	9	4	16	3	9	4	16	2	4	5	25	3	9	5	25	3	9	3	9	5	25
4	16	4	16	4	16	2	4	3	9	4	16	2	4	2	4	4	16	5	25	4	16	3	9
3	9	4	16	3	9	4	16	3	9	3	9	4	16	3	9	4	16	3	9	4	16	2	4
2	4	3	9	2	4	3	9	3	9	4	16	4	16	4	16	4	16	3	9	5	25	3	9
3	9	2	4	3	9	2	4	2	4	3	9	4	16	3	9	3	9	4	16	4	16	2	4
3	9	5	25	4	16	2	4	3	9	3	9	2	4	3	9	2	4	4	16	3	9	3	9
4	16	3	9	4	16	4	16	4	16	4	16	3	9	2	4	4	16	3	9	3	9	4	16
4	16	2	4	5	25	3	9	3	9	4	16	4	16	3	9	3	9	2	4	5	25	3	9
4	16	3	9	2	4	2	4	4	16	6	36	3	9	2	4	4	16	3	9	3	9	2	4
3	9	4	16	2	4	2	4	4	16	3	9	2	4	4	16	5	25	4	16	4	16	4	16
2	4	3	9	4	16	4	16	3	9	2	4	4	16	3	9	4	16	3	9	4	16	2	4
3	9	4	16	4	16	3	9	4	16	3	9	3	9	4	16	4	16	2	4	3	9	2	4
4	16	4	16	3	9	3	9	3	9	3	9	4	16	3	9	3	9	3	9	5	25	3	9
3	9	3	9	2	4	4	16	2	4	4	16	5	25	3	9	3	9	4	16	3	9	4	16
5	25	3	9	2	4	4	16	5	25	4	16	4	16	2	4	4	16	4	16	2	4	3	9
3	9	4	16	2	4	3	9	5	25	3	9	4	16	5	25	3	9	3	9	2	4	4	16
4	16	5	25	4	16	5	25	3	9	2	4	3	9	3	9	3	9	3	9	3	9	4	16
4	16	3	9	2	4	2	4	3	9	2	4	2	4	2	4	2	4	2	4	3	9	3	9
3	9	4	16	3	9	4	16	4	16	4	16	3	9	2	4	2	4	2	4	3	9	5	25
4	16	3	9	3	9	4	16	3	9	3	9	2	4	2	4	3	9	2	4				

$$\text{Mean } X = \frac{948}{250}$$

$$= 3.792$$

$$S^2 = \frac{\Sigma X^2 - \Sigma(X)^2}{n}$$
$$\frac{}{n-1}$$

$$= \frac{3801 - \frac{(948)^2}{250}}{250 - 1}$$

$$S^2 = \frac{3801 - 3594.8}{249}$$

$S^2 = 0.8281$

$S = \sqrt{0.8281}$

$S = 0.9100$

Items in key position in simplified language.

X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2
3	9	5	25	3	9	3	9	3	9	4	16	3	9	4	16	3	9	4	16	3	9	3	9
2	4	4	16	4	16	6	36	6	36	3	9	5	25	3	9	4	16	3	9	3	9	5	25
6	36	3	9	3	9	3	9	3	9	4	16	3	9	4	16	5	25	4	16	4	16	4	16
2	4	2	4	5	25	4	16	4	16	3	9	4	16	5	25	5	25	5	25	2	4	3	9
4	16	5	25	4	16	4	16	3	9	3	9	4	16	3	9	2	4	4	16	2	4	3	9
3	9	4	16	6	36	3	9	3	9	3	9	2	4	6	36	6	36	3	9	5	25	4	16
4	16	2	4	2	4	3	9	5	25	4	16	4	16	2	4	6	36	4	16	6	36	4	16
3	9	3	9	3	9	2	4	4	16	4	16	3	9	5	25	6	36	5	25	3	9	3	9
5	25	3	9	4	16	3	9	4	16	4	16	2	4	3	9	3	9	4	16	4	16	2	4
3	9	2	4	4	16	2	4	5	25	3	9	5	25	2	4	4	16	3	9	2	4	6	36
3	9	4	16	3	9	2	4	3	9	5	25	3	9	4	16	3	9	2	4	4	16	3	9
4	16	3	9	2	4	3	9	2	4	3	9	6	36	3	9	2	4	4	16	3	9	5	25
5	25	2	4	3	9	4	16	3	9	5	25	3	9	2	4	3	9	5	25	4	16	4	16
2	4	2	4	3	9	5	25	4	16	4	16	6	36	2	4	4	16	3	9	3	9	3	9
3	9	3	9	3	9	5	25	5	25	4	16	4	16	4	16	4	16	4	16	2	4	4	16
4	16	3	9	3	9	4	16	5	25	3	9	3	9	3	9	4	16	5	25	6	36	5	25
4	16	5	25	2	4	3	9	3	9	2	4	3	9	4	16	5	25	3	9	6	36	4	16
3	9	2	4	4	16	5	25	6	36	3	9	4	16	5	25	3	9	4	16	2	4	3	9
4	16	3	9	2	4	5	25	6	36	4	16	3	9	4	16	3	9	3	9	2	4	6	36
3	9	6	36	5	25	3	9	2	4	2	4	6	36	2	4	3	9	6	36	3	9	6	36
3	9	3	9	3	9	3	9	3	9	4	16	5	25	2	4								

Mean X = $\frac{904}{250}$

= 3.616

$S^2 = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n-1}$

$= 3628 - \frac{(904)^2}{}$

$$\frac{250}{250-1}$$

$$= \frac{3628 - 3268.8}{249}$$

$$S^2 = 1.4426$$

$$S = \sqrt{1.4426} = 1.2010$$

$$t = \sqrt{\frac{X_1 - X_2}{\frac{S_1^2}{n} + \frac{S_2^2}{n}}}$$

$$= \sqrt{\frac{3.792 - 3.616}{\frac{(1.2010)^2}{250} + \frac{(0.9100)^2}{250}}}$$

$$= \frac{0.176}{\sqrt{0.058 + 0.033}}$$

$$= \frac{0.176}{0.0955}$$

$$t = 1.8429$$

APPENDIX 4.6

Test Items with Long and Complex Variables in Original Form

X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2
3	9	4	16	3	9	3	9	2	4	2	4	3	9	3	9	2	4	3	9	2	4	3	9
2	4	2	4	2	4	4	16	5	25	4	16	4	16	4	16	4	16	4	16	4	16	2	4
3	9	3	9	3	9	2	4	3	9	3	9	3	9	2	4	3	9	2	4	3	9	3	9
2	4	4	16	4	16	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	4	16
3	9	2	4	3	9	4	16	3	9	3	9	4	16	4	16	4	16	4	16	3	9	2	4
4	16	3	9	2	4	3	9	4	16	2	4	3	9	3	9	3	9	3	9	2	4	3	9
3	9	3	9	4	16	5	25	3	9	2	4	2	4	3	9	3	9	4	16	4	16	3	9
4	16	4	16	3	9	5	25	5	25	2	4	3	9	3	9	4	16	3	9	2	4	3	9
5	25	3	9	4	16	4	16	2	4	3	9	3	9	2	4	3	9	2	4	3	9	2	4
2	4	3	9	5	25	3	9	3	9	2	4	4	16	3	9	4	16	4	16	2	4	4	16
3	9	2	4	3	9	4	16	2	4	3	9	2	4	4	16	4	16	3	9	3	9	3	9
2	4	2	4	2	4	3	9	4	16	2	4	4	16	3	9	2	4	4	16	2	4	2	4
4	16	3	9	4	16	3	9	4	16	4	16	3	9	4	16	3	9	3	9	4	16	2	4
2	4	4	16	3	9	2	4	3	9	2	4	2	4	4	16	2	4	4	16	3	9	4	16
4	16	5	25	3	9	2	4	2	4	4	16	4	16	3	9	4	16	3	9	2	4	3	9
3	9	4	16	4	16	3	9	3	9	3	9	3	9	3	9	3	9	3	9	2	4	2	4
3	9	3	9	2	4	4	16	3	9	2	4	3	9	2	4	5	25	2	4	4	16	4	16
2	4	3	9	4	16	2	4	4	16	3	9	4	16	3	9	2	4	2	4	2	4	3	9
2	4	2	4	3	9	3	9	4	16	4	16	3	9	2	4	3	9	3	9	2	4	4	16
4	16	2	4	2	4	3	9	3	9	3	9	2	4	3	9	4	16	4	16	4	16	3	9
2	4	2	4	4	16	4	16	2	4	2	4	3	9	3	9	2	4						

$$\text{Mean } X = \frac{762}{250}$$

$$= 3.048$$

$$S^2 = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n-1}$$

$$= \frac{2536 - \frac{(762)^2}{250}}{250-1}$$

$$= \frac{2536 - 2322.5}{249}$$

$$= 0.8570$$

$$S = \sqrt{0.8570} = 0.9258$$

Test Items with Simplified Words in Long and Complex Form

X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2
5	25	3	9	3	9	5	25	3	9	4	16	4	16	3	9	3	9	3	9	5	25	4	16
3	9	4	16	4	16	3	9	4	16	3	9	3	9	5	25	2	4	4	16	3	9	3	9
3	9	3	9	4	16	4	16	3	9	2	4	5	25	4	16	4	16	3	9	4	16	4	16
4	16	5	25	3	9	3	9	5	25	2	4	6	36	5	25	4	16	3	9	3	9	4	16
5	25	3	9	4	16	2	4	4	16	3	9	3	9	4	16	3	9	4	16	4	16	3	9
4	16	4	16	3	9	3	9	5	25	4	16	4	16	4	16	3	9	3	9	3	9	2	4
3	9	3	9	3	9	4	16	5	25	3	9	2	4	3	9	5	25	4	16	4	16	3	9
4	16	4	16	5	25	4	16	4	16	5	25	3	9	2	4	4	16	3	9	4	16	4	16
3	9	4	16	3	9	4	16	4	16	2	4	3	9	4	16	3	9	4	16	3	9	4	16
4	16	2	4	5	25	2	4	3	9	3	9	4	16	4	16	5	25	4	16	5	25	3	9
3	9	4	16	3	9	3	9	4	16	3	9	5	25	3	9	6	36	3	9	4	16	4	16
3	9	3	9	4	16	4	16	3	9	5	25	3	9	5	25	3	9	4	16	5	25	3	9
2	4	2	4	4	16	5	25	4	16	3	9	2	4	4	16	3	9	4	16	4	16	2	4
2	4	4	16	4	16	4	16	3	9	3	9	5	25	4	16	4	16	5	25	4	16	3	9
4	16	3	9	4	16	4	16	2	4	2	4	4	16	2	4	3	9	2	4	5	25	4	16
3	9	4	16	3	9	3	9	3	9	4	16	3	9	3	9	4	16	5	25	2	4	4	16
2	4	3	9	2	4	3	9	2	4	4	16	3	9	4	16	4	16	4	16	3	9	5	25
3	9	3	9	4	16	2	4	3	9	3	9	4	16	5	25	3	9	3	9	2	4	4	16
4	16	4	16	3	9	3	9	3	9	4	16	5	25	3	9	5	25	2	4	4	16	3	9
3	9	2	4	3	9	3	9	4	16	5	25	5	25	4	16	3	9	3	9	3	9	3	9
4	16	3	9	4	16	5	25	3	9	6	36	4	16	3	9	3	9	4	16				

$$\text{Mean } X = \frac{891}{250}$$

$$= 3.564$$

$$S^2 = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n - 1}$$

$$= \frac{3320 - \frac{(891)^2}{250}}{250 - 1}$$

$$= \frac{3320 - 3175.5}{249}$$

$$S^2 = 0.5803$$

$$S = \sqrt{0.5803} = 0.7617$$

$$t = \frac{X_1 - X_2}{\sqrt{\frac{S^2_1}{n} + \frac{S^2_2}{n}}}$$

$$= \frac{3.564 - 3.048}{\sqrt{\frac{(0.7258)^2}{250} + \frac{(0.7617)^2}{250}}}$$

$$= \frac{0.516}{\sqrt{0.0034 + 0.0023}}$$

$$= \frac{0.516}{0.0756}$$

$$t = 6.8253$$

APPENDIX 4.7

Test Items with Negative Phrase in Original Form

X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2
5	25	3	9	6	36	5	25	3	9	4	16	5	25	4	16	5	25	4	16	3	9	5	25
3	9	5	25	3	9	3	9	5	25	3	9	3	9	5	25	3	9	3	9	4	16	3	9
4	16	4	16	3	9	4	16	4	16	2	4	4	16	4	16	4	16	4	16	3	9	2	4
3	9	3	9	2	4	4	16	2	4	3	9	2	4	4	16	3	9	3	9	2	4	4	16
5	25	4	16	6	36	3	9	3	9	4	16	3	9	3	9	2	4	5	25	3	9	3	9
4	16	3	9	4	16	4	16	4	16	3	9	4	16	4	16	3	9	4	16	4	16	2	4
3	9	5	25	3	9	5	25	6	36	3	9	3	9	5	25	3	9	6	36	3	9	3	9
4	16	4	16	4	16	5	25	3	9	4	16	2	4	4	16	4	16	4	16	4	16	4	16
4	16	3	9	5	25	4	16	4	16	4	16	5	25	2	4	5	25	3	9	4	16	3	9
3	9	4	16	4	16	3	9	5	25	2	4	4	16	4	16	4	16	5	25	5	25	5	25
3	9	3	9	3	9	2	4	4	16	2	4	3	9	2	4	3	9	2	4	4	16	4	16
5	25	3	9	4	16	5	25	4	16	4	16	3	9	4	16	3	9	3	9	5	25	4	16
4	16	4	16	4	16	2	4	3	9	4	16	3	9	4	16	3	9	4	16	3	9	3	9
3	9	4	16	2	4	2	4	4	16	3	9	3	9	2	4	3	9	4	16	2	4	2	4
3	9	4	16	4	16	3	9	4	16	4	16	3	9	4	16	3	9	3	9	4	16	4	16
4	16	3	9	3	9	4	16	3	9	4	16	3	9	2	4	4	16	4	16	3	9	3	9
3	9	4	16	3	9	3	9	4	16	4	16	3	9	4	16	3	9	4	16	2	4	4	16
3	9	3	9	4	16	3	9	4	16	4	16	5	25	4	16	4	16	3	9	4	16	2	4
4	16	2	4	2	4	4	16	2	4	2	4	2	4	2	4	3	9	5	25	3	9	3	9

$$\text{Mean } X = \frac{802}{250} = 3.208$$

$$S^2 = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n-1}$$

$$= \frac{3044 - \frac{(802)^2}{250}}{250-1}$$

$$= \frac{3044 - 2572.8}{249}$$

$= 1.8924$

$S = \sqrt{1.8924} = 1.3756$

Test Items with Positive Phrase

X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2
3	9	3	9	4	16	3	9	4	16	2	4	5	25	3	9	5	25	3	9	3	9	5	25
4	16	4	16	4	16	2	4	3	9	4	16	2	4	2	4	4	16	5	25	4	16	3	9
3	9	4	16	3	9	4	16	3	9	3	9	4	16	3	9	4	16	3	9	4	16	2	4
2	4	3	9	2	4	3	9	3	9	4	16	4	16	4	16	4	16	3	9	5	25	3	9
3	9	2	4	3	9	2	4	2	4	3	9	4	16	3	9	3	9	4	16	4	16	2	4
3	9	5	25	4	16	2	4	3	9	3	9	2	4	3	9	2	4	4	16	3	9	3	9
4	16	3	9	4	16	4	16	4	16	4	16	3	9	2	4	4	16	3	9	3	9	4	16
4	16	2	4	5	25	3	9	3	9	4	16	4	16	3	9	3	9	2	4	5	25	3	9
4	16	3	9	2	4	2	4	4	16	6	36	3	9	2	4	4	16	3	9	3	9	2	4
3	9	4	16	2	4	2	4	4	16	3	9	2	4	4	16	5	25	4	16	4	16	4	16
2	4	3	9	4	16	4	16	3	9	2	4	4	16	3	9	4	16	3	9	4	16	2	4
3	9	4	16	4	16	3	9	4	16	3	9	3	9	4	16	4	16	2	4	3	9	2	4
4	16	4	16	3	9	3	9	3	9	3	9	4	16	3	9	3	9	3	9	5	25	3	9
3	9	3	9	2	4	4	16	2	4	4	16	5	25	3	9	3	9	4	16	3	9	4	16
5	25	3	9	2	4	4	16	5	25	4	16	4	16	2	4	4	16	4	16	2	4	3	9
3	9	4	16	2	4	3	9	5	25	3	9	4	16	5	25	3	9	3	9	2	4	4	16
4	16	5	25	4	16	5	25	3	9	2	4	3	9	3	9	3	9	3	9	3	9	4	16
4	16	3	9	2	4	2	4	3	9	2	4	2	4	2	4	2	4	2	4	3	9	3	9
3	9	4	16	3	9	4	16	4	16	4	16	3	9	2	4	2	4	2	4	3	9	5	25
4	16	3	9	3	9	4	16	3	9	3	9	2	4	2	4	3	9	2	4				

$$\text{Mean } X = \frac{768}{250}$$

$$= 3.702$$

$$S^2 = \frac{\Sigma X^2 - \frac{\Sigma(X)^2}{n}}{n-1}$$

$$= \frac{2703 - \frac{(768)^2}{250}}{250-1}$$

$$= \frac{2703 - 2359.3}{249}$$

$S^2 = 1.3803$

$S = \sqrt{1.3803}$

$= 1.1748$

$$t = \frac{X_1 - X_2}{\sqrt{\frac{S^2_1}{n} + \frac{S^2_2}{n}}}$$

$$= \frac{3.208 - 3.072}{\sqrt{\frac{(1.1748)^2}{250} + \frac{(1.3756)^2}{250}}}$$

$$= \frac{0.136}{\sqrt{0.0055 + 0.0075}}$$

$$= \frac{0.136}{0.1143}$$

$t = 1.1898$