A STUDY OF THE FACTORS THAT AFFECT THE UNDERSTANDING OF PHYSICS CONCEPTS BY SECONDARY SCHOOL STUDENTS IN KADUNA STATE

BY

JAMES OBINNA EBERECHI OTUKA

JANUARY 1986

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DECLARATION

I hereby declare that this thesis has been written by me and that it is a record of my own research work. It has not been presented in any previous application for a higher degree. All quotations are indicated by quotation marks or identation and the sources of information are specially acknowledged by means of references.

James Obinna Eberechi Otuka

January, 1986.

CERTIFICATION

This thesis entitled "A STUDY OF THE FACTORS THAT AFFECT THE UNDERSTANDING OF PHYSICS CONCEPTS BY SECONDARY SCHOOL STUDENTS IN KADUNA STATE by James Obinna Eberechi OTUKA meets the regulation governing the award of the degree of Doctor of Philosophy of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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J. O. OTUKA
27th January, 1986.

DEDICATION

This work is dedicated to three groups of people Firstly my dear parents: Chief Michael Nwachukwu OTUKA and Mrs. Christianah OTUKA for their fervent prayers for my success in life. Secondly my nucleus family namely: My dear wife Mrs. Comfort Chinyere OTUKA for her understanding and tolerance of my regular absence from the house even at the hours of need and my children

Miss Ifeoma Otuka

" Chinyere Otuka

" Ijeoma Otuka

Ogechi Otuka

Master Chukwuemeka Otuka

" Ikechukwu Otuka

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ABSTRACT

Over the past 25 years, there has been considerable growth quantitatively and qualitatively in many aspects of secondary and tertiary education in Nigeria. The enrolment of students in physics and the availability of physics teachers have not risen correspondingly. The depressed status of physics as a school subject was the concern of this study.

The objective of the study was to determine the relationships between eleven selected variables and physics concept attainment. The study also tried to determine the extent to which each of the variables independently affected physics concept attainment. Nine hypotheses of possible relationships between the independent variables and physics concepts were formulated and tested. Ten instruments were used for the study: six were designed for the study, 2 were adopted and two others were available elsewhere. 300 form five students from 16 secondary schools in Kaduna State were used for the study. The Pearson correlation coefficients revealed that the variables listed under each column were significantly related ($\alpha = 0.05$) to physics concept attainment as follows:

Boys only	Girls only	Boys and Girls combined
Parents Background	Fathers' background	Parents' Background
Attitude toward physics	Laboratory factor	Attitude toward physics
Laboratory factor	Attitude toward physics	Laboratory factor
Tutor/Administration	Reasoning Ability	Tutor/Administration
Capital Cultural factor	Reading Comprehension	Capital Cultural factor

Environment/Peer	Reasoning Ability
Reasoning Ability	Reading Comprehension
Reading Comprehension	

Further exploration by using the step-wise multiple regression analysis revealed that the variables listed under each column contributed significant effects ($\alpha = 0.05$) on physics concept attainment as follows:

Boys only	Girls only	Boys and Girls Combined
Reading Comprehension	Reading Commpre-hension	Reading Comprehension
Reasoning Ability	Reasoning Ability	Reasoning Ability
Attitude toward physics	Attitude toward physics	Attitude toward physics
Tutor/Administration	Fathers-background	Tutor/Administration
Capital Cultural factor	Laboratory Factor	

The main finding of the study was that (i) Reading Comprehension (ii) Reasoning Ability (iii) Attitude toward Physics, are determining factors for physics concept attainment among secondary school students used in this study. Also a modified Duncan path model showing the level of relationships among the variables used for the study was produced.

Based on the finding, the study therefore arrived at the conclusion that for effective physics concept learning, the most helpful learning conditions are those previously learned abilities of the student than those that are external to the student.

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ABBREVIATIONS, DEFINITIONS, GLOSSARIES AND SYMBOLS

CACUFAC;		Capital Cultural Factor
CAT	:	Concept Attainment Test
COT	:	Comprehension Test
NERC	:	Nigerian Educational Research Council
NIP	:	Nigerian Institute of Physics
RAT	:	Reasoning Ability Test
SAN	:	Science Association of Nigeria
STAN	:	Science Teachers Association of Nigeria
TAT	:	Test for Attitude
P and q:		Common Factors
j	:	Variable
R	:	Regression Weights
R^2	:	Square of Regression Weights
ΔR^2	:	The difference between two Regression Weights
S.D	:	Standard Deviation
$\overline{X}$	:	Mean
α	:	Alpha
$\geq$	:	Greater than or equal to
$\leq$	:	Less than or equal to
Σ	:	Summation sign
%	:	Percentage
i.e	:	that is

For the purpose of this study certain terms will assume definite meanings.

1. Attitude. A tendency to react positively or negatively toward physics as a school subject.
2. Capital Cultural Factor. The principal ways of behaving, the values, ways of living, language, beliefs, family life, house, art and possession of a people.
3. Concept. Ordered information about the properties of one or more things --- objects, events or processes that enables any particular thing or class of things to be differentiated from, and also related to other things or classes of things (Klausmeier, Chatala and Frayer (1972).
4. Concept Attainment. As used in this study means ability to identify the correct statement relating to a particular concept among a number of distractors.
5. Environment. All the things a pupil interacts with that could influence his thoughts and behaviour.
6. Experts. Thos who have obtained atleast a master's degree in pure physics or physics education with atleast five years of teaching experience.
7. Extroversion. The characteristics of a pupil who is active and expressive.
8. Factors. These are variables that could promote or inhibit concept attainment.
9. Fathers Background means the pupil's father's educational attainment as well as the job he does for a living.

10. Mothers Background means the pupil's mother's educational attainment as well as the job she does for a living.

11. Neuroticism. The state of a pupil characterized by tension, fear and worry.

12. Peer group. This refers to a pupil's associates at school and at home with whom he spends most of his free period.

13. Perception. The students opinion, dispositional reaction, significance and utility of the variable to his study of physics concepts.

14. Performance. A pupil's final score in any of the tests to be administered for the study.

15. Reasoning Ability as used in this study is determined by a pupil's total score in the (AH_4 Part II) non verbal reasoning ability test.

16. School factor as used in this study rerfers to such school variables as pupil teacher relationship; Administration and laboratory equipment which could influence the teaching and learning of physics.

17. Socio economic background. This term means the educational attainments of a pupil's parents as well as the jobs they do for a living.

18. Topic. A prescribed area of a subject matter. In this case the subject is physics.

19. Understanding. The ability to perform most of the tasks is taken as an evidence that a student understands the concepts.

20. Use. The student's ability to apply the knowledge of concepts in explaining new learning experiences and other physical occurrences.

Chapter 1

THE PROBLEM AND ITS SETTING

1.1 Introduction

1.1.1 Concept Development Study

In recent years, studies in concept development have attracted the attention of science educators. The interest in the study of concept development is clear from the international conferences that have been organized to discuss the inherent problems in the field and progress that are being made in the studies in concept development. For example, an international seminar was held at the University of Leeds England in 1979 (Archenhold; 1979). The theme of the seminar was "Cognitive development in science and mathematics." Papers presented centred on researches in the field of concept development and attainment at the secondary school level. The topics discussed included: 'Personality and Cognitive development'; 'Language learning and cognitive development'; 'Understanding of the concepts of "work" and "potential" in physics by 16-19 years and 'the environmental factors that affect the assimilation of science concepts'. At the University of Nottingham, the Institute of Physics, London, organized another conference on the theme "Concept development in the learning of physics" (Hull, 1983). Harrison (1983) in one of the conference papers said: "Over the past years, research has accumulated to show that students of physics do not understand many of the fundamental concepts

taught in their courses even when they have passed the usual form examinations". He attributed the situation to a number of variables such as: poor comprehension, home-back-ground effects, poor teaching and negative attitude to physics. Other research papers presented and discussed were: 'Preconceptions in physics by pupils', 'Language use and concept change' and 'childrens ideas, how can we find out'?

The recent awareness of the importance of concepts in physics instruction and of the factors that affect the understanding of physics concepts have affected curriculum planning and thinking. For example, the new senior secondary school physics curriculum being developed in Nigeria recognizes the importance of concepts in physics learning. One of its principal objectives is: "To acquire basic concepts and principles of physics as a preparation for further studies" (Ivowi et al 1985). The investigation of the factors affecting the understanding of physics concepts by Nigerian secondary school students seems to be in order.

1.1.2 Physics And Development

The importance and relevance of science and physics in particular to national development continues to be emphasized by enconomic planners, scientists and educators in Nigeria. Ajakaiye (1984) observed that "Without physics teaching at school, there will be no sicentists, engineers and

technicians, without engineers and technicians there will be no national prosperity. Physics and the teaching of physics are the doors and the keys to national development." Amusa (1977) stressed the importance of physics thus, "The measures for promoting physics have turned out to be sine qua-non for the rapid acquisition of technological know-how in most countries of the world." Ette (1977) expressed very similar views by asserting that "The technological potential of a country is more accurately gauged by the quality of its physics education than by any other single index such as the size of its population, for without physics, technological culture cannot really take root no matter the amount of imported technical expertise." These observations emphasize the need for effective instruction of physics to help students acquire physics concepts, ideas and principles to facilitate rapid technological development of the country. Technological development invariably leads to enconomic growth. As for example, Germany that has nearly the same population as Nigeria, has a labour force of over 10,000 industrial physicists and more than the same number as physics teachers (Ajakaiye, 1977). By 1969, Germany had 5,600 full members in German physics society while in 1983 Britain had 13,022 members of the 'Institute of Physics' of which over 95% are British nationals (Valentine, 1983). It is estimated that over 0.03% of the population of Europe are industrial physicists and physics educators (Europhysics

1983). Such large number of physicists in developed countries is a pointer to the importance of physics to the development of a country as well as its prosperity. Yet the physics subject panel for Science Teachers Association of Nigeria (STAN) has an enrolment of less than 300 teachers (Otuka 1984).

If technological development and the accompanying enconomic growth are to be aspired for in Nigeria, physics teaching in schools and universities should receive greater attention than what obtains now. Effective physics instruction has much to contribute to national development.

1.1.3 Dearth Of Physics Learners

Inspite of the importance of physics to national development, only few students study physics in secondary schools and institutions of higher learning. Uzodinma (1982), Adejumobi (1976), and Fasemore (1970) in different studies showed that physics has a low level of student enrolment of between (15% - 21%) when compared with the other school subjects at the secondary school level. Also the apparent scarcity of physical scientists and physics teachers in our educational institutions as well as the inadequate number of high level manpower in other physics related careers have provided evidence to support the situation as it is today. For example, during a period

of seven years between 1970 and 1976, five universities in the country produced only 249 physicists, 210 electrical engineers, 261 mechanical engineers 241 civil engineers and 28 surveyors (Ozoro, 1977). For a population of over 60 million then, these numbers are insignificant. In 1982, of the 309, 610 candidates who sat for the West African School Certificate Examinations only 55,589 or 18% registered for physics (Uzodinma, 1982). In the same year in Kwara State, a statistical analysis revealed that while 4,126 pupils offered biology, 1,929 chemistry only 675 offered physics (Abdullahi, 1982). This situation is not likely to be different in the other states particularly as this state is regarded as one of the educationally more advanced states. This situation is a contrast to what happens in developed countries. A survey in Europhysics (1983) shows that in European countries of Hungary, Germany, Italy and Denmark, compulsory physics courses are provided for (14-18) year olds. The low enrolment is also partially due to the non availability of physics teachers. During a period of three academic sessions from 1978 to 1981 the six older universities in the country produced only 87 physics educators (Abdullahi, 1982). Ardo (1985) in a study of the teaching of Physics in Sokoto State showed that in a sample of 44 secondary schools that offered physics at the school certificate level, there were only 29 qualified teachers. Of these only one was a Nigerian.

1.1.4 Concept Mastery

The process of acquiring additional concepts is called concept attainment as distinct from concept formation which is the way children learn to think conceptually (Frayer, Fredrick and Klausmier 1969). There are many advantages in understanding the fundamental concepts of any subject or topic. For example studies carried out by Lyle and Bourne (1967), Frayer and Klausmeier (1970), Alan, Volker and Harris (1971) Ghatala Frayer and Klausmeier (1972) and statements by psychologists like Piaget (1952), Gagne (1965), Lovell (1969) show that concepts help in the identification of environmental objects and events. They reduce the necessity of continued re-learning by providing easily recallable class labels. They provide direction for instrumental activity and they permit the ordering and relating of classes of objects and events. They are the fundamental agents of intellectual work.

The concepts of any particular subject, phenomenon or process may exist in a continuum from simple to complex. The same concept may be taught to varying age groups, the younger concerning themselves with the simple end of the continuum, while the experienced and more mature learners are directed to the more complex section. Frayer and Klausmeier (1972) stated that one of the problems in science education is concerned with the relationship of the concepts

taught to the levels of pupils' maturity and that concepts are seen as the fundamental agents of intellectual work.

It is very likely that, poor understanding of physics concepts contributes to this continuing low enrolment of pupils and inadequate supply of physics teachers. The shortage of physics students and teachers is a serious problem that deserves concern and solution. The understanding of physics concepts is considered a pre-requisite to the mastery of the subject.Johnstone and Mughol, 1976; Hull, 1983; Watts, 1984). Hence a study of the factors that affect the students' understanding of concepts in physics could help in providing better insight into the problems of physics instruction in Nigeria.

1.2 Statement Of The Problem

Over the past 25 years there has been considerable growth quantitatively and qualitatively in many aspects of secondary and tertiary education in Nigeria. Yet the enrolment of students in physics and the availability of physics teachers have not risen correspondingly. The depressed status of physics as a school subject is the concern of the research. Earlier studies elsewhere suggest the following factors as affecting the teaching and learning of concepts (Child, 1964; Klausmeier, 1967; Ogoston, 1968; Lunger, 1969; Keeves, 1975; Lawrence, 1976;

Frazer, 1978; Lynoh, 1979; Cuttance, 1980; Blakemore, 1981; Saloane, 1981; Fraser, 1983; Hassan, 1985; Lynn, 1985).

(i) Pupils home-background

(ii) Pupil's Personality traits

(iii) The Pupil's environment

(iv) The attitude of pupils to physics

(v) The reading comprehension ability of the pupils

(vi) The school factor

It is however pertinent to point out that the results of the effects of these variables on teaching and learning of concepts seem to be inconsistent. Examples of such controversies are: Mendick (1967) Eysenck (1967) found that personality variables of extroversion and neuroticism promote understanding of concepts, while Arnoff (1964) found that these personality variables have no significant relationship with understanding of concepts. Lawrenz (1976) Gardner (1979) showed that positive attitude towards science and concept attainment were significantly related while Orisaseyi (1976), Jencks (1972) found that positive attitude towards science had no significant relationship with concept attainment. Preston (1962) reported a comparison of reading ability of German and American children in fourth and sixth grades. He found that with American children, the mean scores on reading ability for girls were superior to those of boys, but the reverse was true of German children

where the mean scores of the German boys exceeded those of the girls. Similar controversies in the contributions of the following variables also exist. The references are first for positive contribution and next for negative contribution: Reasoning Ability: Lynoh, (1979), Lockley, (1977). School factor Jegede, (1985), Slavin (1977), Socioeconomic Status Hauser, (1976), Norton (1979) Environment/Peer, Fraser, (1978) Cuttance (1980). It therefore seems reasonable to study the effects of these variables on physics concept attainment of students in Kaduna State. This study sought to establish relationship between different variables associated with the contributing factors listed above and the learning of physics concepts in secondary schools in Kaduna State. The variables chosen for the study and the factors to which some of them were related were the following:

Table 1.1: Factor And Related Variables

Factor		Related Variables
(i)	Pupils home background	Fathers' background Mothers' background.
(ii)	Pupils Personality traits	Extroversion, Neuroticism
(iii)	Pupils' Evironment/ Peer.	School and Home Environment. Peer group interaction at home and in school. Capital cultural factor.
(iv)	School Factor	Perception of Tutor ability and characteristics. Perception of the laboratory perception of school administration.

Could the lack of understanding of physics concepts be responsible for the depressed status of the subject in Nigerian schools?

More specifically this study sought to establish whether any relationships exist between these variables and concept attainment by attempting to find answers to the following questions:

(a) Are there any relationships between the pupils' understanding of physics concepts and their
  (i) Reading Comprehension Ability
  (ii) Reasoning Ability
  (iii) Socio-economic factors of parental background
  (iv) Personality traits
  (v) Perception of school factors
  (vi) Capital cultural factor and
  (vii) Environment/Peer group interaction?

(b) Is there any sex difference on the effect of these variables on the pupils' understanding of physics concepts?

(c) To what extent does each of the variables contribute to the pupils' understanding of physics concepts?

1.3 Purpose Of The Study

The purpose of this study was to determine the relationship between such factors as parents' background, environment, personality, students attitude towards physics, reading comprehension and school factor with concept attainment physics. The study also tried to determine the extent to which each of the factors contributed to the concept attainment.

The need to undertake the study stemmed from two major considerations: First, there is a general concern felt in Nigeria by secondary school physics teachers, university and college lecturers, national educational bodies charged with science and technology development over:-

(a) Poor enrolment in physics in secondary schools, colleges and universities.

(b) High failure rate of physics candidates in WAEC and

(c) The alarming shortage of indigenous physics teachers (Awokoya, 1977 Ozoro, 1977; Shuaibu, 1982; Bajah 1982; Yoloye, 1982; Ardo, 1985; Emevon, 1985).

Second was the increasing realization that Nigeria may not develop rapidly both scientifically, technologically and enconomically without producing large numbers of scientists, particularly physicists. Added to these is the fact that many educators hold the view that the need to understand

why learners experience difficulty should underpin any discussion on how teaching might be improved (Butt, 1962; Kendler and Kendler, 1969; Klausmaiere and Frayer, 1970; Abdullahi, 1982; Ajomogobia, 1983).

It was hoped that this study might yield information for guidance and counselling for prospective physics students. It might also make useful contributions to the educational system in the area of curriculum and instruction development. This is in view of the present efforts to increase enrolment of science students in general and physics students in particular. This study was also expected to identify some of the variables that could be useful predictors for students with potential for studying physics.

1.4 Significance Of The Study

This study attempted to establish if there is any relationship between the independent variables and physics concept attainment. The findings of the study could be used to clarify, support or substantiate the existing learning theories enunciated by such psychologists and educators like Bruner, Piaget, Gagne, Lovell, Ausubel and Eysenck. Coupled with this was the fact that this is an attempt to carry out pioneering work as little has so far been done on physics concept learning by Nigerian physics educators. It is hoped that the findings of this could contribute ideas for improving the teaching and learning of physics at the

secondary school level in Nigeria.

The world in general is becoming more and more scientifically and technologically oriented. Nigeria is also moving in that direction. Physics is one particular subject that is a pre-requisite for almost all engineering and other technological courses. It is therefore anticipated that the findings of this study would be found valuable by various bodies engaged in scientific and technological policy formulation and development in the country.

(a) This study is hopefully expected to identify some of the variables that are the most useful predictors of students with potenital for physics. It is also hoped that the findings would be useful to the following:

(b) Teachers. Teachers responsible for the teaching of physics to secondary school pupils would hopefully utilize the factors that are found to promote the understanding of physics concepts in order to:

(i) Guide and counsel the pupils in their choice and learning of physics as a school subject.

(ii) Create environment that would enhance the study of physics.

(iii) Select and order the physics concepts in a way to maximize teaching and learning.

(e) Universities and Colleges. The faculties of education of universities and colleges of education where physics teachers are mostly trained could benefit from the study as they might become aware of the factors that promote or inhibit the learning of physics concepts. The importance of concepts in the learning of physics could be given greater emphasis while teaching undergraduate physics educators.

(f) National Education Organizations. Bodies like science Teachers Association of Nigeria (STAN) National Institute of Physics (NIP) and National Educational Research Council (NERC) that carry out research, discuss and disseminate research findings might wish to consider the results of this research with a view to using some of the factors effectively to promote the teaching and learning of physics. They might also decide to carry out further research on some of the findings if such studies will improve enrolement in secondary school physics.

(g) Parents. Parents might as a result of the findings be in a better position to appreciate the effect of a conducive home - environment, i.e. the supply of adequate learning materials and the guidance of brothers, sisters and other relatives on their children's understanding of physics concepts.

(h) Employers of secondary school teachers. There is no rough and ready method of determining the correlation between the paper qualification of a prospective physics teacher and his actual competence. Consequently some teachers employed on the strength of their certificates often prove incompetent in their performance. This discrepancy could possibly be discovered at the interview if questions demanding familiarity with the notion of concepts as a means to problem solving were put to the applicant. This could be an additional criterion of determining their suitability for the job which they have applied.

1.5 Delimitation Of The Study

1.5.1 Variables

The study took into consideration the fact that the variables which affect learning are numerous and cannot be exhausted in one study. This study is concerned with the relationship between the psychological and sociological factors and physics concepts than factors involving the academic relationships between the school subjects for example physics and mathematics. The variables that have been chosen concentrate on three basic areas of the students life namely: His parents background; his home and school environment and his personality traits. Other variables

are his reading comprehension ability, his reasoning ability as well as his attitude towards physics.

These can always constitute a label on an individual or the characteristics with which he is identified such as: He is from a rich and educated family. He is an extrovert and often seeks notice. He hardly understands what he reads and rarely speaks the English language. His parents are uneducated and live in a squalor in the outskirts of the town and he is attending an ill-equipped school (Blackmore, 1981, Brown, 1984). This study tried to determine how these basic variables affect the understanding of physics concepts.

1.5.2 Scope

Studies on concept attainment could be conducted over long or short interval of time. This study was for a short time interval to limit cost and meet other requirements. It was also limited to environmental factors rather than biological/genetic factors. However the study took into consideration the fact that individuals of the human specie have certain genetically - determined abilities that emerge as the individual matures and interacts with social and physical environment and these abilities make concept attainment possible. The study did not consider mathematical process as it has always been emphasized that students who aspire to do physics must endeavour to master basic elementary mathematics.

1.5.3 Physics Concepts

The study used the concepts of Energy, Work, Force and Pressure. These topics are fundamental in the study of secondary school physics. They are all stated for elementary treatment in the third year as shown in the Core Curriculum for Integrated Science for Junior secondary school in the 6-3-3-4 system FME (1981). This curriculum is expected to prepare students who would eventually study physics, chemistry and biology as seperate subjects in the senior secondary, the fundamental nature of these topics is further supported by the fact that in the Physics Curriculum for Senior Secondary Schools, the same topics are recommended to be studied in the first year of the three year programme FME (1981).

A review of the WAEC syllabus for the past five years (1982-1986) by the writer showed that the topics: Energy, Work, Force and Pressure occupied topic numbers 4, 6 and 10 respectively in the syllabus that always contained 36 topics. All the ordinary level physics textbooks used in Nigeria treated these topics at their initial chapters; for example in Abbot, Force is treated in chapter two, Work and Energy chapter 7 and Pressure in chapter 10 and the same pattern holds in the others namely: Nelkon, Oyewole and Folivi and Godman. The topics: Energy, Work, Force and Pressure are also likely to be misunderstood and misapplied because their

meanings in various contects in everyday language are usually misused in those contexts with their scientific connotations. They also cut across almost all the topics in WAEC syllabus. For example machines are treated in physics as devices for making work easy, under kinetic theory the pressure of the gas is determined using the theory; under Electric and Magnetic fields, Force on a conductor carrying a current in a magnetic field and electrical energy, Work and Power are always treated as ordinary level topics. They are used as operational tools to explain and convey specific facts, ideas and other phonomena in physics to the students during physics instruction. It might not be wrong to state that any ordinary level physics syllabus that does not contain any one of these topics is incomplete. These topics have therefore been chosen for this study because of their basic and fundamental importance in secondary school physics instruction.

1.5.4 Respondents And Location

Form five students in Kaduna State who are mostly within the average age range of 16-17 years are used for this study. At this stage of their development they are expected to be able to handle abstractions and relationships, (Piaget, 1952). Though the chosen topics are given elementary treatment in the first two years of secondary education as contained in the STAN integrated science books, a pilot study revealed that they are treated in detail, as

contained in WAEC syllabus, in form III, in secondary schools within Kaduna State. After two years of studying these topics, it is expected that the students should be able to explain their meanings and apply them in solving more difficult problems.

Form V physics students in Kaduna State were used for this study. This helped to save time, reduce cost and travelling hazards as the writer resides, in the state.

1.6 Assumptions

This study made the following assumptions:

1. That all concepts held by an individual are learned and they do not emerge simply by maturation.
2. That human learning is largely determined by specific environmental factors and learning experiences.
3. That difficult concepts and new problems can be tackled by the application of appropriate basic concepts acquired previously.
4. That the education of an individual includes his becoming familiar with usable concepts in a discipline and knowing how to solve problems using these concepts.
5. That learnability varies among concepts in the sense that some concepts are more readily learned by individuals who share similar cultural experiences and language than others.

7. There is no significant relationship between the students' scores on school factors as measured by:

   (a) Perception of laboratory scale

   (b) Perception of Tutor/Administration scale and their performance in CAT ($\alpha = 0.05$).

8. There is no significant relationship between the students' scores in the Capital Cultural Factor Scale and their scores in CAT ($\alpha = 0.05$).

9. There is no significant relationship between the pupils' scores on the Environment/Peer group scale and their scores in CAT ($\alpha = 0.05$).

Chapter 2

REVIEW OF LITERATURE

2.1 Introduction

In chapter one, it was stated that the purpose of this study was to investigate the relationship between the following factors:

Parents' Background

Personality

Environment

Attitude Towards Physics

Reading Comprehension

Reasoning ability and students' concept attainment in physics. An attempt would also be made to determine the extent to which each of these variables affected physics concept attainment by students. In this chapter, relevant literature concerning: Concepts and Concept learning, views of educators and psychologists on the listed factors and their relation to learning were looked into. The study of literature was used to highlight certain trends in this study and to call attention to existing gaps which the present study tried to fill.

The review of literature was organised as follows: Ideas and notions about concepts; concept learning; Views and Opinions of educators and psychologists on the variables, concept attainment and related studies.

The related studies were sub-divided into: studies done in Nigeria and studies done elsewhere.

2.2 Definitions, Ideas And Notions Regarding Concept And Concept Learning

2.2.1 What is a Concept?

In the fields of both educational psychology and science education much discussion in the literature has been devoted to classifying or defining types of concepts. According to Klausmeier, Harris Davis, Schewenn and Frayer (1968), concepts may be defined in one or more of four ways:

(a) Structurally in terms of perceptible or readily specifiable properties or attributes.

(b) Systematically, in terms of synonyms or antonyms.

(c) Operationally in terms of the procedures used to distinguish the concept from other concepts or

(d) Axiomatically in terms of logical or numerical relationships.

Some of the definitions based on these are:

....Woodruff (1951): concept deals with the meaning an individual attaches to a word or other sysmbols rather than with the mere fact that any given symbol is associated with anv given object.

....Cronbach (1954) "A concept is the recognition of a group of situations which have a resemblance or common element. We usually give a name or label to the group." Russell (1960) "Concepts are learning that permeates thinking." Staats, (1961) "A concept may be regarded as a verbal habit.. family formed usually on the basis of a class of stimulus objects having identical elements." Burne, (1966) "A concept exists whenever two or more distinguishable objects or events have been grouped or classified together and set apart from other objects on the basis of some common feature or property characteristics of each." Pella (1972) A concept may be defined as a summary of the essential characteristics of a group of ideas and/or facts that epitomize important common features or factors from a larger number of ideas. A concept may be a classification or description of objects or phenomena in nature a relationship or correlation between two or more facts or be a theory that is useful in explaining observations" Shalvonson, (1974) defined concept as an assemblage of identifiable elements and the relationship between them. Stone (1979) "A concept is an abstraction from objects, situations or events of the attributes these phenomena have in common.

The term concept means different things to different individuals, to some it is an idea or abstraction to others, a theory or principle and to some others an object or fact. However physics concepts as used in this study may be defined as abstractions from specific topics which have common properties and relationships between them.

2.2.2 Attributes Of Concepts

Klausmeier, Davis, Ramsay, Fredrick and Bourne (1965) formulated a conception of concepts in terms of the defining attributes and values which are identified as common to many concepts from various disciplines. Flavell (1970) indicated that a formal definition of 'concept' in terms of its defining attributes is useful in specifying what concepts are and are not and also in identifying the great variability among concepts. The major attributes of 'concept' are learnability, usability, validity, generality, power, structure. A brief description of each attribute is as follows:

(a) Learnability. Learnability of a concept varies from concept to concept in the sense that some concepts are more readily learned by individuals who share similar cultural experiences and language than others. Also the level to which a particular concept as a mental construct is attained by a given individual varies and increases with learning. The level of mastery of any concept also varies among individuals of roughly equivalent maturational and experiential levels.

(b) Usability. Concepts vary in usability because some concepts can be used more than others in understanding and forming principle and in solving problems. Concepts as mental constructs of the individual become more usuable as they are attained at higher levels.

Bruner, Goodnow and Austin (1956) indicated that attaining a classificatory concept aids the individual by

1. reducing the complexity of the organism's environment
2. identifying the objects of the world about him
3. reducing the necessity of constant learning
4. providing direction for instrumental activity
5. ordering and relating classes of events (Bruner et al, 1956).

As the individual matures, he begins to use the acquired concepts more effectively in the ways listed above and therefore attains successively higher levels of attainment.

(c) Validity. A concept is valid to the extent that experts agree on its definition. An individual's concept increases in validity as with learning his concept comes closer to that of experts. Markle and Tiemann (1969) assess the validity of an individual's classificatory concepts by ascertaining the extent to which he makes errors or overgeneralization, under-generalization, and misconception. These errors on the part of students are identifiable by an experimenter or teacher to the extent that there is agreement among experts as to the defining attributes of the concept and its instances and non-instances.

(d) Generality. The generality of a concept refers to its position on hierarchial system of concepts in the subject. Concepts are normally arranged in hierarchical taxonomic systems. The higher a concept is within the same taxonomy, the more general it is in terms of the number of subclasses or subordinate concepts it includes.

(e) Power. The attribute of power refers to the extent to which a particular concept facilitates or contributes to the attainment of other concepts. Bruner (1961) for example stated that there were certain big ideas, or fundamental concepts, in each of the various disciplines. He recommended that these should be taught first so that less powerful concepts and factual information could be related to them. Ausubel (1966) dealt with power of concepts through the construct of advance Organizer, that is, the introductory material to a lesson should include concepts at a higher level of generality than those in the lesson so that the concepts presented in the new material could be related to those in the advance organizer. The relative power of the concepts held by an individual may or may not coincide with the judgement of scholars in the various disciplines, such as (Bruner, (1961), Fehr, (1966), and Novak (1966).

(f) Structure. Any concept defined in terms of attributes has a structure which is a relatedness of the defining attributes. An individual may or may not be able to either identify or name the defining attributes of the concepts he holds. However attaining a concept to highest level of mastery requires recognition and naming of the defining attributes. Bruner, Oliver, Greenfield et al (1966) Wiviott (1970) and Nelson (1971).

(ii) Concept learning. Closely related to these attributes are the views of some educators and psychologist on the importance of concepts in the process of learning. Piaget (1952) was of the view that children's ability to conceptualize changes with age. He said that the changes are qualitative and at successive states that can be very roughly identified with age, distinct changes occur in the kind of mental operations that people can perform. Bruner (1964) stressed the understanding of subject matter in a way that permits many things to be related to it meaningfully. Gagne (1970) posited a hierarchically ordered set of learning capabilities that determine for the individual what he can and cannot learn and the efficiency of the learning process itself. He defines concept attainment as..... and organized stimulus.....is a function of an individuals underlying prerequisite capabilities that permit the processing of information in certain ways'. He is of the view that as concepts become internally stored

as either perceptually organized classes of stimuli or as verbal chains or units, they develop an individual's capacity for making a common response to a class of stimuli. Concepts can also become the actual informational conceptual linkages in the process of what Gagne called the learning of 'defined' or 'relational' higher - level concept or what others have called the process of concept assimilation. Ausubel (1968) proposed that all meaningful learning is tied to the existence of previous acquired knowledge. For new material to be meaningfully learned, it must be relatable to and incoporated within what Ausubel refers to as 'Cognitive structure'. He suggested that concepts which embodied and represented an individuals knowledge are the crucial variables in the learning process. Woodruff (1967) proposed a model of human learning and behaviour that is based on the assumption that concepts play a central mediating role in human self regulatory and self directing functions (decision-making). He said "Concepts not only are essential building blocks for the individual's gradual acquisition of an objective construction and representation of reality, they also are the information catalysts in the adjustmental adaptive process of daily living.

Although Guilford's approach to the organization of information is not as rigidly structured as the approaches of Gagne and Ausubel, he can nontheless be seen to be in agreement with them in his belief that lower level products

(concepts) such as units or classes are often prerequisite to the acquisition of often higher level products such as systems (Guilford, 1969).

All these psychologists among others strongly agree that basic concepts form the foundation and provide the framework upon which more complex ideas can be tackled. They therefore affirm that concepts play a vital role in the understanding of various disciplines. It was conceived in this study that the factors affecting the understanding of the basic concepts of any discipline should be identified and studied. This has necessitated the need to look at the factors that might affect the understanding of physics concepts by the Nigerian secondary school students.

2.3 Views And Statements Of Educators And Psychologists On The Factors In Relation To Learning

2.3.1 English Language (Reading Comprehension)

"Without language there can be little communication, without communication there can be little education (Taylor and Brown, 1967). The study of physics as a science subject starts in the senior secondary school in the Nigerian secondary schools. The medium of instruction is usually English language. All textbooks that are used for secondary school physics in Nigeria are written in English.

The ability of the student to understand what he hears during instruction and what he reads from textbooks in English may likely affect his understanding of the subject. Many educators have commented on the importance of comprehending the language of instruction. Carr (1970) observed that since much of the knowledge contained in the school curriculum is transmitted through the medium of written and spoken English, the failure and success of the educational enterprise is heavily dependent upon how well students are able to comprehend language in their instructional materials. Also Quinto (1970) noted "The problem of English language use and comprehension continue to mitigate against the efforts of science educators in Nigeria and reported that over 90% of the Nigerian secondary school chemistry students cannot distinguish between the verbs heat and warm, words routinely used in chemistry laboratory classes. Ali (1983) stressed that it is possible that language problems experienced by Nigerian secondary science students whose mother tongue is not English, who have to use foreign published textbooks in their science education programmes have continually contributed to poor performance and achievement in their school science programmes. While Aliyu (1983) on account of the poor performance of junior students in English, expressed that 'Junior post primary school students particularly those in the northern parts of the country demonstrate a shocking narrow range of ability in English which

continue to serve as Nigeria s official language. Sutton (1983) explained that language may be seen in at least two ways: (i) As a medium for transmission of knowledge from person to person and hence into the learner's head. (ii) As a tool for the construction of knowledge intimately involved in the process by which concepts are formed, given precision and put to use. Sutton, tried to emphasis here the importance of language in the instructional process. Gagne (1970) argued that the first step in learning a concept is probably for the child to learn the word which symbolise it through an instrumental conditional reflex so that the child can repeat the word at will when asked. Luna (1968) said "Language enables the child.....to form concepts and draw conclusions from accepted assumptions. Spair (1970) was of the view that" The acquisition of language transforms the nature of thought while Stone (1969) explained that 'Language helps to create categories of things which have no existence in the real world. Lovell (1969) stated that language, numbers and other mathematical symbols play a great part in concept formation, they enable us to think. Kendler and Kendler (1980) observed that 'As a child matures and learns, his activity is mediated through words." Vigostsky (1969) argued that although conceptual thought may be possible without language, conceptualization expected of school children is bound to be dependent upon language. Competence in abstract thought depends upon competence in lanaguage usage. Language reduces

to mere gesticulation if it is not comprehended by the listener or reader. Scholars have emphatically stressed the importance of language ability for the understanding of concepts. This study therefore attempted to determine the effect of students English Reading Comprehension Ability on their understanding of physics concepts.

2.3.2 Reasoning Ability

Piaget (1953) explained that concepts are not born with us but they develop with maturity. He believed that experience and teaching affect the process of concept attainment. Stone (1969) stated that when a child has reached a stage where he is capable of reasoning by hypotheses, then his thinking ever makes use of concepts; by the time he is adult, he will have formed a complex repertoire of concepts. He will always think conceptually but faced with new situations or with new phenomena, he will seek to impose some order on them drawing on his stock of concepts. Lovell (1968) argued that reasoning is often involved when concepts are being formed because the selection of the relevant and the rejection of the irrelevant must take place. This study attempted to investigate the effect of reasoning ability of Nigerian pupils on their understanding of physics concepts.

2.3.3 Socio-economic Factors

In a typical Nigerian village or urban community the inhabitants can be divided into three major categories (Brown, 1982). The first category includes the well-educated with a relatively well paid job. He is very aware of the values of education. The educated strives to make sure that his children are given good education. In this group is the wealthy businessman, though he might not be very much convinced about the values of education, he tries to give his children good education because he can afford to do so.

In the second category is the fairly educated person (from TC II to NCE teachers) who can afford to just maintain the family fairly well. He might as a priority he places on education shelve other projects to ensure that his children are given good education. In this group also is the self-employed who makes a fairly good income. He endeavours to send the children to school for prestige and also to show that he can afford it.

The third category consists of people with little or no-education and illiterates. This group finds it difficult to feed the family properly. People from this group could withdraw from schooling or not attend at all because of financial problems. Some people in this category may not be aware of the value of education. Such people may resist efforts to send their children to school.

Blakemore (1981) was conscious of this emerging societal pattern when he said 'A distinct class structure is emerging in Africa with the result that access to and performance in education is increasingly becoming a reflection of class background. Also Cooksey (1981) reported that lack of interest in education may at times be a reflection of economic conditions. He continued by saying that parental income, occupations and education are extremely important determinants for educational attainment. The greater the material gap between the classes the more will the previleged dominate the educational system. Blakemore also asserted that the failure to control adequately for home background vitiates more studies of school effectiveness than any other defect. This study investigated the effect of socio-economic background of Nigerian pupils on physics concept attainment.

2.3.4 Attitudes

Recently the development of attitudes has received a considerable surge of interest as evidenced by the increasing number of articles and research studies dealing with their description, measurement, learning and influence on cognitive learning in science. Ramsay and Howe (1969) Taylor (1964). It is fairly reasonable to assert that the development of attitudes is considered today as a basic goal for science teaching no less important than cognitive goals Taylor (1974).

Attitudes are viewed as representing the underlying dispositional and motivational urge for learning and the need to produce scientifically literate citizens. (Brown, 1964, Hard, 1967, Wood, Pella and Hearn, 1968). The term attitude refers to one's feelings, thoughts and predispositions to behave in some particular manner towards some aspect of ones environment. Attitudes are best expressed when individuals make statements about their feelings or opinions about certain objects, issues or things (Mukherjee, (1978). Blair (1968) indicated that when teachers were asked to describe those forms of behaviour which gave them the most concern or which represented the most serious difficulties, it was found that teachers were most concerned with the existence of negative attitude, attitudes of indifference and lack of interest in their subjects on the part of their pupils. He continued by saying that in several ways, the kind of attitude which a child has affects his school work and learning. If he has positive attitude about school work he will work more effectively and achieve nearly to his capacity, conversely negative attitude will make fight against attempts to make him learn. Also Hassan (1985) is of the opinion that attitude towards science is contagious and when attitude towards science becomes increasingly negative during adolescence an accelerated downward spiral may result leading to increasingly negative attitude. Many educators and psychologists hold the view that the study of attitudes

is necessary for a teacher who expects to understand why his efforts are sometimes so well rewarded and sometimes so seemingly hopeless (Mukherjee, 1968; Hassan and Soreson 1968; Blair, 1968; Butcher, 1969; Walberg 1976; Gardner 1976; Baja 1982; Shuaibu 1984; Hassan 1985). Butcher (1969) is of the view that attitude variables can be of considerable value as predictors of subject choice. Gardner (1969) however explained that attitude research is important because important decisions which students make such as subject and career choices are strongly bound up with their attitudes.

Though it should be pointed out that positive attitude towards a school subject is not the only factor that promotes achievement, lack of it however could mitigate a student's effort to improve on a consistent poor performance in a subject. This study tried to determine the effect of attitude on the understanding of physics concepts by Nigerian pupils for Duckwork (1977) identified attitudes as one of the correlates of science choice which could often be determined before pupils are forced to make commitments towards arts or science.

2.3.5 Extroversion And Neuroticism

Carl-Jung (1965) divided individuals on the basis of personality characteristics namely: extroverts and introverts. An extroverted person is one whose interests, attentions are directed towards external stimuli. He is sociable,

talkative and his brain is always under stimulation. He is high scoring, takes risks, outgoing, optimist, active and lively. Another personality trait is neuroticism (neurotic anxiety). This is always characterized by a constant or [illegible] periodic state of apprehensive expectancy. Eysenck (1967) found that neuroticism does not exert its influence unless the testing situation is perceived as provoking. Eysenck (1975) also observed that good educational attainers scored high on neuroticism and low on extroversion scales. Lynn (1983) stated that "It seems probable that various personality and motivational factors are likely to be important for educational achievement. While Grey (1973) found that individuals with a high level of anxiety form conditional responses more easily than individuals with low level of anxiety. On a study of personality characteristics, Denis (1972) reported that science specialists are more introverted and less neurotic than arts specialists. The Encyclopaedia Britanica (1969) defined personality as a unique organization of the individual that distinguishes him from his fellows. The opinion of educators, sociologists and psychologists on personality variables indicate that they play a vital role in the learning process. This study attempted to investigate the effect of some personality variables (extroversion and neuroticism) on the understanding of physics concepts.

2.3.6 The Teacher/Administration

The teacher determines the topics to be learnt, the order of the study, the nature of assignments and the time of testing. He also ensures discipline and conducive atmosphere for classroom instructions. How he handles these activities determines the outcome of the classroom activities. If a teacher establishes his authority and knowledge, he earns the legitimacy to exercise power in the classroom while a weak teacher on the other hand finds that his legitimacy is always challenged and the students will try to control the classroom and cause confusion. Bajah (1977) commented on the importance of the teacher as follows: "No matter how well our thoughts about science have been developed and documented, no matter how realistic we think our objectives are, the success of our science programme depends to a great extent on the classroom teacher." It is he in the final analysis who translates our thoughts into action. Closely related to this point of view is the observation by Orisaseyi (1976) of secondary school physics teaching thus "It is an observed fact that most secondary school students find physics difficult and therefore develop antipathy against the study of the subject, but it is possible that the difficulty arises from the bewildering way teachers present and teach the subject matter physics." These statements reinforce the importance of qualified, knowledgeable professional teacher for effective instruction.

A number of studies have shown that the personality and behaviour of the teacher is an important variable in the formation of positive attitude towards physics by pupils. (Good, 1970; Davidson, 1972; Schwab and Cherline, 1972; Shaycroft, 1975; Shuaibu, 1979; Attah 1981).

The physics teacher could also be seen as part of the school administration. He helps in keeping law and order, he recommends books for the students and the library. He compiles list of materials and equipment for physics teaching. He attends staff meetings and makes his views on instruction related issues known. A perception of poor administration of the school by pupils could lead to the collapse of law and order. For unlike factory workers, students interpret and pass judgement on the way they are processed through the organization.

This study therefore tried to find out the effect of the perception of the physics teacher in terms of

(i) His characteristics

(ii) His administrative capabilities

by the pupils on the understanding of physics concepts.

2.3.7 The Laboratory

Laboratory work in secondary schools is undergoing rapid change from the emphasis on verification experiments in the traditional mode to one in which the student is now

invited to investigate a problem. In effect the laboratory is becoming increasingly an indispensible part of an effective course in science. Here again the teacher plays a central role. Neither good equipment nor excellent facilities will result in effective use of the laboratory if the teacher does not have an adequate understanding of the science and the essential role of the laboratory in the science course (Killian, 1967). The laboratory in a science course is concerned with a combination of facilities and techniques that will enable the student to observe natural phenomena with a discerning eye. The laboratory is therefore an integral part of the course of instruction, related inherently to class discussion and text materials.

The study of science through laboratory experience serves a dual function. Firstly the student learns how to grow in his knowledge and understanding of science concepts. Secondly he learns the concepts and facts of the science itself. This study investigated the effect of the pupils' perception of their laboratory on their understanding of physics concepts.

2.3.8 Capital Cultural Factor

The home where one grows up has an important influence on who and what he becomes (Kalinowski and Stone, (1981). The capital cultural factor looks at the parents' aspiration for the child and their interest in the knowledge of and

standards of reward for the childs' educational achievement. The quality of language used in the home; the availability and quality of help provided by the home (Parents, senior brothers and sisters or a hired teacher for related tasks). The intellectual interests and activities of the family. The types of reading done, the nature and extent of conversation about ideas and the nature of intellectual models parents provide. The extent to which parents stimulate and encourage their children to explore the larger environment, the degree of structure and routine in home management and emphasis on educational activities over other pleasurable things (Marjoribanks, 1980).

The intuitive sense of the family to mould to some degree the future of the child has been the object of research by educators and social scientists of all persuasions; (Leichter, 1974, 1979 Hassan, 1976). Sewell, 1976; Marjoribanks 1980; Cuttance, 1980; Kalinowski, 1981; Fraser and Fisher 1983; Lynn, 1984). In late seventies most universities in the United States of America showed concern over the home influence on the education of children. It was hoped that the information adduced would serve as a basis for intervention programme that would be beneficial to both parents and children (Kailinowski, 1981) • Also Bloom (1980) explained that there was a curriculum and teaching style in each home which accounted for differences in a child's preparation for guidance

through the learning tasks of school. Speaking on home culture Dave (1963) Wolf (1964) were of the view that familial interactions could be identified as relevant to the development of particular individual characteristics. It is generally agreed by sociologists, psychologists and educators that irrespective of parents financial means and educational aspirations, the culture of the home and community affect educational chances (Simpson, 1968; Sorenson, 1968; Ghatala and Frayer, 1972; Benard, 1973; Blakemore 1981).

This study therefore tried to assess the effect of cultural factor on pupils' understanding of physics concepts.

2.3.9 Environment And Peer Group

(a) Environment. Differences in environment and experience are to be found even for children in the same family. The differences are much greater between children of different families or communities and enormously greater for different countries and cultures. Despite a long standing tradition for researchers to concentrate either on persons or situations, there is evidence of a recent movement towards a synthesis of the two and strong encouragement of educators and psychologists to direct more attention to the person-environment interaction as a key determinant of students classroom functioning and achievement (Endler and Magnusson, 1976; Doyle, 1976; Kahle, Riding, 1979 Dahl, 1983; Magee et al

1984). Armor (1972) was of the view that if differential in achievement among children from different social groups are to be reduced then programs should give as much attention if not more to the environment both family and neighbourhood in which the child lives. Also Lovell (1962) revealed that "concept formation" is likely to be aided by memories and images of events and objects within the environment. He cited the example that as the child is building up his concept of transport he is helped by memories of car and train journeys and by images of ship seen at the seaside and aeroplanes flying over his hometown. He also showed that adolescents and young people from stimulating backgrounds were able to categorise and form fresh concepts superior from those of less favourable backgrounds. Stone (1969) expressed identical view when he explained that when the environment is grossly deficient in stimulation the development of the child is correspondly retarded. Children from slumps are likely to suffer from effects or neglect to a greater degree than other children. A survey by Manchester school of education (1964) showed that poor social environment is closely related to poor school attainment while Burt (1979) reported that backward children were to be found in greatest numbers in poor and overcrowded areas.

(b) Peer Group. As children grow older they begin to move away from their families and start to relate to their peers. A peer group is a homogeneous age group. All the members are of the same or very similar age. Musgrave (1973) warned that he who during adolescence does not master the social skills of mixing with his peers will not be able to lead a normal adult life. Adolescence is one of the critical periods of human development. Also the way friends in general and best friends in particular view and perform in science may be an important influence. Peer will influence fundamental attitudes, values and other goals of young people. This relationship intensifies and reaches its peak during the adolesence period (Eisenstadt, 1966; Shortrom, 1974; Simson 1982).

This study therefore attempted to determine the influence of environment/peer on pupils' understanding of physics concepts.

2.4 Concept Attainment

The process of acquiring additional concepts is called concept attainment as distinct from concept formation which is the way children learn to think conceptually. The Wisconsin Research and Development Centre for Cognitive Learning Technical Report No 197 (1971) has stated that "In assessment of concept attainment the learner may be

asked to demonstrate his attainment of a concept by performing a variety of tasks. The ability to perform one or more tasks is usually taken as the critical evidence that a student does or does not understand a concept." A scheme was developed by Frayer Fredrick and Klausmeier (1969) for testing the level of concept mastery. It consists of ten types of questions each of which gives an indication of some level of understanding of a concept. These are:

1. Given the name of an attribute, select an example of the attribute.
2. Given an example of an attribute, select the name of the attribute.
3. Given the name of a concept, select an example of the concept.
4. Given the name of a concept, select a non example of the concept.
5. Given an example of a concept, select the name of the concept.
6. Given the name of a concept, select the relevant attribute(s).
7. Given the name of a concept, select the irrelevant attributes
8. Given the definition of a concept, select the name of the concept.
9. Given name of the concept, select the definition of the concept.

10. Given the names of two concepts, select the relationship between them.

Also as a modification of Klausmeier and others' work, Voelker, Sorenson and Frayer (1971) came up with more ways of assessing concept attainment. 'A concept may be described in many ways in terms of its criterial relevant and irrelevant attributes, its examples and non-examples, its supra-ordinate, coordinate and subordinate hierarchical relationships (theoretically determined) and its lawful or other types of relationships to other concepts. Knowledge of each of these kinds of information may be tested to determine a student's level of attainment of a concept.

They went further to recommend that from the nature of the tasks identified above, the multiple choice format, which requires an examinee to select an answer, is preferable to a testing format which requires an examinee to produce an answer. The modified scheme which has been used widely both in U.S.A and Britain was adopted for the purposes of constructing and scoring the concept attainment test.

2.5 Related Studies

The review of related studies has been divided into two major sections. These are (a) Studies done in Nigeria (b) Studies done outside Nigeria.

2.5.1 Studies Done In Nigeria

Very few studies have been done in the area of concept learning in science in Nigeria. So far, it seems that very few studies were conducted in the area of physics concepts learning. More attention was therefore given to the studies on related variables rather than concept learning.

(i) Oyenoyin and Balogun (1981) studied the performance of some Nigerian pupils on some selected concepts in Integrated Science. The objective of the study was to find out (i) the extent to which Nigerian pupils exposed to the Nigerian Integrated Science Project mastered some of the fundamental concepts (energy, heat, solutions and motion/movement) treated in the project. (ii) Whether there were significant differences in achievement at various cognitive levels. (iii) Which of the concepts concerned was most easily mastered by the pupils. The subjects were two hundred pupils randomly selected from five secondary schools in Oyo State. The instrument used was an achievement test constructed and validated by the researchers. They found that achievements at lower cognitive levels were significantly better than at higher cognitive levels. The correlation between the basic knowledge and comprehension levels and application and integration levels was the lowest. The descending order of case of mastering the concepts

was found to be energy, heat, motion/movement and solution, although the difference between the means were not significant. The reviewer noted that a single achievement test was inadequate to elicit all the information listed as objectives of the study also the ranking of the concepts did not give any insight into their difficulty indices since the means were not significant. This study is related to the present study only to the extent that it is dealing with concept mastery and it identifies science concepts as a necessary area to be investigated by Nigerian educators

(ii) Ehindero (1982) investigated the developmental analysis of certain Piagetian Concepts of distance, area and co-ordinate reference systems in relation to the displacement volume task. His sample consisted of 300 randomly selected primary and secondary school children in Nigeria. Four tasks were used to investigate the acquisition of these concepts developmentally and the data obtained were analyzed by the Chi-square, Pearson Correlation Coefficient and the 50% success criterion suggested by Laurendea and Pinard (1962, 1970). The data confirmed Piaget's theororizing but when compared with similar studies in Europe and America Lovell (1971), Dansen (1972), Karplus et al (1977) a "developmental lag" of about two years was observed among the Nigerian

students. The study confirmed that Nigerian students conformed with Piaget's developmental stages but the researcher did not give enough evidence to show that the students he compared their rates of development in Nigeria and Europe were of the same age and at the same educational levels. He however, explained that most of the tasks demanded scientific inferences which are abundantly available to a highly literate and technologically advanced western culture. Children developing in such a culture are naturally bound to interact and comprehend some of the principles involved in solving these tasks. Ehindero's study suggested that environmental factors could promote or inhibit concept attainment. Though he compared Nigerian and European pupils, the present study will be concerned mainly with the effect of such variables on Nigerian secondary school pupils and to what extent the variables affect physics concept attainment in particular.

(iii) Okeke (1976) studied the understanding of transport mechanism among Nigerian school certificate biology pupils. One hundred and twenty candidates were questioned orally using prepared tasks in order to test their understanding of the concepts and ideas subsumed under the heading (Transport Mechanism . She subjected the data to rank order correlation and two way analysis of variance. Her findings showed that many of the ideas involved in this area of biology were poorly understood and some even

misunderstood. This is a useful study that tried to elicit information on a specific biology concept with a view to finding remedies to any problems that might be identified as a result of the study. Okeke's study shows the need to investigate Nigerian students' understanding of science concepts generally and physics concepts in particular. A poor conception or misconception of science concepts as Okeke's study has shown, could create an awareness of students' problems to the teacher who would then strive to seek ways of minimizing or solving such problems. The sample for the study is small for a generalization for Nigerian students as the researcher stated.

(iv) Mukherjee (1980) studied the effect of personality factors on the performance of secondary school students in mathematics. He administered the AH_4 Reasoning Ability test and the Junior Eysenck Personality Inventory on 1900 form III secondary school pupils in some selected states in Nigeria. He found that the best performance in mathematics were the students with low level score on anxiety and extroversion. The result of this study showed that there was a low correlation between mathematics achievement, anxiety and extroversion. The size of the sample and the spread of the sample over a number of states lends support to the acceptability of the findings

of the study. Mukherjee's study differs from the present study in that his respondents were form III students and the dependent variable was mathematics. Any dissimilarities in the findings of the two studies could be attributed to these differences.

(v) Kolawole (1982) studied the relationship between school certificate pupils' attitude and their achievement in biology. His sample consisted of 100 pupils, 50 boys and 50 girls who were prospective candidates for June 1980 school certificate biology examinations in Ibadan Oyo State. The pupils were selected by random sampling. Fifty three specifically designed and validated questions on photosynthesis, respiration and related physical science concepts (designated 'core concepts') were presented orally to the participants in individual interviews to probe their comprehension of these concepts. Their answers were tape recorded, later transcribed and scored using specially predetermined criteria. The respondents were also given questionnaires to complete on attitude towards biology and pendulum test for reasoning ability. He found that pupils did not match their positive attitude with corresponding achievement as their overall performances were poor. The administration of 53 item-questionnaire orally does not seem appropriate as the respondents could get bored and supply answers without given serious thought to the questions. This study

indicated that positive attitude alone does not guarantee good performance. Closely related to this is the study by

(vi) Orisaseyi (1978) titled 'A critical look at the attitude of secondary school pupils to physics'. 6 secondary schools were randomly selected from Ibadan city in such a way that there were 2 female schools, 2 male schools and 2 co-educational schools. A total of 945 students made up of 524 boys and 421 girls were used for the study. She found that the students had positive attitude to physics. She blamed teachers for the poor performance of students in WAEC physics examinations. The study attempted to draw conclusions beyond what it set out to do, this is indicated by the fact that there was no evidence for WAEC result and no instrument to test physics teachers' performances. The present study is similar to this in the selection of the sample. Orisaseyi tried to accommodate male, female and co-educational schools like the present study. It has also tried to find out the attitude of Nigerian pupils to physics. Attitude towards physics is one of the variables for the present study. Orisaseyi's study differs from the present study in that the present study tried to establish a relationship between attitude towards physics and physics concept attainment, it also tried to delve further into the attitudinal problem by attempting to establish the

extent to which right attitude or lack of it contributes to physics concept attainment relative to other variables used in the study.

(vii) Daramola (1983) sought to find the influence of location and sex difference on the knowledge of basic physics possessed by entering form III studdents in Kwara State secondary schools. His sample consisted of 172 boys and 110 girls entering form III. They were chosen from 5 urban and 4 non urban secondary schools in Kwara State. The researcher developed a 25 items multiple choice questionnaire called 'Basic Physics Test'. Eight of the items were drawn from mechanics, six from heat, two from light and four from electricity and magnetism, 5 from elementary mathematical calculation. All the materials on the test were based on the general science syllabus for forms I and II of the secondary schools in Nigeria. The data collected were subjected to stepwise regression analysis. The results of the study revealed that the urban students obtained a mean score which was significantly greater than that obtained by non-urban schools. The mean scores on the Basic Physics Test for male and female were not significantly different. He explained that the difference in performance could be attributed to the fact that urban schools had more qualified teachers and facilities. Judging from the areas the physics items were drawn from, one would be

tempted to conclude that the items were rather few for the study. Daramola's study call for the need to establish the affect of such variables as teacher characteristics and laboratory factor on physics concept attainment. The present study has attempted to investigate such a problem as the two variables are included in the study. The present study is also using stepwise regression analysis.

(viii) Bajah (1979) studied the correlates of students extrinsic school environment factors with level of attainment in a standardised test in chemistry. The correlates were laboratory adequacy, number of chemistry text-books used, teacher attendance at Teacher Vacation Courses and type of school. The sample for the study was drawn from the secondary school population of one of the states in Nigeria. It consisted of 103 form five chemistry students from twenty secondary schools in the state capital. The sample was drawn from male, female and co-educational schools. A standardized chemistry test was administered on the form five students. The data collected were subjected to PDP statistical package. One of the findings of the study was that there was no significant correlation between laboratory adequacy and chemistry test scores. He stressed that there was the need to emphasisze the unique role of the teacher more than the equipment in the laboratory. He contended that

cupboards full of equipment are only helps to excellence in teaching. The population and statistical technique for the study are quite appropriate but the teacher was not one of the variables. The emphasis on the role of the teacher appears unjustified from the objectives of the study.

The similarities in Bajah's study and the present are: use of form V students as the respondents to the instruments and the laboratory as one of the independent variables. However the present study is on physics concepts and the sample was drawn from both a state capital, urban and rural areas. The main objectives of the two studies are also different.

(ix) Jegede (1985) examined the ways in which characteristics of the educational environment of the home, school and classroom affect students achievement in physics. His sample consisted of 168 form five students and their respective teachers from 11 secondary schools in Imo State. The instrument used included (i) An achievement test constructed and validated during the study. The 50 items were drawn from topics taught and supplied by the physics teachers (ii) Three questionnaires for the students, teachers and school authorities adapted from IEA (1973) studies in mathematics and science were used. The data obtained from the administration of the questionnaires were saubjected to group means, variance,

t-values, correlation coefficients and others. He found that, educational and occupational status of the home; teachers interest in physics teaching; homework load given by the teacher, students attitude towards physics and students perception of the relationship between physics and society correlated positively with achievement in physics while locations of home and school in terms of rural or urban correlated negatively with physics. Though the sample size was small and the data subjected to many statistical techniques, the objectives of the study are worthwhile. Few of the variables used by Jegede namely home and school environment and attitude towards physics are used in the present study. However most of the variables used by Jegede are different from those for the present study. The present study will not only determine the relationship between the independent variables and physics concept attainment but would attempt to determine the extent of the influence of each of the variables on concept attainment.

(x) Abubakar (1979) studied the relationship between personality factors, attitude, self concept and mathematics achievement of secondary school pupils in Kaduna State. His sample consisted of 200 pupils, 100 boys and 100 girls. His instruments consisted of the JEPI, a self concept inventory and a mathematics achievement test specifically designed for the study.

He found that there was negative correlation between extroversion, neuroticism and mathematics achievement for both boys and girls. This study is useful as it could help to guide and counsel students with personality problems over their study of mathematics particularly as it is found out that personality factors do not affect performance in mathematics.

(xi) Nema (1978) studied the socio-economic background of students of Basawa teachers' college and its impact on their academic achievement. His sample consisted of 120 students of the college. He administered an achievement test and socio-economic inventory on the students. He found that the adverse influence of number of children was minimal and socio-economic background had no influence on pupils' academic achievement. Parents assistance and encouragement promoted the academic performance of the students. Though the statistical technique of mere percentages seems inadequate, it is noteworthy that the study found no relationship between socio-economic background and academic achievement.

(xii) Fika (1978) studied the relationship between parental background and pupils' educational achievement in Fika local government area of Borno State. He interviewed 70 parents and gave attainment test to 70 pupils who were children/wards of the interviewed parents. He

found that the educational background of parents had close relationship with the pupils' educational achievement. There was no relationship between occupation, level of wealth and educational achievement. This is a worthwhile study as it identifies the need for parents to be literate in order to help pupils' with their studies.

Studies X, XI and XII were all carried out when the government was in a position to supply almost all the educational needs of the pupils particularly in the State where the sample for this study was drawn. The present study tried to determine the effect of these background variables now that parents and guardians are called upon by the government to shoulder the greater part of their children's educational needs coupled with depressed economic situation.

2.5.2 Studies Done Elsewhere

In this section, related studies outside Nigeria would be discussed. Efforts will be made to highlight where these studies are similar to the present study and where they differ. The gap in the existing studies which the present study intends to tackle would also be mentioned.

(i) Reading Comprehension Ability. Goslin (1978) examined the relationship between reading ability and science concept achievement of Puerto-Rican students enrolled in

bilingual science education programme. He examined the relationship between oral language proficiency, Reading Ability and Science achievement. He used two instruments namely: The oral language proficiency test and a reading comprehension test. He subjected the data collected to a simple correlation test. He found that there was a high correlation between the variables and science achievement. He concluded that proficiency in English was a strong indicator of science achievement. Though this study is simple in design and the number of respondents to the questionnaires was notmentioned, it was a worthwhile research as it was able to highlight the relationship between reading comprehension ability and science achievement.

Adrian and Raven (1978) studied the relationship between reading comprehension, self concept and science achievement among "average and above average students" in ninth to eleventh grade classes. His respondents were made up of 249 students. The instruments used were Raven reading comprehension test (RRCT), the self concept Ability scale (SCAS) the Sequential Test of Education Progress series II (STEP).

Science and mathematics achievement scores were obtained from school records. They described the study as a correlational study but did not give details of the type of correlation used. This is a worthwhile study on reading comprehension and science achievement but it

could have been more informative if below average students were included in the study. They found that, there was a positive correlation between students' reading comprehension ability and science achievement.

Fraser and Fisher (1983) studied student-achievement as a function of person environment fit. The sample consisted of a representative group of 116 pupils. A total of 29 variables were used to explore the relationship beteen achievement and person environment fit. The data collected from the 29 variables were subjected to stepwise multiple regression analysis. They found that reading ability had a high significant effect (22.5%) on science science concept attainment among others. This result is obtained from the series of intercorrelations and subsequent regression analysis. The studies of Goslin , Adrian and Raven and Fraser and Fisher support the need to study the effect of reading comprehension ability on science concept attainment among secondary school students in Kaduna State.

Mallinson (1975) in a summary of research in science education, stated that, there was a growing interest in science education in the relationship between reading and science achievement. He later gave a summary of the following research studies:

(i) Brown et al (1964) studied the relationship between the acquisition of science concepts and reading comprehension among Anglo-American pupils. He found there was a positive correlation between comprehension ability and concept acquisition . (ii) Davis (1973) found that the difficulties encountered in problem solving in science are due to inability to read analytically in order to select details; locate and remember information, organize what is read and seperate essential data from non-essential data. While Thorndike (1973) identified background factors that seemed to be moderately predictive of the achievement of individual pupils as reading comprehension and socio-economic variables such as: parental occupation, education, as well as reading resources at home. Although the details of, sample, types of instruments used and statistical technique were not stated it is pertinent to point out that all these studies identified reading comprehension ability as a possible predictor of science concept attainment potentials. Yow (1975) studied the effect of reading comprehension on Science - A Process Approach. The subjects were 48 boys and 34 girls who were divided into two groups one group as control group and the other as experimental group. The treatment lasted for six months. At the end of the treatment all the subjects were administered the reading section of the Carlifornia Vocabulary and reading

comprehension achievement tests. The data were analyzed using Harvey's least square analysis. The analysis indicated that the experimental group did not score significantly higher than the control group on reading comprehension scores. Equally significant differences were not found for the average and superior subgroups in reading comprehension achievement. This makes the effect of reading comprehension on learning achievement inconclusive as the result of this study did not agree with those of Goslin, Adrian and others.

Preston (1962) compared the reading achievement of German and American children. He used fourth and sixth grades pupils from the two countries. He administered tests of reading comprehension, speed and retardation. Though the mode of analysis was not mentioned, he found that with American children, the mean scores of girls were superior to those of boys on all tests in both grades while the mean scores for German children showed that boys means scores exceeded those of the girls on all tests. This international study shows that there is no clear-cut result on reading comprehension ability of students (male or female).

In most of the countries where the reviewed studies were conducted, English language is the only medium of instruction. This supports the need to find out the effect of reading comprehension ability on physics

concept attainment in Nigeria where many languages are spoken along with English language.

(ii) Reasoning Ability. Elmer, Lemke, Herbert and Klausmeier (1967) studied the relationship of selected cognitive abilities to science concept attainment and information processing. The respondents to the instruments were 94 secondary school pupils, 34 task ability variables were intercorrelated and factored using Alpha factor analysis. The 12 alpha factors were rotated to an oblique solution according to the Harris-Kaiser criterion 3 abilities; General Reasoning Induction and Verbal Comprehension were found to be related to concept attainment and information processing. This is a worthwhile research as it attempted to elicit the relationship between reasoning ability verbal comprehension, induction and concept attainment using standard statistical techniques. The study of these variables by these scholars, shows their importance as possible predictors of concept attainment capabilities as the present study tried to find out. Karplus et al (1977) administered two Piagetian tasks: Ratio Paper Clip task and the control of variables task by Wollman to approximately 3,500 students. The researchers analyzed test scores in terms of concept attainment, reasoning ability, gender and socio-economic status. They found that reasoning ability affected concept attainment, gender

has no significant effect on concept attainment and socio-economic status of parents had significant effect on concept attainment. The number of respondents used for this study favours the acceptability of the findings though the statistical technique adopted was not made explicit. It is noteworthy that reasoning ability was found to promote concept attainment.

Pella and Carcy (1969) studied levels of maturity and levels of understanding for selected concepts of the particle nature of matter. The respondents consisted of pupils in grades 2-5 from the Oregon elementary school Wisconsin-140 in the second grade, 152 in third grade 150 each from fourth and fifth grades. Instruction proceeded with 30 pupils per class at each grade. The procedure was three 30 min periods of instruction and two 30 min periods of testing. The rolls for each class were rank ordered according to the pupil's I.Q score on the Kuhlmann-Finch test. A number of statistical techniques were used for the analysis of data namely: rank order; means and standard deviations, correlation and analysis of variance. They found that the level of mastery attained with respect to a concept appears to be in part a function of level of maturation of the pupils. They also found that the degree of relationship between concept test scores and reasoning ability is greater at higher grades than at lower grades. Though this study was for

elementary school pupils, the experimental design and the nature of the variables make the findings withwhile and acceptable. The present study differs from this in that it was carried out over a short period of time and with secondary school pupils. The two are however similar in trying to establish a relationship between concept attainment and reasoning ability.

Lawson and Nordland (1977) studied: conservation, reasoning ability and performance on BSCS blue version examinations using 23 higher school pupils enrolled in Biology. Though the nature of the instruments was not mentioned, the researchers used correlational technique to analyse the data collected. They found that those with higher reasoning ability found the course less difficult. This study is worthwhile as it could assist the teachers to determine which group of students needed assistance.

Peterson (1978) in a summary of research in science education reported the following research findings: Mebridge (1978) studied American pupils aged 14^{+}. He found that there was a significant relationship between reasoning ability and achievement in selected concepts. The present study varies from Mcbridge's because pupils of 16 and above are used and physics concepts only are considered and the pupils are from a developing country. Lunzer (1969) found that the

earliest age at which pupils are able to study science with real appreciation of core concepts is determined by the rate of development of their reasoning ability. His study found a positive relationship between reasoning ability and core-concept attainment. Lockley (1977) found that there was no significant relationship between level of reasoning ability and area of academic specialization in science and humanities. Lockley's finding supports the present writer's claim that the research findings on the variables appear inconsistent.

(iii) Parents' Background and Capital Cultural Factor

Lynoh et al (1979) investigated the effect of: age, gender, reasoning ability and socio-economic status of parents on scores of essential science concepts definitions. 1,635 Tasmanian school pupils were used for the study. The instruments consisted of four tasks for reasoning ability namely: Balance task, Ratio task, Metric puzzle and Islands puzzle, Parents' educational and occupational Inventories and definitions of selected concepts. Pearson correlation and multiple regression analysis were used to analyse the data collected. They found that verbalization of simple but important reference concepts were somewhat neglected in the classroom and laboratory dialogue; the average total score increased significantly with socio-economic status and there was significant

positive effect between reasoning ability and concept scores. This is a worthwhile study as it gave insight into the effect of reasoning ability and socio-economic status of Tasmanian pupils on their concept attainment. The variables like reasoning ability socio-economic status are used in the present study also the two studies adopted the same statistical approach for the analysis of data but it should be pointed out that the studies vary in location culture and sample.

Nelson (1979) studied the grade placement of concepts of light and sound. 919 students in grades 10, 11 and 12 were used for the study. The instruments consisted of 20 achievement questions based on the concepts of light and sound, the educational and occupational inventories of parents and a personal data inventory. The data were subjected to correlation and regression analysis. He found that pupils in grade 12 made the most significant gains and neither socio-economic background nor sex was a significant factor in determining the observed gains. This study was worthwhile because it would enable curriculum experts to know exactly where to place the study of light and sound in the school curriculum. This study is similar to the present study in choice of the independent variables and method of analysis of data but

varies with it in the choice of dependent variable, location and culture of the pupils.

Fournier (1976) tried to determine if cultural differences existed between Mexican and Anglo American students on how they perceived science concepts. He used 298 secondary school students. His instrument consisted of science concepts Instrument (SCI), Cultural Background Information and Socio-economic Inventory. A simple correlation analysis was used to analyze the data. He found that SCI correlated significantly with the father's educational level. A significant correlation existed between the scores on the SCI and sex within Mexican American children group but not within the Anglo-American group. Correlations between the SCI and cultural background, language background, age and father's occupational level revealed no significant differences. Though the design of the study can be described as simple, it supports the notion that there seems to be some disagreement on the findings of researchers of the effect of culture and socio-economic background on science concept attainment.

Chao (1975) attempted to ascertain whether the elements perceived in the physics concepts of mass and weight differed for students of different cultural backgrounds. The variables consisted of sex, score on the Carlifornia Short-form Test of Mental Maturity and

reading score. The respondents were made up of 38 students. The method of analysis of data was not mentioned. He found that there were cultural effects on perceptions of physics concepts resulting from human relationships and societal economic achievements among others. Though the sample was small and the mode of analysis not mentioned it is worthwhile to note that culture affects perception of physics concepts. This finding supports the need to study the effect of such variables as capital cultural factor and socio-economic backgrounds of students on physics concept attainment.

Shaycoft (1975) examined the growth in performance from grades 9-12 employing a variety of statistical techniques including step-wise multiple regression analysis and factor analysis. He found that socio-economic status had little direct effect in accounting for variation in performance over three years. This differs from the findings of Nelson and Chao but agrees with the findings of Lynoh and others. Shaycoft study varies from the present study in that it was over a long period of time and in a developed country.

Giddings (1966) studied the factors related to achievement in secondary school science in disadvantaged areas of New-York City. Two groups were selected for the study, one was called the high science achieveing group and the other low science achieving group.

500 students were used for the study. The study investigated socio-economic status of parents, family size and structure, home facilities for school work, attitude towards science among others. Standard statistical procedures (Not mentioned) were used to test the null hypotherses. The findings showed that the socio-economic status of students made no significant difference in the performance of the two groups. Low science achievers tended to come from larger familes. There were significant differences in favour of the higher achieving group in terms of degree of contact with books and magazines, interest and encouragement by parents, the use of cultural facilities for the preparation of homework and a place which was conducive to study and free from emotional tensions and disturbances. This study delved into the capital cultural factors of disadvantaged Negroes and Puerto Ricans in America with a view to finding how to improve the education of the pupils. It is quite a worthwhile research. It is noteworthy that capital cultural factor is one of the independent variables for the present study.

The reviewed studies on home-background and capital cultural factors show that research findings on their effect on science concepts appear inconsistent. For example, findings from Nelson and Chao differ from those of Lynoh et al and Shaycoft.

(iv) Personality Variables (Extroversion and Neuroticism)

Mendick (1967) studied the personality characteristics of Grade II pupils in U.S.A. 200 grade II pupils filled the Taylor Manifest Anxiety Scale (MAS). He found that high anxious group showed consistently greater median amplitude than the lower anxious group. This study is only helpful to the psychologist as it compares high and low anxious people. This study carried out a comparison of low and high anxiety groups but did not relate it to the effect of anxiety on achievement as the present study has set out to accomplish.

Arnoff (1969) investigated the correlation between students' scores on MAS and their scores on science concept attainment. He used 320 students drawn from 15 secondary schools. He administered the concept attainment test and MAS on the students. The scores on MAS and Concept attainment tests were correlated. His findings revealed a high negative correlation between scores on anxiety scale and scores on concept attainment test. He also reported that the decrement in concept attainment due to high axienty was greater on more difficult questions. Such a study could be helpful to both the science teacher and the counsellor to assist a student with neurotic problem. Arnoff study shows that there is a negative correlation between neuroticism and concept attainment. This supports Mendick finding. It could be mentioned that

all these studies are done in developed countries with different cultural and environmental situations. The findings of the present study could differ from these owing to the differences.

Riding and Dyer (1981) studied extroversion, field independence and performance on cognitive tasks in twelve-year-old children. His subjects consisted of 120 twelve-year-old children. Sex was not included as a variable. The JEPI; Group Embedded Figures Test, Test for prose recall, Test for Verbal Imagery learning style were administered on the students. The data collected were subjected to analysis of variance. They found that extroversion was unrelated to concept attainment. This study dealt with cognitive tasks and 12 year old which is different from physics concepts and 16 year old pupils used in the present study. Conklin and Ogston (1968) studied the prediction of academic success of freshmen at the University of Calgary and found that there was negative relationship between extroversion and academic success and very low correlation between neuroticism and academic success. Closely related to this, is the study by child (1964) in which he studied the relationship between extroversion, neuroticism and performance in school examinations. He used 200 pupils from urban comprehensive schools in Leeds. He administered the JEPI on the pupils. He reported that extroversion,

neuroticism were statistically unrelated to school attainment. He added that demoted pupils were mainly extroverts. Such a study is worthwhile for guidance and assistance to students with personality problems.

Mendick, Arnoff, Dyer, Ogoston and Child all reported negative or low correlation between concept attainment neuroticism and extroversion. It could be recalled that Mukherjee's finding with form III mathematics students in Nigeria did not differ from these findings. It is noteworthy that it seems the findings are inconsistent as some obtained negative correlation and others low positive correlation. The present study is dealing with 16^{+} year old pupils and physics concepts. Any discrepancies in the findings could therefore be attributed to age and subject studied.

(v) Attitude. Lawrenz (1976) studied the relationship between selected teacher characteristics such as knowledge of subject matter, experience among others and student outcomes such as achievement and attitude towards science. In order to gather data, a stratified random sample of 236 secondary science teachers from 14 states were selected as subjects. Each teacher randomly selected one of his classes to complete four instruments including students attitude scale. Canonical correlation was used to examine the relationship between the teacher and student variables. There was a significant relationship between

teacher characteristics and students achievement and attitude. This study indicated that good teacher characteristics promote students achievement and attitude to science. It supports the need to study teacher variables and attitude toward physics as the present study sets out to accomplish.

Gardner (1976) studied physics students' attitude towards physics. 1,014 students using PSSC materials were studied using three instruments developed by the researcher. In addition to the instruments, the personal preference index (PPI) measured personality characteristics. He found that males have better attitude towards science than do females. Higher achieving students have better attitude towards science than do lower achieving students. He also reported that more enjoyment of science lessons was found to be associated significantly with students perception of the teacher as well organized, intelligent, ambitious and stimulating. This is a worthwhile study as it tried to establish that positive attitude towards physics and well organized and ambitious teacher seemed to promote physics instruction. Gardner's study recognized attitude towards physics and teacher characteristics as important instructional variables. The present study tried to determine how these same variables affect the understanding of physics concepts among selected Nigerian students.

Ward (1976) studied secondary school biology, chemistry and physics students in 12 states in U.S.A. to assess their attitude toward science. The attitude toward science was measured by Moore's Science Attitude Inventory (SAI). In addition to this, science concept attainment test was given to the students. He found that there was relationship between positive attitude towards science and science concept attainment. This study re-inforces the need to inculcate positive attitude towards science in students. The present study tried to determine the effect of attitude towards physics on physics concept attainment in an environment completely different from the one the reviewed studies on attitude were carried out.

(VI) Environment/Peer

Talton and Simpson (1984) studied the relationship between peer and individual attitude towards science. The investigation was part of a large longitudinal multidimensional study designed to follow students achievement from grade six through ten. 4,500 students were administered effective and achievement instruments at the beginning, middle and end of the year. One subscale was a Likert-type questionnaire measuring attitudes of friends toward science. Friends' attitude towards science was correlated with individual attitude toward science at various time during the year in order to learn more about the relationship between peer and individual

feelings toward science. He found that correlation of peer attitude toward science with individual attitude toward science indicated a strong positive relationship between the two variables. This study revealed that peer interaction affects pupils' performance in science. It therefore seems reasonable to investigate the effect of peer interaction on physics concept attainment as the present study has set out to do. Marijoribanks (1980) studied the relations between school environments and pupils achievement in science concepts. The study involved 20 American schools and 20,000 students from diverse communities. The instruments consisted of a school climate measure constructed for the study and science concepts achievement test, among other variables. The study revealed that when students ability, social status and academic values were controlled statistically by using step-wise multiple regression analysis, school environment had significant effect on students science concepts achievement. This study shows the need to provide a comfortable school environment for studying science. It is therefore desirable to study the effect of environment on students' understanding of physics concepts in Nigeria.

Kalinowski and Sloane (1981) studied the relationship between home environment and school achievement. The study focused on particular educational experiences taking place in the

homes. Six variables were used for the study namely: The parental press for achievement, language use, academic guidance, intellectually, activity in the home and work habits. Each of these six variables was broken down into more specific processes which could be measured along a a nine-point rating with data collected in a semi-structured interview. 150 students were used for the study. The findings showed that the home had its greatest influence on the students language development but was less influential on the specific skills taught at school. This study was worthwhile as it tried to elicit the effect of home-environment on school achievement. The study showed that the home environment had little impact on school achievement. In Nigeria where there are still many poorly equipped homes, for school work, it appears reasonable to study the effect of home-environment on school achievement.

Fraser (1978) studied students perception of their environment. He found that environment perception had incremental predictive validity in accounting for appreciable amounts of variance in learning outcomes beyong those attributable to general ability while Anderson (1970) used pupils from different subject areas and found that course achievement was related to the perceived environment. Also Blowden national survey in Britain (1971) using regression analysis showed that

home and school variables made small but recognizable contributions to change in performance. In Nigerian schools where in some places there are no chairs and desks, rowdy atmosphere seems to prevail most of the time. It appears necessary to determine how the school environment affects physics concept attainment Outtance (1980) studied affective factors in the mediation of background effects on cognitive performance. 500 students were used for the study. The variables were 17 in number. The data collected from the variables were subjected to Pearson correlation and path analysis. He found that home-environment variable was a low predictor of cognitive performance also that parental education had a moderate influence on cognitive performance at age 14. However both scocioeconomic status and parental education had no significant influence in predictive achievement at age 16 once other variables were controlled. This finding appears to be inconsistent with earlier findings like those of Talton and Simpson. The variables suspected to have no effect at 16 are used in the present study. Most of the respondents are 16. The present study would determine the effect of these variables on Nigerian children as against Outtance study in Europe.

Koeves (1975) examined the ways in which the educational environment of the home,the school and the peer group accounted for changes in performance in

science and mathematics at school over a period of one year. A random sample of 242 students was used for the study. The students were administered a science test, an attitude questionnaire in addition, data were collected on the structural and attitudinal dimensions of the home, structural characteristics of the classroom and structural attitudinal and process dimensions of the peer group. He found no direct relationship between peer influence and student achievement in science and mathematics among others. This study appeared to assemble many unrelated variables together but did not explain how the analysis was carried out. It was silent on the effect of the environment on the students' achievement. Keeves finding appeared inconsistent with that of Fraser (1978). The present study is concerned with how the combined effect of environment and peer affect selected Nigerian students physics concept attainment.

(VII) Studies involving two or more of the variables used for the study. Lynn, Hampson and Magee (1985) studied the the determinants of science concept achievement at 16^{+}, the variables were: Intelligence, Personality home background and school. The target sample consisted of all adolescents in their 5th year of secondary schooling in a country town in North. Ireland. The number of students tested were 347

science activities and intensity of practicing science hobbies. Thus, students involvement in science activities outside the classroom did not seem to have an important influence on their attitudes. Similarly the variable mother's educational level did not influence students attitude toward science. This was a useful study in that it gave some insight to how extra curricula activities affected science attitude. This study is similar to the present study to the extent that the same statistical techniques were used and some of the variables are common to both studies. It varied from the present study because its main objective was attitude toward physics while the present study is on physics concept attainment.

2.6 Summary

The literature review reveals that from studies done in Nigeria, there is little or no information concerning factors that affect in particular students' concept attainment in physics and concept attainment in science in general. Concepts form the foundation and provide the framework upon which more complex ideas can be tackled. Educators and psychologists affirm that the variables for this study do influence learning but there seems to be controversy over the form these influences take. It is against this background that the writer has seen the need to study the effects of the variables on physics concept attainment of selected students

Chapter 3

DESIGN AND PROCEDURE

The following details of the study design are discussed in Chapter 3.

The Research model

The Construction of instruments

Procedure for collection of data

Administration of the instruments

The pilot study and

The procedure for analysis of data

3.1 The Research Model

The path model which was developed by Duncan,(1968) in the United States of America and later modified and used in Britain by Tyler (1977) and Hansel et al (1980) was adopted for this study. The model was however modified to accommodate all the variables used for the study. The sketch for the research model is as shown in Figure 3.1. The model shows the hypothesized relationships among the selected variables. The independent variables are numbered from 1-11 and the dependent variable is number 12. The intercorrelations between the variables are hypothesized thus: Fathers' background is likely related to not only the dependent variable 12 but also other variables such as 3, 4, 5, 6, 7, 8, 9 and 11. Variable number 6 (Attitude) is

suspected to be influenced by 1, 2, 3, 4, 5, 7, 8, while it might likely influence 9, 10, 11 and 12. In some cases, the arrows could be reversible. The arrows join variables that are suspected to be related. This model has been adopted in a number of studies in recent times. Such studies as by Benard (1973); Cuttance (1980); Marjoribanks (1980, 1983); Kalinowski and Sloane (1981) Tsoi and Nicholson (1982); Thomas and Ward (1982) Fisher (1983); Lynn Hampson and Magee (1983), 1984) and Hassan (1985) to mention but a few. The statistical analysis associated with the model is discussed later in this chapter.

3.1 The Instruments

Ten questionnaires were used for this study; some constructed by the researcher, others already available and others modified. The full list is as follows:

The Concept attainment test

The Reading comprehension test

The Non verabal reasoning ability test

The Attitude test

The Socio-Economic background information

The Junior Eysenck Personality Inventory

The Capital Cultural factor instrument

Environment and Peer factor instrument

Tutor/Administration Questionnaire and

Laboratory factor instrument.

3.2 The Concept Attainment Test (CAT)

(i) The test was constructed specifically for this study. Initially 50 multiple choice items were constructed based on the scheme by Frayer and Klausmeier (1969) for testing the level of concept mastery and modified by Volker, Sorenson and Frayer (1971). The items were drawn from: Energy, work, Force and Pressure. Each item had four options numbered (a-d) out of which one is the correct answer. The items tested the quantitative level of mastery.

The Item Analysis. The item analysis technique used for this instrument was used for all other instruments constructed for this study therefore a detailed description of the technique follows: The acceptability of each item and the appropriateness of the test instrument were determined by calculating: (a) The facility index of each item as the percentage of all respondents giving an item the keyed rating. (b) The discrimination index for each item and for the whole test. Each respondent was scored according to the total correct answers he obtained from the test. The respondents were rank ordered from highest to lowest score. In order to calculate the discrimination index, 27% of the respondents at the top and bottom of the scale were used.

Macintosh and Morrison (1969) and Shuaibu (1979); have argued that 27% provides the best practical compromise between making the extreme groups as large as possible and making them as different as possible. The discrimination index D was calculated using the formula $D = \frac{N_H - N_L}{n}$

where N_H = No of respondents giving the desired response in the upper 27%.

N_L = No of respondents giving the desired response in the lower 27%.

n = 27% of all respondents in the sample.

The facility index of the item is defined as the percentage of all respondents who make the keyed response to the item. Using the notations explained earlier, the facility index (F) for each item was calculated according to: $F = \frac{N_H + N_L}{2n} \times 100$

All items with $D \geq 0.3$ and $40\% \leq F \leq 70\%$ were selected. In all 30 items were finally selected see appendix (D)

The reliability of the items was determined by Kuder-Richardson formula which states: $R = \frac{n}{n-1} \cdot \frac{s^2 - Pq}{s^2}$

where n = number of items in the test

S^2 = Variance of the total test scores

P = Proportion of sample passing each item

q = 1 - P.

Using the above formula the reliability coefficient of the test was found to be 0.89.

Five experienced secondary school teachers, five lecturers from Advanced Teachers College (A.T.C) Zaria and Kano and four from physics department A.B.U Zaria went through the test items and unanimously agreed on the correct answers. The items were reduced from 50 to 40 after this exercise According to Bloom (1974) this is an accepted method of establishing content validity of an instrument.

(ii) The Attitude Test (TAT). The attitude test was adopted from Akinboye (1975) Personal Attitude and Motivation Inventory, Orisaseyi (1976) Attitude of Secondary School Students to Physics. 32 items were initially constructed. The students were expected to respond on five point scale devised by Likert, Bloom (1971):

Strongly Agree: Agree : Undecided: Disagree :Strongly Disagree

Not all statements were positive in nature. Some were the reverse type or negative type. An example of a a positive type is:

I find it interesting to attend physics lessons. An example of negative statement is: Physics is not good for people. By including negative statement it was hoped that the student would read all the statements carefully in order to respond consistently. The discrimination and the facility indices were determined as described under section 32(i) on concept attainment test. The reliability test using the split half reliability technique gave a reliability of 0.76. The validity of the instrument was carried out by two Sociologists, four Psychologists four Science educators and one Evaluation specialists all from different arms of Ahmadu Bello University, Zaria. After the exercise the items were reduced from 32 to 26.

(iii) The Socio-economic Background Inventory

A Socio-economic background inventory construced by Brown (1982) was adopted for this study; parts of the questionnaire that were not relevant to the present study were deleted. It sought to provide information about educational attainment and occupation of parents.

(iv) The Reading Comprehension Test. A culture free instrument was developed by Aliyu (1984) on reading comprehension specifically for this study. The instrument consists of a passage and eleven multiple

choice questions based on the passage. The time allocated for reading and answering the questions was 30 minutes. The facility and discrimination indices of the items were determined as described under 32(i). It's reliability coefficient (.79) was determined by using Kuder - Richardson formula. The validity of the test was determined by seeking the critical opinion of the instrument from English language experts. 2 from Advanced Teachers' College Zaria, 1 from Institute of Education, 2 from Department of English and 2 from School of Basic Studies (SBS), ABU., Zaria.

(v) The Junior Eysenck Personality Inventory(JEPI). An inventory developed by Eysenck and believed to have minimum cultural influence was adopted for the study. It was used to test extroversion and neuroticism traits in the pupils. The lie variable was dropped as the review of literature indicated that such a variable has not been used in any science education study. The reliability of the instrument was determined by using test, retest technique. The two tests were given at an interval of two months. Two sets of data were obtained from the same instrument. The questions were sorted out as to whether they were for extroversion or neuroticism. The two sets of data for each variable were correlated. Extroversion gave a reliability

(correlation coefficient) of 0.95 while neuroticism gave a coefficient of 0.73 . Both Fox (1969) and Kerlinger (1973) recommended test - retest technique as one of the ways of testing reliability of instruments. They explained that this technique could be used for instruments that do not involve multiple choice or equal number of odd and even items.

(vi) The AH_4 Non Verbal Reasoning Test. This test consists of 65 items each with 5 options of which only one is the correct answer. It is a non verbal test with little or no cultural trait. This test has been used for many studies in the psychology section of the Faculty of Education, Ahmadu Bello University Zaria. Such studies include Ibrahim (1980); Musa (1982) and Jatto (1982). The reliability (.70) of the test was re-established by using the Kuder-Richardson formula. The psychologists from A.B.U. Psychology section and Sociologists from Sociology Department of A.B.U. revalidated the instrument.

(vii) The Capital Cultural Factor, Evironment and peer instrument, Tutor/administration and laboratory factors were constructed specifically for this study.

(a) Capital Cultural Factor. This instrument was constructed by the researcher. It consists of 16 statements that were mainly designed to find out: the main language used at home, the discussion of scientific ideas and events in the home, the concern of parents about the progress of their children in physics learning, the assistance or lack of it of elder brothers and sisters on a pupil's study of physics.

The statements were so framed that a respondent could answer 'Yes' or 'No' to each of the questions. The split half reliability technique was used to determine the reliability coefficient (0.71) of the instrument. The validity was determined by seeking the critical views of 3 Sociologists and 2 Psychologists and 1 Specialist on Evaluation.

(b) The Environment and Peer Factor. This instrument was constructed by the researcher. The instrument consisted of 16 statements that were designed to find out:- The type of environment a pupil lives in crowded and noisy; low density and quiet. The encouragement or lack of it towards learning physics from peer group. The scientific enrichness of the pupils environment and the use of facilities within the environment by the pupils to improve their physics learning. The statements were so framed that

a pupil could answer 'Yes' or 'No' to them. The split half technique was used to determine the reliability coefficient (0.69). Two psychologists, two educators, two sociologists and one evaluation specialist made critical analysis of the instrument from which a final draft was produced.

(c) Tutor/Administration Instrument. This instrument was constructed by the researcher. It consists of 16 statements that sought to elicit information for: the availability or non availability of physics tutors in a school, the characteristics of the physics teacher, the attitude of the physics teacher to his work and the general administration of the school as it involves the physics teacher. The measure used in the instrument utlized a Likert type rating scale. The students were to respond as to whether they,

Strongly Agree : Agree : Undecided: Disagree: Strongly Disagree.

The reliability (0.79) was determined by using the split half technique. The validity was determined by a critical evaluation of the instrument by experts 2 School Administrators, and 4 Science specialists.

(d) The Laboratory Factor. This instrument was constructed by the researcher. It consists of 10 statements which were constructed to find the student's perception of their laboratories. The statements sought information

about, the appropriateness of the laboratory and its facilities; the ability of the teacher to organize activities effectively and the general atmosphere in the laboratory during activities. The Likert type rating scale was used. The reliability of the instrument was determined by using the split half technique. The reliability coefficient was 0.83. Six Science educators and one expert in Evaluation helped to validate the instrument.

In constructing the questionnaires (a-d), the following criteria were used:

(a) The statements were framed in a manner to enable the pupils to respond honestly.

(b) The statements were clear, concise and simple in language.

(c) Positive and negative statements were included to prevent stereotyped responses and ensure some care and sincerety in the responses.

(d) The reliability coefficient of each instrument was determined see table (3.1).

(e) Each instrument was validated.

Table 3.1: Table of Reliability Coefficients of The Instruments.

Instrument	Mode of Determination	Reliability Coefficient	Reliability for similar studies
COT.	Kuder - Richardson	0.89	
R/T.	Kuder=Richardson	0.70	Adeyanju 0.71
CAT.	Kuder-Richardson	0.79	
TAT.	Split - half	0.76	
Extroversion	Test - Retest	0.95	(Tsoi 0.88
Neuroticism	Test - Retest	0.73	(Tsoi 0.75
CACUFAC	Split - half	0.71	
Environment/Peer	Split - half	0.69	
Tutor/Administration	Split - half	0.79	
Laboratory	Split - half	0.83	

3.3 Procedure For Collection Of Data

The data for this study was collected from 16 secondary schools in Kaduna State. The eight educational zones in the state were identified through the help of the Zonal Director of Zaria Zone.

By the use of stratified random sampling, the following types of schools were sampled. 8 Girls Secondary Schools, 4 Boys Secondary Schools, (Co-education), 6 Government Day Secondary Schools. Equal number of boys' and girls' schools could not be used because: prior population

sampling showed that only few girls opted for physics in most schools; only co-educational schools qualified for the study in a number of zones. When all the school types that qualified for the study were identified, two schools were finally selected from each zone by random sampling. The list of schools selected for the study is shown on appendix (C). A table of the distribution of the schools is shown as table 3.2.

Table 3.2: Distribution of Types of Schools Used For The Study.

Zone	Boys' School	Girls' School	Co-educational School
Kaduna	1	1	-
Zaria	1	1	-
Zonkwa	-	1	1
Dutsin-Ma	1	1	-
Malumfashi	1	1	-
Katsina	-	1	1
Daura	-	-	2
Anchau	-	-	2
	4	6	6

This study assumes that there is a fair distribution of the sample for the study.

3.4 Administration Of Questionnaire

The questionnaires were administered from late November 1984 to mid January 1985. A minimum of two days and a maximum of three days was spent in each school. The length of time spent in each school depended on the extent to which the school principal allowed the disruption of normal school activities so that student could respond to the questionnaires. The instruments were administered personally by the writer. All form five students offering physics completed the questionnaires in each school. The only exception was Queen Amina where only two classes out of four offering physics were used. This was to avoid a skewed representation of the sample. 520 pupils made up of 352 boys and 168 girls completed the questionnaires. 24 responses were disqualified some because the instruments were not properly completed; others were those belonging to the Lie Scale in the Eysenck Personality Inventory. 336 boys and 160 girls completed the questionnaires properly. Random sampling was used to select 150 boys and 150 girls from those that completed the questionnaires properly.

3.5 The Pilot Study

A pilot study was conducted between January and March 1984. Three schools were used for this purpose namely:

Barewa College Zaria (Boys only)

Government Girls Secondary School Kofa Gaya (Girls only)

Government Day Secondary School Zaria (Co-educational)

Twenty form five pupils offering physics were selected from each school. The sample was made up of 30 boys and 30 girls.

The main purposes of the pilot study were to determine:

(a) The feasibility of the study through a trial run

(b) The appropriateness of the instruments and the proposed statistical analysis.

(c) The appropriate timing for the completion of some of the questionnaires particularly those that were specifically constructed for the study.

(d) Other administrative problems that are likely to hinder the successful completion of all the tasks proposed in the study.

In early August 1984 four additional variables were added as independent variables these were: The Capital Cultural factor, Tutor/administration, Laboratory,

Environment and Peer factors. The pilot study for these instruments were conducted in the same schools between the end of September and middle of October 1994.

On the basis of the results obtained from the pilot studies, the following ammendments were made:

1. The original plan to use 10 schools and 250 pupils was changed to 16 schools and 300 pupils to accommodate all the education zones in the state.

2. The concept attainment test was reduced from 40 to 30 items. This was to delete very easy items and very difficult items as revealed by the pilot study, and subsequent item analysis.

3. The attitude test was reduced from 26 to 20.

4. The questionnaires were originally designed for form III pupils. It was however discovered that most of them could neither understand the questions nor answer them meaningfully. Form V physics students were therefore selected for the study.

5. It was discovered that there was the need to explain some of the phrases before students could answer the (JEPI) test. During the pilot study most students kept asking for the meanings of such expressions as: 'Get Cross', 'thumping in your heart', 'dizzy turns'.

6. It was also found out that authorization to use the schools was needed from the Permanent Secretary Ministry of Education, Kaduna State. The principals also needed prior information to enable them provide time for effective completion of the questionnaires.

7. The Principals of the schools used for the pilot study complained seriously over the time consumed in filling what they described as numerous instrments. This necessitated the reduction of items in the questionnaires as follows to conserve time.

Capital Cultural factor Tutor/Administration Environment and Peer	From 24 items to 16 items.

Laboratory factor: from 16 to 10 items

3.6(A) Procedure For Analysis of Data

(i) Scoring of Responses. A point was awarded for each question a pupil answered correctly in the following instruments:

(a) Concept Attainment Test up to a maximum of 30 points

(b) Reading Comprehension Test up to a maximum of 10

(c) Non Verbal Reasoning Test up to to a maximum of 65.

(ii) The Socio-enconomic and background inventory was scored as follows:

Attendance at Nusery School 0/1 — 1 point

Occupation of Parents = Low —— Average —— High
1 point ____ 2 points ___ 3 points

Educational attainment

From Did not go to primary school — 0 point

Finished in a University = 12 points.

(iii) One point was awarded for any correct response in the 'Yes'/'No' instruments as follows:

Capital Cultural factor up to a maximum of	16 points
Environment and Peer up to a maximum of	16 points
Extroversion up to a maximum	24 points
Neuroticism up to a maximum	24 points

(iv) Responses to each of the Likert - type scale questionnaires namely:

(a) Pupils' Personal Attitude (TAT)

(b) Tutor/Administration

(c) Laboratory were weighted as follows:

Strongly Agree	5
Agree	4
Undecided	3
Disagree	2
Strongly Disagree	1

For negatively worded items, the reverse order of weighting was used in the scoring. Attitude interval is assumed equal.

(B) Analysis of accumulated scores

(i) Descriptive Statistics; Mean and Standard Deviation. The statistical package for the social sciences (SPSS) programme was used for the analysis.

The descriptive statistics of mean and standard deviation for each of the 12 variables were calculated for: Boys only, Girls only, Boys and Girls combined.

(ii) The Pearson - Correlation Coefficients. The Pearson correlation coefficients of the 11 independent variables against the dependent variable 'concept attainment' were calculated for: Boys only, Girls only, and Boys and Girls combined.

The correlation coefficients produced correlation matrices for the dependent and independent variables. The correlation coefficients between the 11 independent variables and the dependent variables were used to test the hypotheses 1-9 on section 1.7 of chapter 1. The test was carried out for: Boys only, Girls only and Boys and Girls combined.

The significant variables for Boys only; Girls only and Boys and Girls were each ranked in order of magnitude. The ordered variables for the different groups were further

subjected to (iii) step - wise regression analysis.
Ferguson (1971) Yamane (1967) both explained that when the number of variables becomes large i.e. greater than 7, the interpretation of regression equation becomes difficult. This means that the cause of the effect of the independent variables on the dependent variable cannot be precisely pinpointed.

They suggested that the best approach would be to keep the number of variables in a range which leads to a clear interpretation of the phenomenon under investigation: For example if we have a depdendent variable Y and x_1, x_2, x_3, x_4, x_5 and x_6 independent variables. The procedure might be to find the simple regression of Y on x_1, Y on x_2 and so on for all xi, then we find r^2 for all k = 6 cases; and select xi which has the highest r^2. Suppose it is x_2 then this selection is denoted Y and $X_1^\circ = x_2$; k-1 = 6-1 = 5 variables x_1, x_3; x_4 x_5 and x_6 remain. The second step will be to find the regression of Y on (x_1°, x_1); Y on (x_1°, x_4) and so on. Then calculate R^2 for all 5 cases and select the variable which gives the largest R^2Y_{21}. Suppose it is x_6. then $x_2^\circ = x_6$. The third step is to repeat the process and find the regression of Y on (x_1°, x_2° x_1); Y on (x_1° x_2° x_3) and so on for the remaining combinations. The process is continued untill the $R^2Y_{26\ldots1}$ variables are completed.

The equation for calculating R^2 can be written thus:

$$R^2 = \frac{SSK}{SS_T}$$

$$\therefore R^2K+1 = \frac{SSK+1}{SS_T}$$

$$\Delta R^2K+1 = \frac{SS^RK+1 - SS^RK}{SS_T}$$

$$\vdots$$

$$\Delta R^2K+L = \frac{SS^RK+L - SSRK\ (L-1)}{SS_T}$$

This approach is called step-wise regression analysis or partial regression which Fraser and Fisher (1983) called hierarchical regression analysis. The statistical approach has been used in a number of studies in recent times. These are studies in which the 'path analysis' model have been adopted in designing the studies. Examples of such studies are those by Walberg (1979) Walberg and Hertel (1980), Cuttance (1980) Kalinoswski and Sloane (1981) Fraser and Fisher (1983) Lynn Hampson and Magee (1983) (1984) Hassan (1985) and many others.

The data for this study were collected by administering the ten instruments listed on section 3.2 on form V physics students at sixteen randomly selected secondary schools in Kaduna State. The analyses of data so collected are reported in the next chapter.

Chapter 4

ANALYSIS OF DATA

4.1 Introduction

The data collected from the ten instruments used for this study were analysed in this chapter. The statistics used for the analysis of the data were:

The Mean and Standard Deviation

The Pearson Product Moment Correlation Coefficient

The Step-wise Multiple Regression Analysis

There were 11 independent variables and one dependent variable. The analysis of data collected for this study would help to test the hypotheses stated in section 1.7 of chapter 1. The subsequent interpretation of such analysis would provide information and figures for the discussion, recommendations and generalisations of this study. The data for the analysis are shown in appendices (N & O).

4.2 Means And Standard Deviations

Tables 4.1, 4.2 and 4.3 show the means and standard deviations for boys only; girls only; boys and girls combined respectively. The means and standard deviations are computed for each of the 12 variables used for this study.

Table 4.1: Means And Standard Deviations For Boys Only.

Variables	Means($\bar{x}$)	Standard Deviations(SP)
Fathers - background	5.09	3.50
Mothers - background	2.37	1.80
Capital Cultural Factor	9.13	3.36
Environment/Peer	9.06	2.77
Tutor and Administration	48.39	7.27
Laboratory	28.69	3.83
Neuroticism	11.33	4.30
Extroversion	14.39	3.18
Attitude	75.44	8.91
Reasoning Ability	24.40	11.49
Comprehension	4.93	2.11
Concept	15.63	4.32

Table 4.3: Means And Standard Deviations For Boys And Girls Combined

Variables	Means($\bar{x}$)	Standard Deviations
Fathers background	6.79	3.07
Mothers background	3.66	2.37
Capital Cultural Factor	9.92	3.31
Environment/Peer	9.07	2.78
Tutor And Administration	47.55	7.70
Laboratory	30.61	4.90
Neuroticism	12.32	4.20
Extroversion	14.65	2.82
Attitude	75.40	8.98
Reasoning Ability	24.35	9.93
Comprehension	5.25	2.00
Physics Concepts	15.52	4.01

Tables 4.1 and 4.2 show the means and standard deviations of the 150 boys and 150 girls in each of the 12 variables respectively. Table 4.3 shows the means and standard deviations of the boys and girls combined (300) in each of the 12 variables.

Tables 4.1 and 4.2 show that the boys had a slightly higher mean and standard deviation in the physics concept attainment test: boys $\bar{x}$ = 15.63 SD = 4.32

Girls $\bar{x}$ = 15.42 SD = 3.77

The boys had higher means in four of the variables as follows: Tutor and Administration Boys ($\bar{x}$ = 48.39) Girls ($\bar{x}$ = 46.72) Attitude Boys ($\bar{x}$ = 75.44); Girls ($\bar{x}$ = 75.38) Reasoning Ability Boys ($\bar{x}$ = 24.4); Girls (24.31) and the Physics Concept test. These differences are less than 1.5 units of measurement except for tutor and administration with a difference of 1.57 in the mean scores between boys and girls. The means for the girls were higher than that for boys in 8 variables; these are:

Fathers background Girls Girls($\bar{x}$ = 8.49) Boys($\bar{x}$ =5.09)

Mothers background Girls ($\bar{x}$ = 4.94) Boys ($\bar{x}$ = 2.37)

Capital Cultural Factor Girls($\bar{x}$ =10.72) Boys($\bar{x}$ = 9.13)

Environment/Peer Girls ($\bar{x}$ = 9.09) Boys ($\bar{x}$ = 9.06)

Laboratory Girls ($\bar{x}$ = 32.54) Boys ($\bar{x}$ = 28.69)

Neuroticism Girls ($\bar{x}$ = 13.31) Boys ($\bar{x}$ = 11.33)

Extroversion Girls ($\bar{x}$ = 14.91) Boys ($\bar{x}$ = 14.39)

Comprehension Girls ($\bar{x}$ = 5.57) Boys ($\bar{x}$ = 4.93).

The highest mean differences were recorded in the following variables: Laboratory (3.65), Fathers background (3.39) and Mothers background (2.57). The differences between the means could be considered small and might not bring about any major differences in the findings.

Table 4.4: The Pearson Correlation Coefficients For Boys Only

		1	2	3	4	5	6	7	8	9	10	11	12
1.	Fathers Background	1											
2.	Mothers Background	.68***	1										
3.	Capital Cultural Factor	.57***	.49***	1									
4.	Environment/Peer	.43***	.40***	.53***	1								
5.	Tutor And Administration	.14	.23	.1[illegible]	.26	1							
6.	Laboratory	.02	.1[illegible]	.09	.[illegible]9	.34*	1						
7.	Neuroticism	.04	-.[illegible]2	.06	-.01	-.03	.[illegible]4	1					
8.	Extroversion	.10	.1[illegible]	.19	.25	.09	.10	.[illegible]8	1				
9.	Attitude	.15	.19	.19	.20	.1[illegible]	.[illegible]4	.09	-.02	1			
10.	Reading Ability	.44***	.41***	.37***	.25	.15	.1[illegible]	.[illegible]3	.03	.37***	1		
11.	Comprehension	.41***	.38***	.38***	.33*	.30	.17	-.02	.11	.28	.50***	1	
12.	Physics Concepts	.35***	.43***	.43***	.31*	.44***	.21	.13	.09	.39***	.54***	.58***	1

x Significant at $\alpha = 0.05$

xx Significant at $\alpha = 0.01$

xxx Significant $\alpha = 0.001$

All Figures Approximated To Two Place Of Decimal

Table 4.4 shows the correlation matrix of the 12 variables used for the study for the case of boys only. This study is particularly concerned with the correlation coefficient between the eleven independent variables and the concept attainment test. This is extracted from table 4.4 and shown on table 4.5 below.

Table 4.5: The Correlation Coefficients Between The 11 Independent Variables And Concept Test (Boys).

Variables	Coefficients With Concept Attainment Test
Fathers Background	0.35*
Mothers Background	0.43*
Capital Cultural Factor	0.43*
Environment/Peer	0.31*
Tutor and Administration	0.44*
Laboratory	0.21
Neuroticism	0.13
Extroversion	0.09
Attitude	0.39*
Reasoning Ability	0.54*
Comprehension	0.58*

* Significant at $\alpha = 0.05$
Critical $r = 0.31$

Table 4.5 coefficients were used to test the hypotheses on section 1.3 chapter 1 for boys only. The significant level was set at $\alpha = 0.05$.

4.3 Test Of Hypotheses For Boys Only

(a) H_1: Hypothesis one which states that 'there is no significant relationship beteen the students' performance in the Comprehension Ability Test and their Concept-Attainment Test was rejected because the correlation coefficient 0.58 was significant at $\alpha = 0.05$.

(b) H_2: Hypothesis two states that: 'There is no significant relationship between the students' performance in their reasoning ability test and their concept attainment test. This hypothesis was rejected as the correlation coefficient 0.54 was found significant at $\alpha = 0.05$.

(c) H_3: Hypothesis three states that: "There is no significant relationship between the students socio-enconomic background as measured by (a) Mother's occupation and educational level score and their performance in the concept attainment test."

Hypothesis three was also rejected as the correlation coefficients:

Father's background = 0.35

Mother's background = 0.43

were both found significant at $\alpha = 0.05$.

(d) H_4: Hypothesis four states that: "There is no singificant relationship between the student's performance in Attitude test and Concept attainment test". The correlation coefficient was 0.38 which was significant at $\alpha = 0.05$ therefore hypothesis four was rejected.

(e) H_5: Hypothesis five states that: "There is no significant relationship between the student's extroversion score as measured by Junior Eysenck Personality Inventory and their performance in the concept attainment test". The correlation coefficient was 0.09 which was not significant at $\alpha = 0.05$. Therefore hypotheses five was not rejected.

(f) H_6: Hypothesis six states that: "There is no significant relationship between the students' neurotic anxiety score as measured by Junior Eysenck Personality Inventory and their performance in the concept attainment test". The correlation coefficient was 0.13. This was not significant at $\alpha = 0.05$. Therefore hypothesis six was not rejected.

(g) H_7: Hypothesis seven states that: "There is no significant relationship between the students' score on school factors as measured by:

Perception of laboratory scale

Perception of tutor and administration scale and

their performance in the concept attainment test. The correlation coefficients were:

Perception of laboratory = 0.21

Perception of tutor and administration = 0.44.

The perception of laboratory coefficient 0.21 was not significant at $\alpha = 0.05$. Therefore the sub-hypothesis 7(a) was not rejected. However the perception of tutor and administration coefficient 0.44 was significant at $\alpha = 0.05$. Therefore hypothesis 7(b) was rejected.

(h) H_8: Hypothesis eight states that: "There is no significant relationship between the students score on the capital cultural factor scale and their score in the concept attainment test". The correlation coefficient was found to be 0.43. This was found to be significant at $\alpha = 0.05$. Therefore the hypothesis was rejected.

(i) H_9: Hypothesis nine states that: "There is no singificant relationship between the students score on the environment/peer group scale and their performance in the concept attainment test. The correlation coefficient was found to be 0.31. This was found to be significant at $\alpha = 0.05$. Therefore the hypotheses was rejected.

their performance in the concept attainment test. The correlation coefficients were:

Perception of laboratory = 0.21

Perception of tutor and administration = 0.44.

The perception of laboratory coefficient 0.21 was not significant at $\alpha = 0.05$. Therefore the sub-hypothesis 7(a) was not rejected. However the perception of tutor and administration coefficient 0.44 was significant at $\alpha = 0.05$. Therefore hypothesis 7(b) was rejected.

(h) H_8: Hypothesis eight states that: "There is no significant relationship between the students score on the capital cultural factor scale and their score in the concept attainment test". The correlation coefficient was found to be 0.43. This was found to be significant at $\alpha = 0.05$. Therefore the hypothesis was rejected.

(i) H_9: Hypothesis nine states that: "There is no singificant relationship between the students score on the environment/peer group scale and their performance in the concept attainment test. The correlation coefficient was found to be 0.31. This was found to be significant at $\alpha = 0.05$. Therefore the hypotheses was rejected.

Table 4.4 revealed that hypotheses H_1, H_2, $H_3(b)$, H_4, H_7 and H_8 were significant at $\alpha = 0.001$. It also showed that some of the variables had high correlation with others. Comprehension ability correlated highly with Fathers background, Mothers background, Capital Cultural Factor, Environment and Peer as well as Reasoning Ability. Reasoning Ability also correlated highly with Fathers background; Mothers background; Capital Cultural Factor as well as comprehension and a very low correlation with environment/peer.

Table 4.6: The Pearson - Correlation - Coefficients: For Girls Only

		1	2	3	4	5	6	7	8	9	10	11	12
1.	Fathers-background	1											
2.	Mothers-background	.64^{xxx}	1										
3.	Capital Cultural Factor	.35^{xxx}	.27	1									
4.	Environment/Peer	.17	.27	.59^{xxx}	1								
5.	Tutor and Administration	.18	.15	.28	36^{xxx}	1							
6.	Laboratory	.12	.03	.18	.18	.20	1						
7.	Neuroticism	.07	-.04	-.11	-.26	-.16	-.00	1					
8.	Extroversion	.04	.08	.08	.04	.27	-.15	.09	1				
9.	Attitude	.15	.09	.17	.19	.30	.13	.17	.15	1			
10.	Reasoning Ability	.20	.23	.20	.27	.24	.19	-.01	-.05	-.25	1		
11.	Comprehension	.23	.17	.10	.06	.16	.24	-.04	-.10	.09	.56^{xxx}	1	
12.	Concepts	.38^{xxx}	.20	.10	.09	.24	.36^{xxx}	.06	.15	.41	.56	.63^{xxx}	1

x Significant at $\alpha = 0.05$

xx " at $\alpha = 0.01$

xxx " at $\alpha = 0.001$

4.3.2 Testing Of Hypotheses For Girls Only

The correlation matrix on table 4.6 is for the 12 variables used for this study for the case of girls only. However this study is particularly concerned with the correlation coefficients between the 11 independent variables and the dependent variable. This part of the matrix is therefore extracted from table 4.6 as shown in table 4.7.

Table 4.7: The Correlation Coefficient Between The 11 Independent Variables And Concept Attainment Test

Variables	Correlation Coefficients
Fathers-background	0.36*
Mothers-background	0.20
Capital . Cultural Factor	0.10
Environment/Peer	0.09
Tutor and Administration	0.24
Laboratory	0.36*
Neuroticism	0.06
Extroversion	0.15
Attitude	0.41*
Reasoning Ability	0.56*
Comprehension	0.63*

* Significant at α = 0.05
Critical r = 0.31

The coefficients in table 4.7 were used to test hypotheses (1-9) in section 1.3 of chapter 1. The findings were as follows:

(a) H_1: Hypothesis one states that: There is no significant relationship between the student's performance in the comprehension ability test and their concept attainment test. The correlation coefficient was found to be 0.63. This was significant at α = 0.05. The hypothesis was therefore rejected.

(b) H_2: Hypothesis two state that: There is no significant relationship between the student's performance in the reasoning ability test and their concept attainment test. The correlation coefficient was found to be 0.56. This was significant at α = 0.05. The hypothesis was therefore rejected.

(c) H_3: Hypothesis three states that: There is no significant relationship between the student's socio-enconomic background as measured by:
Father's occupation and educational level score
Mother's occupation and educational level score and their performance in the concept attainment test. The correlation coefficient were found to be (a) Fathers-background 0.38 (b) Mothers-background 0.20. The father's-background coefficient was significant

at $\alpha = 0.05$ while the mothers-background was not significant at $\alpha = 0.05$. Therefore hypothesis 3(a) was rejected while 3(b) was not rejected.

(d) H_4: Hypothesis 4 states that: There is not singificant relationship between the student's performance in the attitude test and the concept attainment test. The correlation coefficient was found to be 0.41. This was significant at $\alpha = 0.05$. Therefore the hypothesis was rejected.

(e) H_5: Hypothesis five states that: There is no significant relationship between the student's extroversion score as measured by Junior Eysenck Personality Inventory and their performance in the concept attainment test. The correlation coefficient was found to be - 0.05. This was not significant at $\alpha = 0.05$ therefore the hypothesis was not rejected

(f) H_6: Hypothesis six states that: There is no significant relationship between the student's neurotic anxiety scores as measured by the Junior Eysenck Personality Inventory and their performance in the concept attainment test. The correlation coefficient was found to be 0.06. This was not significant at $\alpha = 0.05$ therefore the hypothesis was not rejected.

(g) H_7: Hypothesis seven states that: There is no significant relationship between the student's scores on school factors as measured by

Perception of the laboratory scale

Perception of the tutor and administration scale

and their performance in the concept attainment test. The correlation coefficients were found to be (a) Laboratory =0.36 (b) Tutor and Administration = 0.24. The coefficient of 7(a) was found to be significant at α = 0.05 while the coefficient of 7(b) was not significant at = 0.05. Hypothesis 7(a) was therefore rejected while 7(b) was not rejected.

(h) H_8: Hypothesis eight states that: There is no significant relationship between the student's score in their capital cultural factor scale and their score in the concept attainment test. The correlation coefficient was found to be 0.10. This was not significant at α = 0.05. Therefore the hypothesis was not rejected.

(i) H_9: Hypothesis nine states that: There is no significant relationship between the student's score on the environment/Peer group scale and their performance in the concept attainment test. The correlation coefficient was found to be 0.09. This was not significant at α = 0.05. Therefore the

hypothesis was not rejected.

Table 4.6 revealed that the following hypotheses: H_1, H_2. $H_3(a)$, H_4, $H_7(a)$ were also significant at $\alpha = 0.001$. It also showed that comprehension correlated highly with : Reasoning ability; Mother's background; correlated with father's background capital cultural factor also correlated with father's background.

Table 4.8 The Correlation Coefficients For Boys And Girls

		1	2	3	4	5	6	7	8	9	10	11	12
1.	Fathers-background	1											
2.	Mothers-background	.68***	1										
3.	Capital Cultural Factor	.50***	.40***	1									
4.	Environment/Peer	.28***	.30***	.55***	1								
5.	Tutor and Administration	.07	.14	.20	.31***	1							
6.	Laboratory	.19	.17	.22*	.13	.19	1						
7.	Neuroticism	.13	.05	.04	-.12	-.12	.10	1					
8.	Extroversion	.10	.14	.16	.15	.15	.02	.10	1				
9.	Attitude	.07	.11	.11	.13	.23*	-.02	-.01	.01	1			
10.	Reasoning Ability	.31***	.28***	.29***	.25***	.18	.15	.05	-.00	.30***	1		
11.	Comprehension	.35***	.29***	.29***	.20	.21	.25***	.01	.05	.13	.51***	1	
12.	Concept	.34***	.27***	.27***	.22*	.34***	.25***	.08	.03	.32***	.55***	.59***	1

x Significant at $\alpha = 0.05$

xx Significant at $\alpha = 0.01$

xxx Significant at $\alpha = 0.001$

4.3.3 Testing Of Hypotheses (1-9) For Boys And Girls Combined

Table 4.8 shows the correlation matrix for the 11 independent variables and the dependent variable for the case of boys and girls combined. The total population used is 300. This means that the correlation matrix is calculated with the effect of sex removed. However this study is concerned with the relationship between the independent variables and the concept attainment test only. The coefficients between the independent variables and concept attainment are as shown below on table 4.9.

Table 4.9: The Correlation Coefficients Between The 11 Independent Variables and Concept Attainment For Boys and Girls

Variables	Coefficients
Fathers' background	0.34*
Mothers' background	0.27*
Captial Cultural Factor	0.27*
Environment and Peer	0.22*
Tutor and Administration	0.34*
Laboratory	0.25*
Neuroticism	0.08
Extroversion	0.03
Attitude	0.32*
Reasoning Ability	0.55*
Comprehension	0.59*

* Significant at $\alpha = 0.05$
Critical r = 0.22

The coefficients in table 4.9 were used to test the hypothesis in section 1.7 of chapter 1 for the combined cases of boys and girls. The findings were as follows:

(a) H_1: Hypothesis one states that: 'There is no significant relationship between the students' performance in the comprehension ability test and their performance in the concept attainment test'. The correlation coefficient was found to be 0.59. This was found to be significant at α = 0.05. Therefore the hypothesis was rejected.

(b) H_2: Hypothesis two states that; 'There is no significant relationship between the students' performance in their reasoning ability test and their score in the concept attainment test'. The correlation coefficient was found to be 0.55. This was found significant at α = 0.05. Therefore the hypothesis was rejected.

(c) H_3: Hypothesis three states that: There is no significant relationship between the students' socio-enconomic background as measured by:
Fathers' occupation and educational level score.
Mothers' occupation and educational level score, and their performance in the concept attainment test'.
The correlation coefficients were found to be:

(a) Fathers' background = 0.34

(b) Mothers' background = 0.27

Both coefficients were found to be significant at α = 0.05. Therefore the hypothesis was rejected.

(d) H_4: Hypothesis four states that: 'There is no significant difference between the students' performance in attitude test and their performance in the concept attainment test'. The correlation coefficient was found to be 0.32. This was significant at α = 0.05. Therefore the hypothesis was rejected.

(e) H_5: Hypothesis five states that: 'There is no relationship between the students' extroversion score as measured by the Junior Eysonck personality Inventory and their score in the concept attainment test'. The correlation coefficient was found to be 0.03. This was not significant at α = 0.05. Therefore the hypothesis was not rejected.

(f) H_6: Hypothesis six states that: 'There is no significant relationship between the students' neurotic anxiety score as measured by Junior Eysonck Personality Inventory and their score in concept attainment test'. The correlation coefficient was found to be 0.08. This was not significant at α = 0.05. Therefore the hypothesis was not rejected.

(g) H_7: Hypothesis seven states that: "There is no significant relationship between the students' score on school factors as measured by:

(a) Perception of laboratory scale

(b) Perception of Tutor and Administration Scale and their performance in the concept attainment test. The correlation coefficients were found to be (a) Laboratory 0.25 (b) Tutor and Administration 0.34. (a) and (b) were found to be significant at $\alpha = 0.05$. Therefore the hypothesis was rejected.

(h) H_8: Hypothesis eight states that: "There is no significant relationship between the students score in the capital cultural factor scale and their score in the concept attainment test". The correlation coefficient was found to be 0.27. This was significant at $\alpha = 0.05$. Therefore the hypothesis was rejected.

(i) H_9: Hypothesis nine states that: There is no significant relationship between the students' score on the environment/Peer group scale and their performance in the concept attainment test." The correlation coefficient was calculated to be 0.21. This was not significant at $\alpha = 0.05$. Therefore the hypothesis was not rejected. Table 4.8 revealed that:

H_1, H_2, H_3, H_4, H_7 and H_8 were all significant at α = 0.001. The table also showed that Fathers background, Mothers background, capital cultural factor, laboratory and reasoning ability correlated highly with comprehension. The correlation coefficients were significant at α = 0.001. Also fathers background; mothers background; capital cultural factor, environment/peer and attitude correlated highly with reasoning ability. The correlation coefficients were significant at α = 0.001.

4. .4 Stepwise - Multiple Regression Analysis

The step-wise multiple regression analysis was carried out. This was done to explore further the possible contributions of the variables that were found to correlate with the concept attainment test. The multiple regression analysis was carried out for: Boys only; Girls only; Boys and Girls combined.

To carry out this analysis the variables that were found to correlate with physics concepts in each case, were first arranged in a descending order of magnitude. The order in each case is as shown below.

Table 4.10: Order of Variables Used For Multiple Regression For Boys Only.

Order	Correlation Coefficients
Comprehension	0.58
Reasoning Ability	0.54
Tutor and Administratio.	0.44
Capital Cultural Factor	0.43(0.429)
Mothers background	0.43(0.427)
Attitude	0.39
Fathers background	0.35
Environment/Peer	0.31

Table 4.11: Order Of Variables Used For Multiple Regression For Girls Only.

Order	Correlation Coefficients
Comprehension	0.63
Reasoning Ability	0.56
Attitude	0.41
Fathers background	0.38
Laboratory	0.36

Table 4.12: Order Of Variables Used for Multiple Regression for Boys And Girls

Order	Correlation Coefficients
Comprehension	0.59
Reasoning Ability	0.55
Tutor and Administration	0.34(0.343)
Fathers Background	0.34(0.335)
Attitude	0.32
Capital Cultural Factor	0.27(0.268)
Mothers Background	0.27(0.265)
Laboratory	0.25

After the step-wise multiple regression analysis, only variables whose increments in R^2 were significant at α = 0.05 were considered for further discussion. Table 4.13 4.14 and 4.15 show these variables for boys only; girls only, Boys and Girls combined.

Table 4.13: Result Of Step-wise Multiple Regression Analysis For Boys Only.

Variables	R	R^2	ΔR^2	F	Probability
Comprehension	.579	.335	.335	74.690	P/ 000
Reasoning Ability	.648	.420	.085	53.229	P/ 000
Tutor and Administration	.718	.501	.081	48.774	P/ 000
Capital Cultural Factor	.722	.521	.022	39.400	P/ 014
Attitude	.737	.543	.020	31.839	P/ 018

Table 4.14: Result Of Step-wise Multiple Regression Analysis For Girls Only

Variables	R	R^2	ΔR^2	F	Probability
Comprehension	.631	.398	.398	97.986	P/ 000
Reasoning Ability	.678	.459	.061	62.390	P/ 000
Attitude	.711	.505	.046	49.745	P/ 000
Fathers background	.736	.541	.036	42.872	P/ 001
Laboratory	.745	.556	.015	34.622	P/020

Table 4.15: Result Of The Step-wise Multiple Regression Analysis For Boys And Girls Combined

Variables	R	R^2	ΔR^2	F	Probability
Comprehension	.588	.346	.346	157.469	P/ 000
Reasoning Ability	.653	.426	.080	110.248	P/ 000
Tutor & Administration	.684	.467	.041	86.246	P/ 000
Attitude	.711	.505	.038	64.678	P/ 023

Tables 4.13, 4.14 and 4.15 were completed for the sake of exploratory analysis of the different variables contributing in the physics concept attainment. Table 4.13 shows the result of the step-wise multiple-regression analysis for boys only. The table shows that comprehension contributed significantly with 33.5% of the variance for concept attainment. Reasoning ability accounted for 8.5% of the variance while capital cultural factor and attitude accounted for 2.2% and 2.0% of the variance for concept attainment in physics. All these values were significant at $\alpha = 0.05$. This shows that the variables. Reading Comprehension, Reasoning Ability, Tutor and Administration, Capital Cultural Factor and Attitude accounted for 54.4% of the total variance for physics concept attainment for boys. It is noteworthy that reading comprehension alone accounted for 61.6% of the total variance by the five variables.

Table 4.14 shows the results of the step-wise multiple regression analysis for girls only. The table indicates that reading comprehension accounted for 39.8% of the variance for physics concept attainment, reasoning ability contributed 6.1% of the variance; attitude accounted for 4.6% of the variance while fathers-background and perception of the laboratory accounted for 3.6% and 1.5% respectively. The values were all significant at $\alpha = 0.05$.

The result shows that: Reading Comprehension, Reasoning Ability, Attitude, Fathers-background; Perception of the laboratory contributed 55.6% of the total variance towards physics concept attainment for girls only. Comprehension alone accounted for (71.6%) of the total variance by the five variables.

Table 4.15 shows the results of step-wise multiple regression analysis for boys and girls combined. The table shows that reading comprehension contributed 34.6% of the variance for physics concept attainment. Reasoning ability accounted for 8% of the variance while Tutor and Administration and Attitude accounted for 4.1% and 3.8% respectively. These values were all significant at α = 0.05. The result shows that: Reading comprehension, Reasoning ability, Tutor and Attitude accounted for 50.5% of the total variance for physics concept attainment when the effect of sex was removed. Out of the total variance of 50.5% reading comprehension alone contributed (68.5%). Reading comprehension; Reasoning ability and Attitude contributed to the variance for physics concept attainment for boys only, girls only; boys and girls combined.

4.5 Modification Of The Duncan Path Model

The Pearson mement correlation coefficients for boys only, girls only and boys and girls combined produced the correlation matrices shown on tables 4.4 page 115 4.6 page 121 and 4.8 page 127 respectively. The correlation matrices were used to test the hypotheses on section 1.7 for each case. Table 4.16 shows the indepdentdent variables that had significant relationships at $\alpha = 0.05$ with the dependent variable for each group.

Table 4.16: Independent Variables With Significant Relationship With The Dependent Variable For Each Case.

Boys	Girls	Boys and Girls
Fathers-background	Fathers-background	Fathers-background
Mothers-background	Laboratory	Mothers-background
Capital Cultural Factor	Attitude	Capital Cultural Factor
Environment/Peer	Reasoning Ability	Environment/Peer
Tutor/Administration	Comprehension	Laboratory
Attitude		Attitude
Reasoning Ability		Reasoning Ability
Comprehension		Comprehension

The table shows that these independent variables have some degree of relationships with the dependent variable for each of the cases: boys only, girls only, boys and girls

combined. Tables 4.4, 4.6 and 4.8 showed that there were inter-correlations among the independent variables in each case. These inter-correlations are briefly discussed as follows:

Boys only. The inter-correlations are: Fathers-background correlated with mothers-background ($r = 0.68$) capital cultural factor correlated with fathers-background ($r = 0.57$) and mothers-background ($r = 0.49$). Environment/Peer correlated with fathers-background ($r = 0.43$) mothers-background ($r = 0.40$) and capital cultural factor ($r = 0.53$). Laboratory correlated with Tutor/Administration ($r = 0.34$) only. Reasoning ability correlated with fathers-background ($r = 0.44$) mothers-background ($r = 0.41$) capital cultural factor ($r = 0.37$) and attitude ($r = 0.37$) while reading comprehension correlated with fathers-background ($r = 0.41$), mothers-background ($r = 0.38$), capital cultural factor ($r = 0.38$). Environment/Peer ($r = 0.33$) and reasoning ability ($r = 0.50$). All these correlations were significant at $\alpha = 0.05$. The above discussion shows that Reading comprehension correlated significantly with five other independent variables and had the highest significant correlation coefficient with the dependent variable $r = 0.58$. It was followed by Reasoning ability that correlated significantly with four other independent variables and had the second highest significant correlation with the dependent variable ($r = 0.54$). Environment/Peer correlated

significantly with three other independent variables while capital cultural factor correlated with two other independent variables. Tutor/Administration had low positive insignificant correlations with four other independent variables and ranked third on the correlations with the dependent variable r = 0.44. Attitude towards physics had low positive insignificant correlations with seven of the other independent variables.

The stepwise regression analysis showed that those independent variables that had the highest number of intercorrelations with other independent variables and had high correlations with the dependent variable contributed the highest significant positive effect on the dependent variable. These are for boys only: Comprehension 33.5% of the total variance for physics concept attainment, Reasoning ability 8.5% other significant positive effects are tutor and administration 8.1%, Capital cultural factor 2.2% and Attitude 2.0%.

For Girls only. Fathers-background correlated with mothers-background (r = 0.64). Capital cultural factor correlated with fathers-background (r = 0.35), Environment/ Peer correlated with capital cultural factor (r = 0.59). Tutor/Administration correlated with Environment/Peer (r = 0.36), Reading comprehension correlated with Reasoning ability (r = 0.56). All correlations were significant

at $\alpha = 0.05$. It is pertinent to point out that Reading comprehension had low positive insignificant correlations with seven other independent variables and had the highest significant correlation with the dependent variable $r = 0.63$. Reasoning ability had no significant correlation with any other independent variable but had low positive insignificant correlations with seven other independent variables and had the second highest correlation with the dependent variable ($r = 0.56$). Others are Attitude towards physics which had the third significant high correlation with the dependent $r = 0.41$ and had low positive insignificant correlations with eight other independent variables . Fathers-background and laboratory followed in that order with correlation coefficients of $r = 0.38$ and 0.36 with the dependent variable. The stepwise regression analysis showed that the independent variables with the highest number of correlations with other independent variables and ranked first and second in their correlations with the dependent variable, had the highest significant effects on the dependent variable. The results showed that Reading comprehension contributed 39.8% of the variance for physics concept attainment while reasoning ability contributed 6.1% of the variance. Other are Attitude towards physics 4.6%, Fathers-background 3.6% and laboratory 1.5%.

For Boys and Girls combined. Fathers-background correlated with mothers-background (r = 0.68), Capital cultural factor correlated with fathers-background (r = 0.50), mothers-background (r = 0.40). Environment/Peer correlated with fathers-background (r - 0.28), mothers-background (r = 0.30) and Capital cultural factor (r = 0.55). Tutor/Administration correlated with Environment/Peer only (r = 0.31) Attitude towards physics correlated with Tutor/Administration only (r = 0.23). Reasoning ability correlated with Fathers-background (r = 0.31), Mothers-background (r = 0.28), Capital cultural factor (r = 0.29), Environment/Peer (r = 0.24) and Attitude towards physics (r = 0.30). Reading comprehension correlated with Fathers-background (r = 0.35), Mothers-background (r = 0.29), Capital cultural factor (r = 0.29), Tutor/Administration (r = 0.22) Laboratory (r = 0.25) and Reasoning ability (r = 0.51). All the correlations were significant at $\alpha = 0.05$. Comprehension correlated singificantly with six other independent variables and had the highest significant correlation (r = 0.59) with the dependent variable. Reasoning ability correlated significantly with five other independent variables and had the scored highest correlation (r = 0.55) with the dependent variable. Other independent variables that had significant correlations with the dependent variable are Tuto/Administration (r = 0.34), Fathers-background (r = 0.34)

Attitude towards physics ($r = 0.32$), Capital cultural factor ($r = 0.27$) Mothers-background ($r = 0.27$) and Laboratory ($r = 0.25$).

The Step-wise regression analysis showed that Reading comprehension which correlated significantly with six other independent variables and had the highest correlation with the dependent variable Contributed the highest variance of 34.6% to physics concept attainment. Reasoning ability which correlated with five other independent variables and had the second highest correlation with the dependent variable, contributed the second highest variance of 8% to physics concept attainment. Others are Tutor/Administration 4.1% and Attitude towards physics 3.8%. All the variances were significant at $\alpha = 0.05$. It is worthy of note that the personality factors of extroversion and neuroticism did not correlate significantly with themselves, the dependent variable or with any other independent variable. The independent variables that had significant effect with the dependent variable in each of the three cases considered are as shown on table 4.17.

Table 4.17: Independent Variables That Had Significant Effects On The Dependent Variable For The Three Cases Considered

Boys' only	Girls' only	Boys & Girls Combined
Reading Comprehension	Reading Comprehension	Reading Comprehension
Reasoning Ability	Reasoning Ability	Reasoning Ability
Attitude	Attitude	Attitude
Tutor/Administration	Fathers-background	Tutor/Administration
Capital Cultural Factor	Laboratory	

From the correlation matrices and the variances obtained from the step-wise multiple regression analysis, it is evident that Reading Comprehension, Reasoning Ability and Attitude towards physics were the most dominant variables that affect physics concept attainment among the variables used for this study.

A modified path model as a result of the findings of the study is as shown on fig. 4.1. Neuroticism and Extroversion were deleted from the model as they were found to have no significant effects on the independent and dependent variables. The arrows show the variables that relate to each other and the figures show the magnitudes of the Pearson correlation coefficients. Only variables which have significant relationships with each other at α = 0.05 are shown in the figure. The model is not drawn to scale.

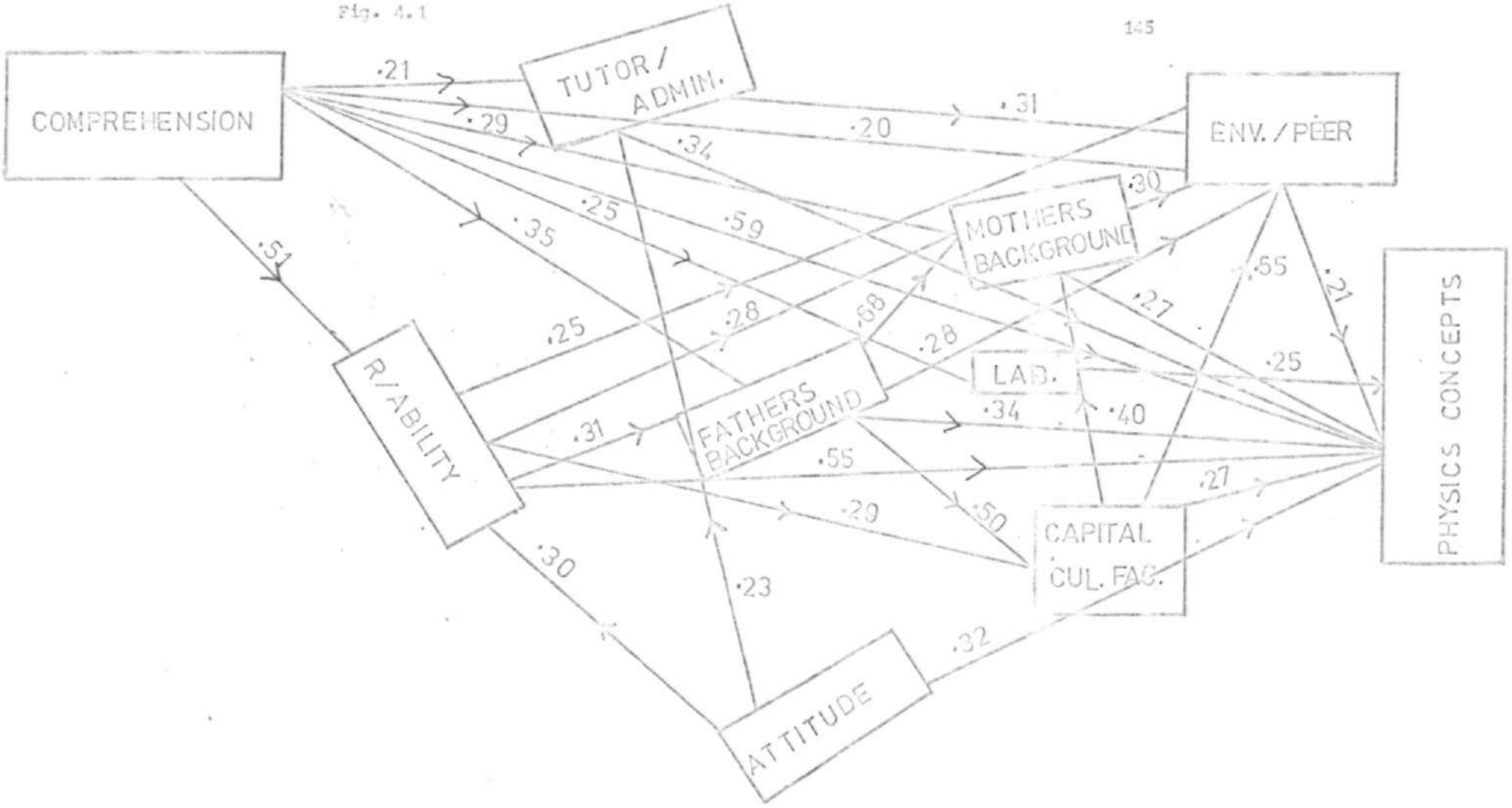


Fig. 4.1 Modified Path Model For Physics Concepts Attaintment Variables.

Chapter 5

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This study was carried out to ascertain if factors such as (i) the home background (ii) the personality traits (iii) the school factors (iv) the environment/peer interactions (v) the attitude towards physics and (vi) the reading comprehension ability of pupils promote or inhibit their physics concept attainment. It was also intended to find out to what extent each of these variables seperately contributed to the attainment. The analysis of data collected was carried out separately for: boys only; girls only; boys and girls combined.

5.2 Discussion Of Analysis Of Data

Table 4.4 shows that the Pearson - correlation matrix of the independent variables for boys only. Table 4.6 shows that of girls only and table 4.8 shows that of boys and girls combined. The correlation coefficients between the dependent variable (Physics concepts) and the 11 independent variables were extracted from the correlation matrices as shown on tables 4.5, 4.7 and 4.9 for boys only, girls only; boys and girls combined respectively. These

correlation coefficients were used to test the hypothesis stated in section 1.7 of chapter 1 of this study. Hypothesis one which stated that "There is no significant relationship between the students' performance in the reading comprehension test and the physics concept test was rejected at $\alpha = 0.05$ for boys only; girls only; boys and girls combined. The correlations was each significant at $\alpha = 0.001$. This means that there is a positive relationship between a student's reading comprehension ability and his physics concept attainment. This is consistent with the findings of (Lemke, 1967; Davis, 1973; Adrian, 1978; and Fisher, 1983).

This shows that reading comprehension is an important factor in physics attainment. Hypothesis two stated that "There is no significant relationship between the students performance in reasoning ability test and their concept attainment test. This was rejected at $\alpha = 0.05$ for boys only; girls only; boys and girls combined. The correlation coefficient for each group was significant even at $\alpha = 0.001$. This therefore indicated that there is a positive relationship between reasoning ability and physics concept attainment. This is consistent with the findings in similar research by (Lemke and Klausmeier, 1967; Pella, 1968; Lunzer, 1969; Lawson and Hordiand, 1977; Mcbridge, 1973; Wynoh, 1979). This shows that reasoning ability could promote the understanding of physics concepts.

Hypothesis three states that 'There is no significant relationship between the socio-economic background as measured by: (a) fathers' occupational (and educational level) scores (b) mothers occupational and educational level scores and physics concept attainment. The hypothesis was rejected at $\alpha = 0.05$ for fathers background and mothers background for boys only while it was rejected for fathers background but not rejected for mothers background for girls only. When the influence of sex was removed, the hypothesis was rejected for fathers and mothers backgrounds. This shows that there is a positive relationship between the fathers background and physics concepts for boys only; girls only; boys and girls combined. However while there is a positive relationship between the students' mothers-background for boys only; boys and girls combined, there is no meaningful relationship between mothers background and physics concepts attainment for girls only. This development could be attributed to the administrative powers and influence of the father as the head of the family which is a culture, highly cherished in Nigeria. However studies by (Thorndike, 1973 Sewell, 1976; Mcmillian, 1979; Lynoh, 1979; Cooskey, 1981; Lynn et al, 1985; Hassan, 1985) show that favourable socio-economic background promote concept attainment. Macmillian in particular found that father's educational level had crucial influence on students' physics

achievement. Shaycoft (1975) Nelson (1979) and Norton (1969) found no relationship between students socio-economic background and physics concept attainment. The discrepancies in the findings by the different researchers could be attributed to differences in culture, belief, national policies, technology and social orientations as these findings were made in different countries of the world.

Hypothesis four states that 'There is no significant relationship between the students' score in attitude scale and their score in physics concept attainment. This hypothesis was rejected at $\alpha = 0.05$ for all the groups. This means that there is a positive relationship between attitude towards physics and physics concepts attainment. This is consistent with the findings in similar research by (Thorndike, 1973; Gardner, 1976; Walberg, 1976; Bajah, 1982; Hassan, 1985). However Orisaseyi,(1976) Kolawole (1982) could ne relate the students' positive attitude to science to meaningful science achievements by students.

Hypothesis five states: There is no significant relationship between the students extroversion score as measured by (JEPI) and their performance in physics concept test. This was not rejected at $\alpha = 0.05$. This means that there is no significant relationship between extroversion trait and physics concept attainment. This finding is consistent with those of (Child, 1964; Conklin

and Ogston, 1978; Mukherjee, 1980; Riding and Dyer, 1981; Lynn et al, 1985).

Hypothesis six states that 'There is no significant relationship between the students' neurotic anxiety trait as measured by (JEPI) and their performance in the concept attainment test. This hypothesis was not rejected at $\alpha = 0.05$ for all the groups. This shows that there is no significant relationship between neurotic anxiety trait and physics concept attainment. This is consistent with the findings in similar studies by (Child, 1964; Conklin and Ogston, 1978; Mukherjee, 1980; Lynn et al, 1985).

Hypothesis seven states that "There is no significant relationship between the students scores on school factors as measured by (a) Perception of the laboratory scale (b) Perception of tutor and administration scale, and their physics concept attainment test. The hypothesis 7(a) was rejected at $\alpha = 0.05$ for girls only; but not rejected for boys only and boys and girls combined. 7(b) was rejected for boys only; boys and girls combined but not rejected for girls only. This indicated that there is a positive relationship between girls' perception of the laboratory and their physics concept attainment, but there is no significant relationship between the boys, boys and girls combined and perception of the laboratory and the physics concept attainment. Also there is positive relationship between boys, boys and

girls combined and their perception of the tutor and administration but there is no significant relationship between girls perception of their tutor and administration and their physics concept attainment (Jenksons, 1972; Lawrenze, 1976; Gardner, 1979; Shuaibu, 1979; Atta, 1981) all found that good teacher characteristics and behaviour promote learning achievements.

Hypothesis eight states that: There is no significant relationship between the students' score on the capital cultural factor and their physics concept attainment. This was rejected at $\alpha = 0.05$ for boys only; boys and girls combined but not rejected for girls only. This shows that there is a positive relationship between cultural factors and physics concept attainment for boys mainly and students in general. This is consistent with the findings in similar studies by (Keeves, 1972; Bloom, 1980; Kalinowski and Stone, 1981; Cooskey, 1981; Franser and Fisher, 1983; Hampson and Magee, 1985; Morjoribanks, 1980, 1985). No significant relationship was however established between capital cultural factors and physics concept attainment for girls only.

Hypothesis nine states: There is no significant relationship between the students' score on the environment/peer scale and their performance in the concept attainment test. This was rejected at $\alpha = 0.05$ for boys only and not rejected for girls, boys and girls combined. This shows that there is a positive relationship between environment/

peer score and the physics concept attainment for boys. This is consistent with the findings in similar studies by (Anderson, 1970; Fraser, 1978; Rutler, 1980; Hower and Durr, 1982). The study also showed that there is no significant relationship between environment/peer interaction and physics concept attainment for girls; boys and girls combined. This finding is however consistent with the findings of (Keeves, 1975; Cuttance, 1980; Hassan, 1985) female students used for this study are mostly from the part of the country where culturally, girls do not have as much freedom of movement as their male counterpart. By the nature of some of the items in the questionnaire like: Do you visit areas of scientific interest around your home? Do you read together with your fellow students who do physics around your home? etc, it is not unlikely that this cultural barrier could affect their scores on these questions. The references cited above however show that there is no clear-cut relationship between environment/peer interactions and achievement.

In order to explore further the contributions of each of the variables to physics concepts attainment; the singificant variables for each category were subjected to more investigation by using the step-wise multiple regression analysis. Tables 4.13-4.15 show the regression analysis results.

Table 4.13 shows that comprehension accounts for 33.5% of the variance for physics concept attainment for boys. Reasonging ability 8.5%. Tutor and administration 8.1% capital cultural factor attitude 2.2% and 2.0% respectively. All the values were significant $\alpha = 0.05$. The results of the regression analysis shows that: Reading comprehension, Reasoning ability, Attitude towards physics, Tutor and administration and Capital cultural factor promote the understanding of phyisics concepts for boys. They could serve as predictive variables for physics concepts for boys only. The major weakness of multiple regression is that it does not bring out the significance of variables that correlate highly with a particular variable once the variance of any of them has initially been determined. Lynn et al (1985). Table 4.4 shows that fathers-background; mothers-background; capital cultural factor correlate very significantly with comprehension. It could therefore be argued that the influence of these variables on concept attainment would be marginal once comprehension has been determined.

Table 4.14 shows the result of the stepwise regression analysis for girls only. It shows that reading comprehension accounts for 39.8% of the variance for physics concept attainment, Reasoning ability 6.1%, Attitude 4.6%, Fathers' background and Laboratory 3.6% and 1.5% respectively.

The results of the regression analysis show that: Reading comprehension; Reasoning ability; Attitude; Fathers' background and Laboratory promote physics concept attainment, they could serve as predictors for concept attainment for girls.

Table 4.15 shows that the results of the regression analysis with the effect of sex removed. It shows that reading comprehension accounts for 34.6% of the variance for physics concept attainment, Reasoning Ability 8.0% Tutor and Administration 4.1% and Attitude 3.8%. These values show that: Reading Comprehension, Reasoning Ability; Attitude; Tutor and Administration could promote the understanding of physics concepts when the effect of sex is removed and the respondents could just be designated as students. They could also serve as predictive variables for the understanding of physics concepts by 'students'. It is noteworthy that table 4.8 shows that: Fathers' background, Mothers' background; Capital Cultural factor and Laboratory correlated very significantly with comprehension. Any further analysis to determine the extent of the effect of these variables after reading comprehension has been considered would give only marginal values (Lynn at al, 1985).

5.3 The Findings

Several factors were identified as the possible determinants of the physics concept attainment ability of secondary school pupils in Nigerian schools. Hypotheses postulated to relate the student scores on the Concept Attainment Test and the different study variables linked to the determinant factors were tested. The analysis of the study data presented in Chapter 4 and discussed in Section 5.2 resulted in the following findings.

The concept attainment scores were significantly related to three variables closely linked to the possible determinant factors considered in the investigation. The variables were the students':

(a) i. Reading Comprehension Ability

ii. Reasoning Ability

iii. Attitude to Physics

(b) Some of the variables could serve as predictors of physics concept attainment potenital for specific sexes. These are:

For males: Perception of Tutor/Administration and Capital Cultural Factor.

For Females: Fathers' background and Perception of Laboratory.

(c) A modified form of Duncan's path model with significant correlation coefficients among the variables was produced using the reults of the study. This model is shown as fig. 4.1 page 145

5.4 Interpretation Of The Study Findings

5.4.1 Physics Concept Attainment And Reading Comprehension Ability

Concept attainment means the learning of a concept. A concept is an abstraction that represents objects or events with similar qualities. Alternately a concept stands for a set of criterial attributes which identify a class of objects together with anticipations about other properties of objects in the class. Reading comprehension is the ability to grasp the meaning of the material being read. There are several ways of expressing the comprehension ability. Basically comprehension involves translating material from one form to another (e.g words to numbers). Other more complex expressions of comprehension ability involves interpretation of the materials being read through explaining or summarising. Or again, the expression of the comprehension ability involves the estimation of future trends by predicting consequences or effects. The closeness of the abilities involved in the acts of concept attainment and reading comprehension is evident from a close examination of the two.

The dependence of concept attainment on the reading comprehension ability as a necessary precondition is evident from the descriptions of the two abilities presented above. Therefore the study finding relating

the concept attainment and reading comprehension ability as a requirement appears to be quite reasonable and in order.

5.4.2 Physics Concept Attainment And Reasoning Ability

The traditionally accepted learning theories have maintained conflicting explanations about how learning occurs. Some maintain that we learn what is rewarding. Others say we learn to do what satisfies our basic needs. And yet another theory is that we learn when we gain understanding. (Thorndike, 1911, Pavlov, 1927, Skinner, 1938, Wertheimer, 1945). All the traditional explanations of learning have been relatively unproductive in advancing our understanding of learning as an event. A more recent alternative point of view about learning is this: there are as many varieties of learning as there are distinguishable conditions of learning. These varieties may be differentiated by means of descriptions of the factors that comprise the learning conditions in each case. In searching for and identifying these, one must look, first, at the capabilities internal to the learner, and second, at the stimulus situation

outside the learner. Each type of learning starts from a different "point" of internal capability, and is likely to demand a different external situation in order to take place effectively(Gagne, (1970). In brief, the varieties of learning that are currently distinguished, based on evidence derived from observation are: (1) Signal Learning. (2) Stimulus-Response Learning. (3) Chaining. (4) Verbal Association. (5) Discriminating Learning. (6) Concept Learning (7) Rule Learning. (8) Problem Solving.

The present view point about learning rejects the traditionally accepted position that all learning is basically the same. Presently, the position is, that each variety of learning listed above begins with a different state of the organism and ends with a different capability for performance. The most important class of conditions that distinguishes one form of learning from another is the initial state of the learning, that is, its prerequisites. The different types of learning listed above are arranged in a hierarchy, so to say, implying that each type of learning requires all the other types of learning coming before, as prerequisites. In other words, stimulus - response learning is easily achieved if the learner has the ability of signal learning and so on. The conclusion derived from this naturalistic point of view due to Gagné about learning is that a sequential approach to learning should be most

pertinent to the development of logical thinking of children. Concept attainment is an important link in the sequence of abilities contributing to the whole process of logical thinking. The process of deducing the implications of facts and assumptions (deductive reasoning) and finding the general principal common to set instances (inductive reasoning) make up reasoning. Reasoning ability is an important pre-requisite for concept learning. The study finding that concept attainment is determined by the reasoning ability of the learner lends support to the progressive view-point on learning.

Again, the rationale of the elementary school science programme developed by the Commission on Science Education of the American Association for the Adveancement of Science, called Science - A Process Approach is the fact that science is more than product (the facts of science) and of equal, if not greater, value is the acquisition of the processes (the intellectual activities) of science. These processes are observation (using five senses), classifying measuring, communicating, quantifying, space/time relations, inferring, and predicting. They are called the basic processes and are structured from the simplest skills to the more complex skills in a definite prescribed instructional hierarchy. The processes are introduced prior to the fourth grade. This hierarchical skill development

continues on through all the elementary levels. In addition, beginning from the fourth grade, specific integrated skills are introduced. These are making operational definitions, formulating hypotheses, controlling variables, interpreting data, and experimenting. Evidently the integrated skills involved more and more reasoning ability. At this point the student would have acquired many basic science concepts. The whole philosophy of the science curriculum is that concept attainment is only possible through the development of reasoning ability. The science process skills are learned to develop logical thinking and reasoning. The study finding that the concept attainment depend on the reasoning ability of the student is once in confirmity with the fact on which the process approach of of science teaching is based.

5.4.3 Physics Concept Attainment And The Attitude To Physics

Attitude can be thought of as the disposition to respond favourably or unfavourably toward people, ideas, events or objects. The disposition is gradually built up as the combined effect of concepts, verbal information and emotions. If we consider attitude to physics as the learning outcome, then, concepts, verbal information and emotions are the preconditions for the learning of the attitude. They all are interrelated and make up a closed

circle. Concept attainment affects attitude to physics and attitude to physics affects concept attainment. The study finding that concept attainment and students attitude to physics are closely linked is a confirmation of the interrelationship between them.

5.5 The Conclusion

There are several time-tested learning principles that are relevant to instructional design. Contiguity, repetition, and reinforcement are the principles that have been with us for many years. Though they are still valid principles, one of their outstanding characteristics is that they refer to controllable instructional events external to the learner. Curriculum designers and classroom teachers can readily devise situations which include these principles. Inspite of contriving learning situations that include these principles, an efficient learning situation will not be guaranteed. There are other necessary conditions to be looked for within the individual learners, that are necessary to ensure learning, in addition to the external environment. These conditions are states of mind that the learner brings to the learning task. These are previously learned capabilities of the individual learner and which appear to be a highly important set of factors in ensuring effective learning. These internal

states include information, intellectual skills, and self-management strategies. These states depend very much upon prior learning. Factual information must be brought to bear upon the act of learning. Intellectual skills needed for learning must be recalled, in order for learning to occur. A learning event requires the activation of strategies for learning and remembering. Other kinds of internal events of motivation and self-confidence are also important for learning to happen. Thus there are two categories of factors involved in a learning event. Older learning theories gave greatest weight to external factors of contiguity, repetition, and reinforcement. The newer model of learning places greater emphasis on the importance of factors which originate from the internal source of the individual's memory and which include information, intellectual skills, and self-management strategies

The study findings suggested the conclusion that for effective learning of physics concepts, the most important determinant factors are those related to the states of mind of the secondary pupils and which in turn depend very much upon their prior learning.

5.6 Implications Of The Study Findings

Features of the educational process should be determined by the requirements of getting students to learn efficiently. The existence of a student who is

capable of learning, a teacher who is competent to help pupils learn, and the essential physical facilities that make up an effective learning environment are the essential ingredients of the required features. It is possible to derive implications of the study findings that have bearing on the above listed ingredients.

5.6.1 For Students

(i) In the most comprehensive sense of "learning", motivations and attitudes must also be included as the necessary learning outcomes. The development of such human dispositions as these is of tremendous importance to education as a system of modern society. Most of the times, teachers limit their considerations to those aspects of learning to what may be termed the intellectual, or subject matter content that leads to improvement in human performances having ultimate usefulness in the pursuit of the individual's vocation or profession. And yet the study findings suggest a positive attitude to physics as a necessary precondition for effective concept learning. There are a variety of personal interactions between the teacher and his students that pertain in a strict sense, to the acquisition of skills and knowledges that typically form the content of a curriculum. There are also yet another set of interactions, including those of

motivating, persuading, and establishing attitude and values. Perhaps the classroom teachers of physics in our schools are only capable of the interactions of the former type to the complete exclusion of the interactions of the second category. And again, even when providing interactions of the first type, teachers are only able to help pupils learn and acquire knowledge and skills that are the learning outcomes of the simpler types of learning from among the hierarchy of eight, mentioned earlier in the chapter. Students are not helped to learn at the higher levels. The higher types of learning are essential for concept attainment.

(ii) All theories of learning, including Gagne's naturalistic view point provide information about how to begin the process of establishing competence through learning. It seems that we do not yet know very much at present about how to continue the process to its highest levels. As for example, it does not seem possible at present to specify all the conditions necessary to attain the highest and most complex varieties of human performance such as those displayed in invention or aesthetic creativity. Even if it is so, the study findings imply that the classroom teachers lack the knowledge of information about how to begin the process of concept attainment.

This is perhaps, one of the main reasons of the depressed state of physics as a school subject. Our students are at a disadvantage, because of this, when it comes to concept learning.

(iii) Learning becomes efficient, if the learning conditions are carefully planned, before placing the student in the learning situation. The planning should be concerned with the student's capabilities both before and after any learning enterprise. In such planning of learning, questions to be asked should include the following. From where does the student begin and where is he going? What are the specific prerequisites for learning, and what will he be able to do next? For example, learning to count numerically must precede learning to add numbers. Planning for learning is a matter of specifying and ordering the prerequisite capabilities within a topic to be learned, and later perhaps among the topics that make up a "subject". The generally observed depressed state of physics as a school subject suggests that concept learning in our classrooms goes on without the proper planning involving the specification and ordering of the prerequisite capabilities for the majority of Nigerian secondary students. As indicated by the study findings, reading comprehension ability, reasoning

ability, and positive attitude to physics are perhaps some of the most important pre-requisites that are lacking among our secondary students who read physics. It is not reasonable to suggest that physics as a school subject has a depressed status because Nigerian children are incapble of learning its content. It is quite possible that perhaps what is lacking is the planning of learning that specifies and orders the pre-requisite capabilities within study topics, and within the entire subject content at the respective levels of schooling.

5.6.2 For Teachers

A student who is capable of learning is the product of the total influences of nature and nurture. The only means of raising the possibilities of getting greater proportion of students capable of learning is by manipulating the influence of nurture on young learners. A great number of Nigerian children are at a disadvantages when it comes to the influence of nurture on them. The disadvantages in this respect becomes an added burden on the schools when the child arrives there. The schools have a great responsibility to mould young children into capable learners even when the contribution of their homes is insufficient or even totally lacking. The burden

falls squarely on the classroom teachers. They are the individuals who have to achieve influencing the development of children into capable learners by manipulating the nurture component of the total growing up environment of the young learners. So by implications the teachers should possess the following capabilities, skills, and competencies.

(a) To create and provide interactions within the classrooms for motivating, persuading, and establishing values and attitudes.

(b) To begin the process of learning in the pupils.

(c) To specify and order the pre-requisite learning capabilities within topics and within the entire subject content that makes up the area of specialisation of the teacher.

5.6.3 For The Learning Environment

All the variables involved in the physical, social, and psychological context of learning make up the learning environment. The variables would include students' attitudes toward, perceptions of, and emotional reactions to patterns of interaction among students and between students and teachers. The study findings have implications for the variables linked to the physical context of physics learning. Though the physical facilities for instruction are generally

considered to be not the ideal in Nigerian secondary schools, the study findings suggest that a possible cause of the depressed status of physics as a school subject should be the lack of the physics facilities that are particularly needed to facilitate the attainment of physics concepts by students. If it were not so, all science subjects would have had the same depressed status like physics. This is not the state of affairs. Even if all science subjects are relatively unpopular among the students, physics is definitely more unpopular among the sciences. It is reasonable to assume that textbooks, laboratory facilities, teaching equipments available to physics teachers in Nigerian schools are not the ideal ones to facilitate comprehension of ideas by students and to develop reasoning ability needed for the learning of physics concepts.

5.7 Recommendations

The implications of the study findings suggested the following recommendations. The recommendations were for:

(i) Improvement of Physics Education in Schools in Nigeria

(ii) Further research related to the present study.

5.7.1 Recommendations For Improvement Of Physics Instruction

i. Concept attainment is important as a basic requirement for intellectual development and the learning of the science process skills. Physics is a school subject that can contribute towards the intellectual development of the students and their mastery of the science process skills. These goals can be more completely achieved if science curriculum materials used in the primary and the secondary schools are within the reading comprehension ability of the students at these levels There is need to examine the available science curriculum materials to see if they are within the comprehension ability of the different groups of students for whom they are written. If found wanting in this regard, other more suitable curriculum materials should be developed.

ii. The ideal physics learning facilities suitable for primary and secondary levels need to be identified and provided as part of normally available learning environment in our schools.

iii. Suitable curriculum materials, and ideal learning facilities do not ensure learning if the teachers competent to make the appropriate use of them are not

available. More efforts should be made to produce specialist teachers for science teaching at the primary school level and Physics, Chemistry, and Biology at the secondary school level.

iv. Primary science and junior secondary school lessons and textbooks should be so organized and structured that sections of the lessons and books could be devoted to tasks, problems and activities that call for individual or group reasoning ability exercises. This could help to prepare the pupils for lessons in physics at the senior secondary.

5.7.2 Recommendations For Further Research

i. Curriculum materials should be developed utilising more of the findings about the learning problems of students at every level. As for example, before textbooks are accepted for a group of students, such should be subjected to tests of analysis of reading difficulty. Research studies directed at the analysis of the reading difficulties of existing curriculum materials should be carried out to provide guidance for teachers and administrators.

ii. Research studies should be carried out to establish the reading comprehension ability norms of Nigerian students in the primary and the secondary schools in the different years of study.

iii. Research studies should be carried out to specify and order the learning conditions for topics in the physics courses.

5.8 Summary

The depressed status of physics as a secondary school subject in Nigeria prompted this study. The main objective of the study was to establish any relationships between: Pupils' homebackground, Pupils' personality traits, Pupils' environment, Pupils' attitude towards physics, Pupils reading comprehension ability, school factors and pupils' physics concept attainment. The study also tried to determine the extent to which each of the variables independently affected physics concept attainment. Nine hypotheses of possible relationships between the variables and physics concept attainment were formulated and tested. The physics concepts of energy, work, force and pressure were used for the study. These topics are very fundamental in the study of secondary school physics. They are also likely to be easily misunderstood and misapplied as their everyday uses are completely at variance with their scientific meanings.

The path model developed by Duncan (1968) and modified by Tyler (1977) Hansel et al (1980) was adopted for this study. Ten instruments were used for the study. Six instruments were constructed exclusively for this study, these are (a) The concept attainment test (b) The

capital cultural factor test (c) Environment and Peer test (d) Tutor/Administration test and (e) Laboratory factor scale and (f) Reading Comprehension test. Two were modified to meet the requirements of the study, these are (a) The Attitude scale and (b) The Socio-economic background information scale. Two instruments were readily available and these are (a) The non-verbal reasoning ability test and (b) The Junior Eysenck Personality Inventory. The reliability and validity of each test were ascertained by using the appropriate statistical techniques.

The data for the study were collected by administering the instruments on Form Five physics students from 16 secondary schools in Kaduna State. The schools were selected by stratified random sampling as effort was made to ensure that two schools were selected from each of the eight educational zones in the state. The study used 300 students made up of 150 boys and 150 girls. The data collected was analysed using the following statistical techniques: Calculation of means and standard deviations, Pearson correlation coefficients and stepwise multiple regression analysis.

The Pearson correlation coefficients revealed that: Reading Comprehension, Reasoning Ability, Fathers-background, Mothers-background, Attitude towards physics, Laboratory factor, Tutor/Administration, Capital Cultural factor and Environment/Peer gave positive significant relationships

(α = 0.05) with physics concept attainment for boys only; Reading Comprehension, Reasoning Ability, Attitude towards physics, Fathers-background and Laboratory factor gave positive significant relationships (α = 0.05) with physics concept attainment for girls only; Reading Comprehension, Reasoning Ability, Mothers-background, Fathers-background, Attitude towards physics, Laboratory factor and Environment/Peer gave postive significant relationship (α = 0.05) with physics concept attainment for boys and girls combined. It is noteworthy that the personality traits of Neuroticism and Extroversion gave no significant relationships (α = 0.05) with physics concept attainment for any of the three cases considered. The data was subjected to further analysis by using stepwise multiple regression analysis and the results revealed that: Reading Comprehension Ability, Reasoning Ability, Attitude towards physics, Tutor/Administration and Capital Cultural factor contributed significant effects to physics concept attainment for boys only; Reading Comprehension Ability, Reading Ability, Attitude towards physics, Fathers-background and Laboratory factor contributed significant effects on physics concept attainment for girls only; Reading Comprehension Ability, Reasoning Ability, Attitude toward physics, Tutor/Administration and Fathers-background contributed significant effects on physics concept attainment for boys and girls combined.

The main finding of the study is that (1) Reading Comprehension Ability (2) Reasoning Ability and (3) Attitudes towards physics are determining factors for phyiscs concept attainment among the secondary pupils used in the study. Also a modified form of Duncan's path model with significant correlation coefficients among the variables used for the study was produced.

The study arrived at the conclusion that for effective physics concept learning the most helpful learning conditions are those relating to the previously learned abilities of the pupils and not those that are external to the pupils. Recommendations made for improving physics instruction in our schools were:

1. Development of physics textbooks that are within the comprehension ability of the pupils.
2. Provision of physics learning environment with facilities to produce learning experiences conducive to develop the reasoning ability of the pupils.
3. Improvement of teacher education programme content to produce physics teachers who understand the conditions of learning.

Suggestions for further research included the following

1. Studies to determine the reading comprehension ability of the secondary pupils in the various years.

2. Identification and classification of learning conditions appropriate for the learning of physics concepts within the course content for the secondary years.

3. Studies for determining the reading difficulty index of physics textbooks available in the market.

4. Identification of the appropriate laboratory facilities and equipment needed for effective teaching of physics in the secondary schools.

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APPENDIX A

AHMADU BELLO UNIVERSITY, ZARIA
FACULTY OF EDUCATION

Date 24th October, 1984.

The Permanent Secretary
Ministry of Education
Kaduna State.

Dear Sir,

COLLECTION OF RESEARCH DATA

The bearer JAMES OTUKA is conducting research in SCIENCE EDUCATION Titled: "A Study of The Factors That Affect The Understanding Of Physics Concepts By Nigerian Secondary School Students" for the degree of Ph.D. (Physics Education).

The Faculty of Education will be grateful if you could permit him/her to conduct classroom experimentation/ collect data at the Schools listed on the next page.

Thank you for your continued cooperation with us.

Yours sincerely,

(signed)
Dr. T. K. Adeyanju
Assistant Dean
Post-Graduate Studies Committee.

APPENDIX B

SPECIMEN OF LETTER FROM THE PERMANENT SECRETARY KADUNA STATE MINISTRY OF EDUCATION TO THE ZONAL DIRECTORS

Ref: No. NCE/CIE/CA/8/Vol.1/81

Ministry of Education
P. M. B. 2017
Kaduna State
Kaduna.

25th October, 1984

The Deputy Director
Zonal Directorate
Dutsin-Ma Zone

Introduction Of Mr. James Otuka A Ph.D. Candidate Conducting Research In Physics

I am directed to inform you that approval has been given to the above named to conduct a research titled "A Study of the Factors that Affect the Understanding of Physics Concepts by Nigerian Secondary School Student."

2. You will please permit him to visit the following schools in your Zone for the above stated purpose.

1. Government Secondary School Dutsin-Ma
2. Government Girls' Secondary School Kankia.

sgd.
(F.Y. Akos)
for: Permanent Secretary,
Ministry of Education,
Kaduna State,
Kaduna.

APPENDIX C

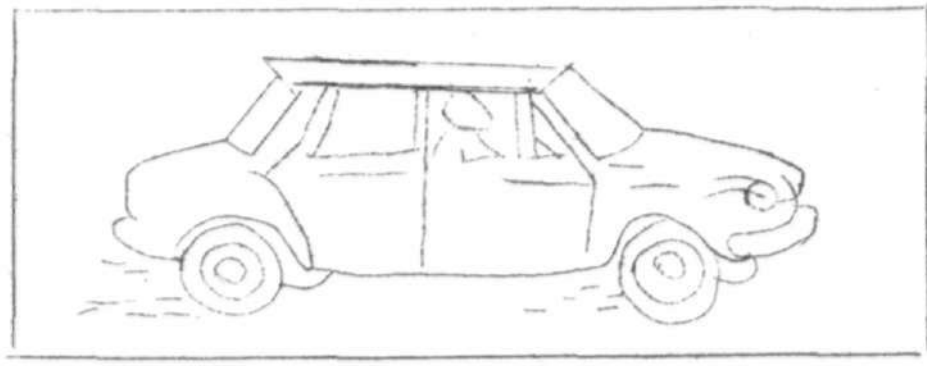
LIST OF SECONDARY SCHOOLS USED FOR THE STUDY

	Names of Schools	Educataional Zone
1.	Alhudahuda College Zaria	Zaria
2.	Government Girls Secondary School Soba	Zaria
3.	Rimi College Kaduna	Kaduna
4.	Queen Amina College Kaduna	Kaduna
5.	Government Secondary School Funtua	Malumfashi
6.	Government Girls Secondary School Malumfashi,	Malumfashi
7.	Government Secondary School Dutsin-ma	Dutsim-ma
8.	Government Girls Secondary School Kankia	Dutsin-ma
9.	Government Day Secondary School Zongo-Kataf	Zonkwa
10.	Government Girls Secondary School Zonkwa	Zonkwa
11.	Government Day Secondary School Katsina	Katsina
12.	Government Girls Secondary School Katsina	Katsina
13.	Government Day Secondary School Daura	Daura
14.	Government Day Secondary School Mashi	Daura
15.	Government Day Secondary School Ikara	Anchau
16.	Government Day Secondary School Pambegwa	Anchau

APPENDIX D

QUESTIONNAIRE FOR THE STUDY OF THE UNDERSTAND= ING OF THE CONCEPTS OF: ENERGY, WORK, FORCE AND PRESSURE BY NIGERIA SECONDARY SCHOOL STUDENTS

In each of the statements numbered (1-30) tick the answer you consider most appropriate out of the options (a - d).



When a person drives a long distance he often finds that the pressure guage indicates that the pressure of the tyre has increased: This happens because:-

(a) The tyre expands and the air inside does not.

(b) The air expands and the tyre does not

(c) The air molecules constently bombard the walls of the tyre at a fast rate and the pressure increases.

(d) The air molecules get further apart and the pressure increases.

(2) Which of the following did the greatest amount of work in the scientific sense?

2(a) The biology student who walked about the hilly school compound chasing insects for one hour.

(b) The history student who sat in the classroom for six hours preparing for an examination.

(c) The senior prefect who stood before the students and addressed them for three hours continuously.

(d) The physics student who stood by the laboratory table trying to obtain readings from an experiment for nearly a whole day.

3. Inertia can be explained as:

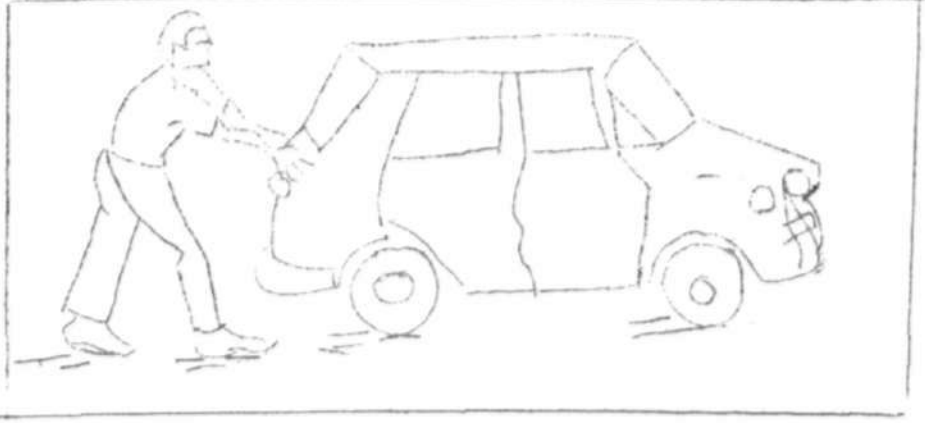
(a) The work necessary to bring a moving body to rest.

(b) The force required to stop a body which is moving

(c) The tendency of a body to remain at rest or continue moving in a straight line.

(c) The energy a body possesses by virtue of its position.

4.



Just as Yahaya reached his compound, the petrol in his car finished. He tried all he could alone to push it to the garage and failed. This happened because:

(a) The car got stiff when the petrol finished

(b) The force applied by Yahaya is more than the mass multiplied by the accalaration of the car.

(c) The force applied by Yahaya is less than the force required to move the car from rest.

(d) When petrol finished the frictional forces between the car and the ground doubled.

5.



When you are carrying a heavy load (as in the figure above) you often make a pad on which to place the load. The pad:

(a) Increasesthe area of contact and reduces pressure

(b) Helps to reduce the mass of the load.

(c) Exerts an upward force equal to the load.

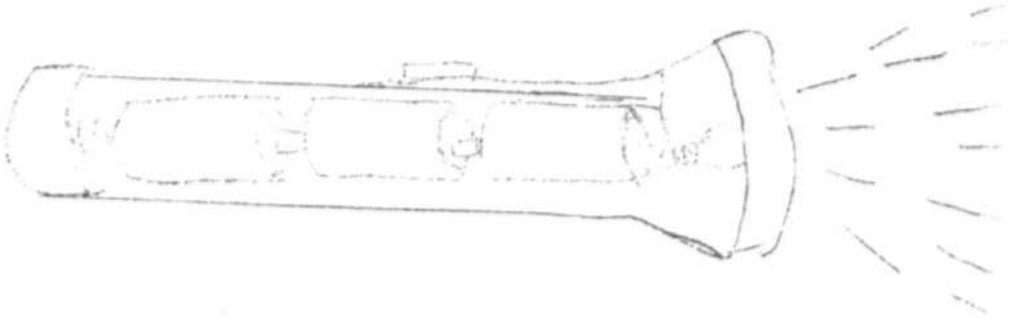
(d) Reduce the potential energy of the load.

6. Energy can exist in different forms, which of the following is not a form of energy?

(a) Sound (b) Light. (c) Heat

(d) Echo.

7.



When a torch is switched on, light is obtained.

The process that has taken place is:

Chemical energy ——> Electrical energy ——> Heat energy ——>

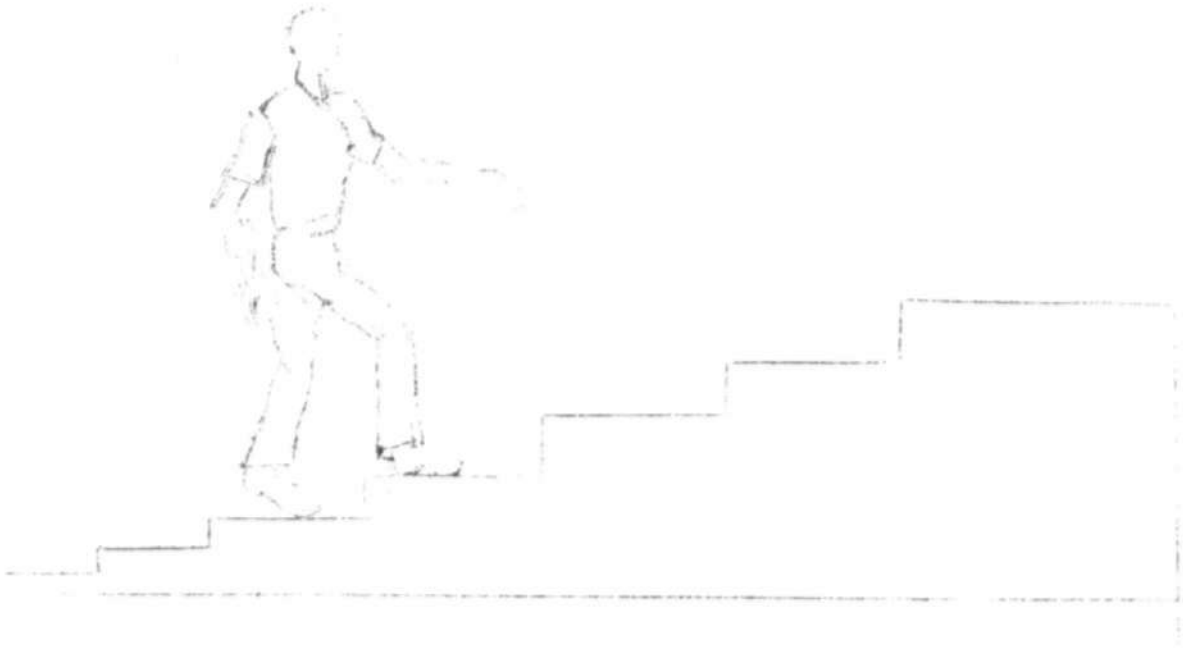
Light energy. This process can be described as:

(a) Use of energy

(b) Production of energy

(c) Transformation of energy

(d) Reaction of energy.



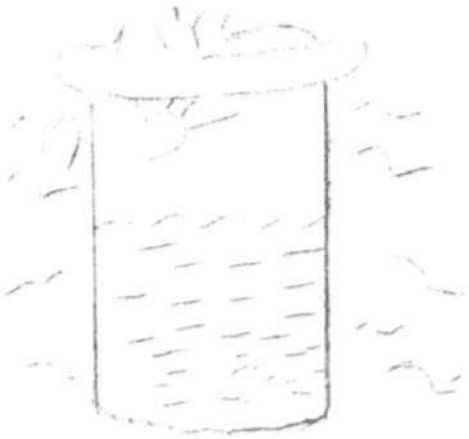
8. When we are climbing the stairs of a tall building, the work we do is:

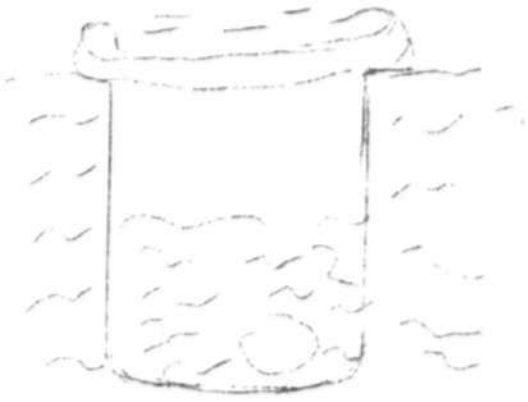
(a) Used to determine the height of the building

(b) Used to overcome the force of gravity.

(c) Used to overcome the force of friction

(d) Used to overcome the pressure exerted on us by the surrounding air.





9. If a stone is dropped into a well nearly full of water, the stone falls to the bottom of the well no matter how deep. This happens because:

(a) The water forces it to go down

(b) The force of gravity pulls it down.

(c) The water is unable to exert any upward force on it.

(d) Surface tension is overcome so the stone must fall.

10. The earth is sorrounded by a layer of air, and the pressure from this high column is great. We are not crushed by this air pressure because:

(a) The human body is a solid

(b) Internal body pressure balances air pressure

(c) The pressure is distributed on our body

(d) The density of air is less than the density of the human body.

11. Astronauts in space always wear space suit when they want to get out of the space-ship. They do this because:

(a) The pressure is less at high attitudes and causes discomfort.

(b) Without a space-suit the blood would dry up and the skin will crack.

(c) The pressure is higher at high attitudes and causes discomfort.

(d) The suit protects them from cold and snow.

12. Which of these is an example of a body possessing potential energy only.

(a) A brick set on top of a building

(b) A racing car

(c) A rolling tennis ball

(d) A trailer climbing a hill very slowly.

13. A flying bullet hits an iron door and the door becomes warm. This happens because:

(a) Iron is a metal

(b) The flying bullet released its power to the door.

(c) The door used its energy to stop the bullet

(d) The kinetic energy of bullet is converted into heat energy.

14. Air has weight

Water has weight

The smallest organism has weight

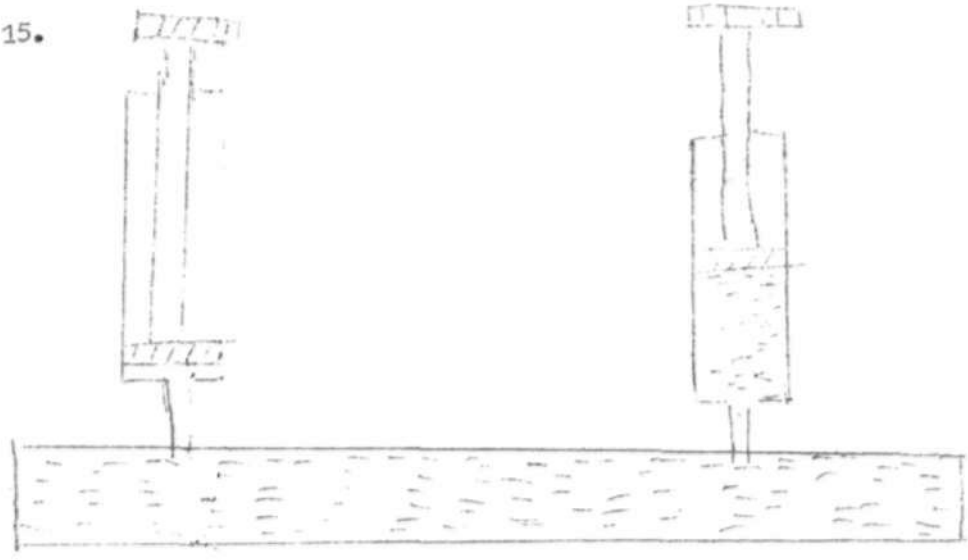
These objects all have weight because:

(a) Air exerts pressure on all of them

(b) All matter is made of some stuff

(c) Of the inertial forces present in the objects

(d) Of the force of gravity acting on the objects

15. 

The injection syringe is operated first by pushing down the plunger in the injection tube. On drawing the plunger back the tube gets filled up. This happens because:

(a) The force used in pushing the plunger draws the liquid.

(b) Liquid pressure alone pushes the liuid medicine into the barrel.

(c) Air pressure pushes the liquid medicine into the barrel.

(d) The injection needle is narrow and the medicine rushes in by force of capillarity only.

16. When one is cooking at high altitude with a stove the cooking water will boil at a reduced temperature. This happens because:

(a) The high altitude is colder.

(b) The wind blowing at the top of the mountain cools the water quickly.

(c) The fuel used does not burn well due to lack of oxygen.

(d) The water boils at reduced pressure.

17. In some bridges you often read warnings that lorries carrying many tones of load should not cross such bridges. This is because:

(a) The lorry tyres will be punctured by the bridge

(b) The weight of the lorry and the load might be too much for the bridge to carry.

(c) The frictional force between the bridge and the lorry might make the bridge expand.

(d) The wood used for the bridge is not elastic.



18. We are often advised to do physical exercises in order to keep healthy and strong. Would you then say that during exercises:

(a) The person loses energy

(b) The person gains energy

(c) The person conserves energy

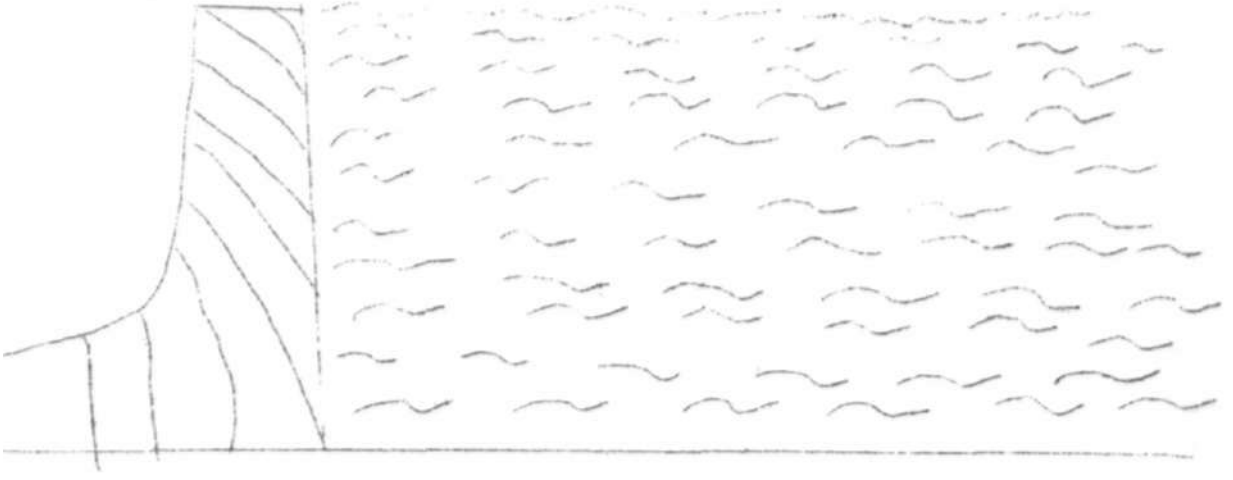
(d) The person receives energy from the air.

19. The chief source of energy on the earth is:

(a) Petroleum (b) Firewood

(c) The sun (d) Gravity

20.



The thickness of the dam wall increases as the depth increases. The construction is this way because:

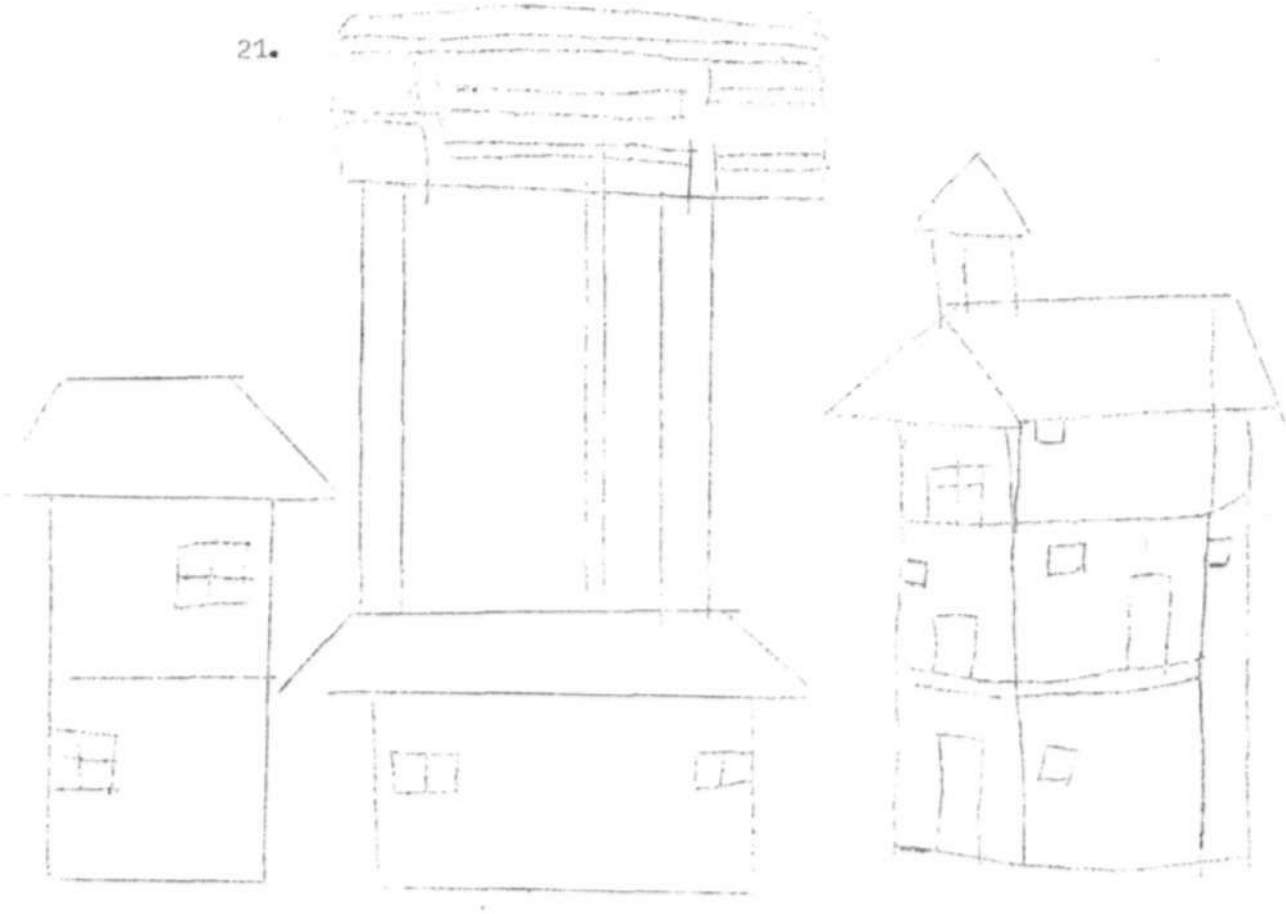
(a) The base of the dam will absorb more water than the top.

(b) Generally in building construction the base is made much stronger.

(c) Pressure increases with depth.

(d) Large volumes of water presses on the dam wall.

21.



The water reservoir in a town is usually made higher than the houses around. The construction is made so as to:

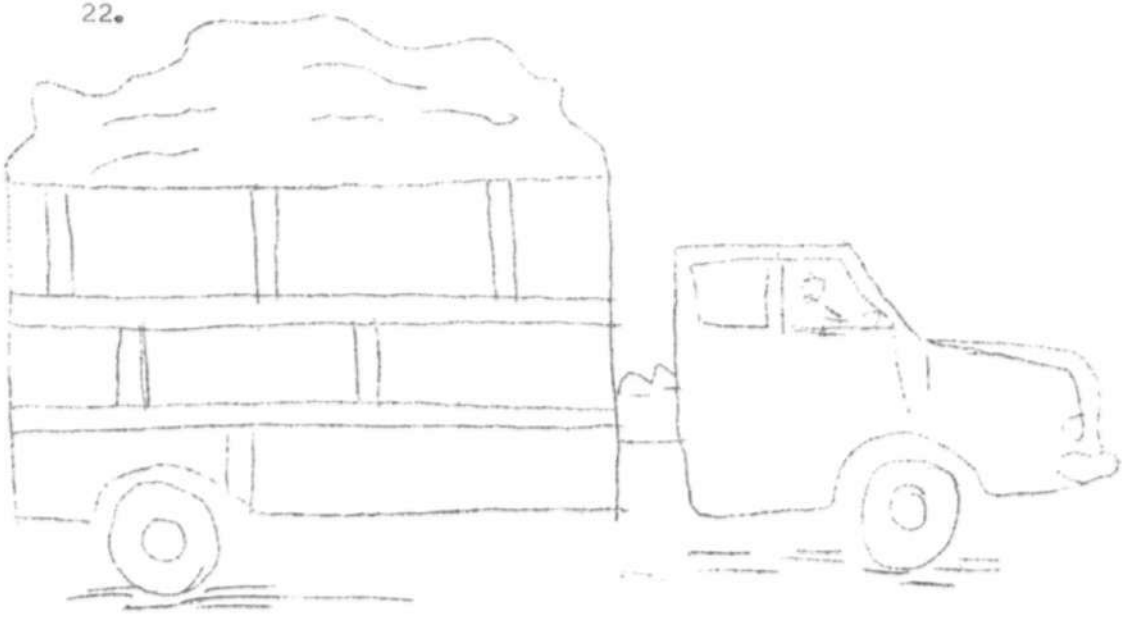
(a) Decrease the great pressure of the water

(b) Create a pressure difference between the tap and the reservoir.

(c) Store enough water for the town

(d) Make it possible for every town dweller to know where the source of water is

22.



A trailer loaded as shown above easily tumbles at bends and corners because:

(a) The trailer has too much weight

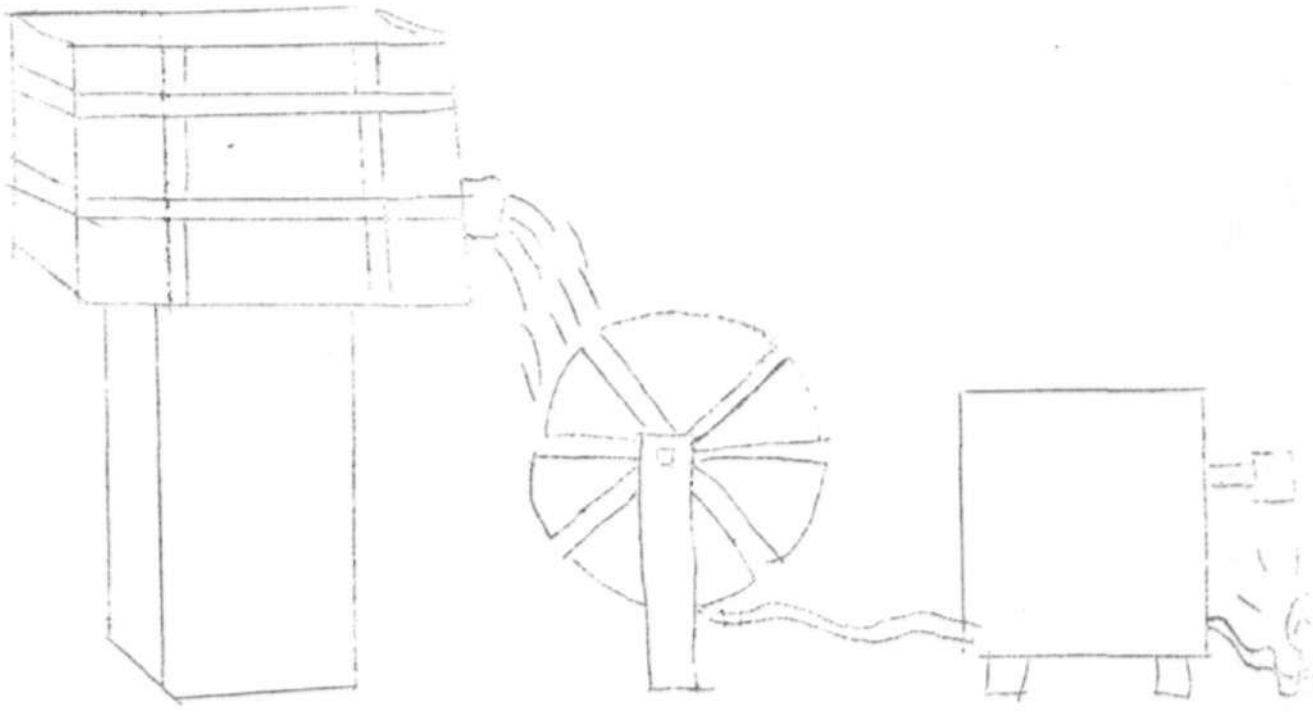
(b) The tyres are overworked

(c) The height of the point at which the weight of the trailer appears to act is raised.

(d) The height of the point at which the weight of the trailer appears to act is lowered.

23. A machine is a device for making work more convenient or easier. Which of these is not a machine?

(a) Broom (b) Hoe (c) Knife (d) Paper.



24. In Kainji Dam, water falling from a high reservoir moves a turbine which is connected to a generator that produces electricity. This process can be described as:

(a) Potential energy ⟶ Kinetic energy ⟶ Mechanical energy ⟶ Electrical energy.

(b) Kinestic energy ⟶ Mechanical energy ⟶ Heat energy ⟶ Electrical energy.

(c) Potential energy ⟶ Mechanical energy ⟶ Chemical energy ⟶ Electrical energy.

(d) Mechanical energy ⟶ Kinetic energy ⟶ Chemical energy ⟶ Electrical energy.

25. Which of the following statements about energy is correct?

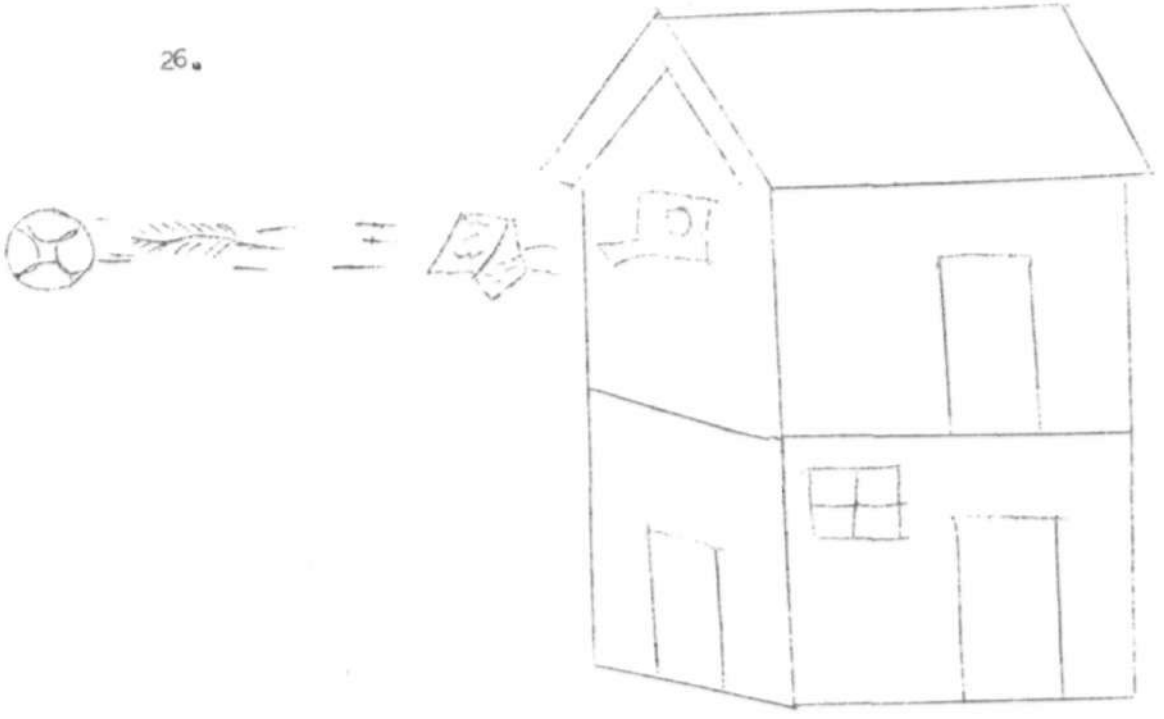
(a) Owing to constant use, the total energy in the universe is decreasing.

(b) Owing to the discovery of more petroleum and gas the total energy in the universe is increasing.

(c) Owing to energy conversion the total energy in the universe is constant.

(d) As the world grows older, its energy becomes weaker.

26.



A metal ball, a feather and a piece of paper dropped from the top of a tall building do not reach the ground at the same time. This is because:

(a) The force of gravity acts differently on different objects.

(b) The force of gravity is greatest on the ball and it falls first.

(c) The upward force on the objects varies according to their surface areas.

(d) The force of gravity is least on the feather and it should fall last.

27. Farm tractor tyres often have vary large surface areas. This is because:

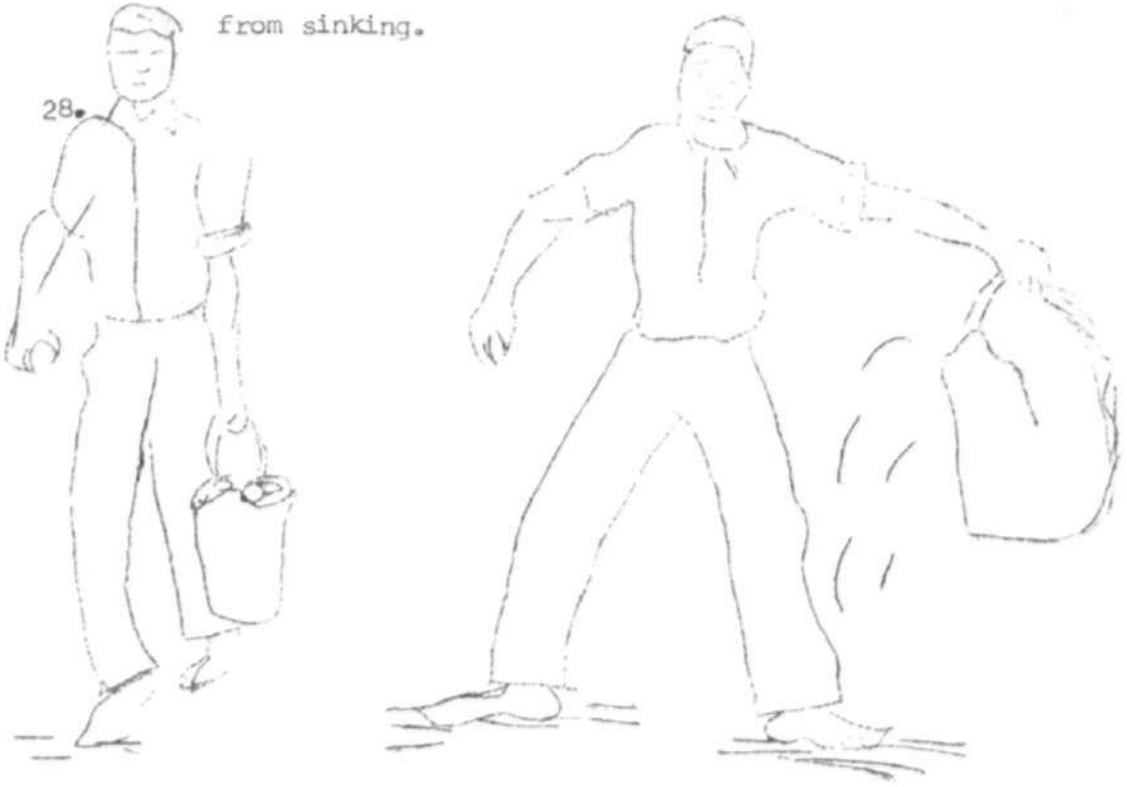
(a) They help the tractor to do more work

(b) They help to increase the pressure exerted by the tractor.

(c) They make the dirver do less work

(d) They reduce the pressure and prevent the tractor from sinking.

28.



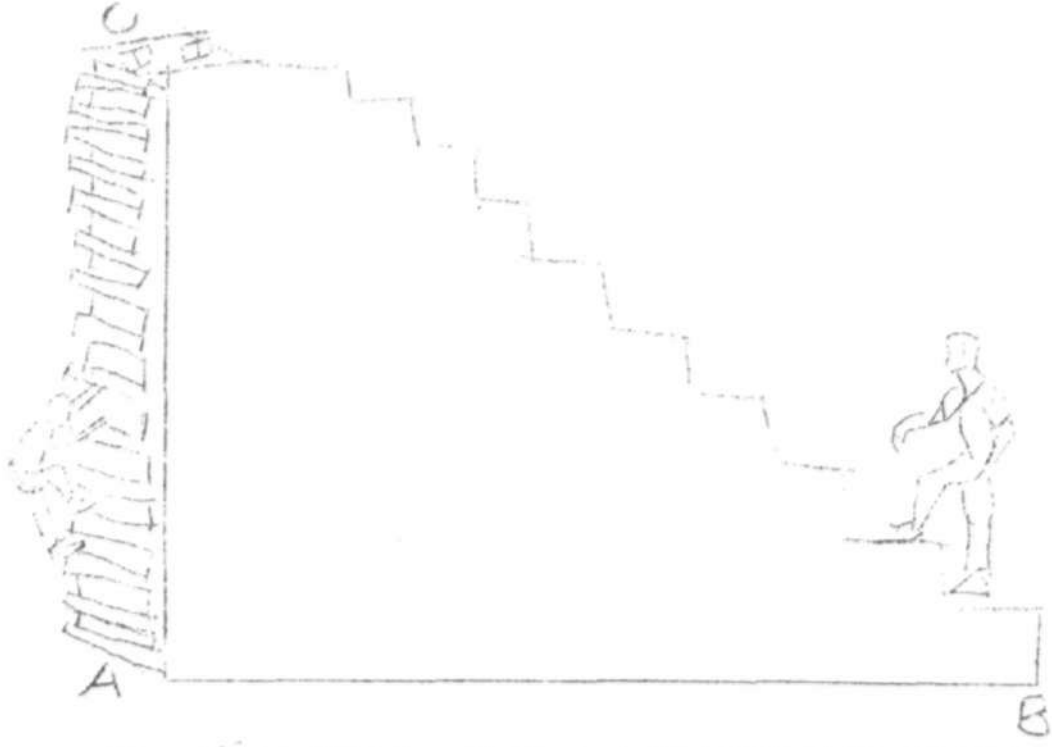
A man can easily hold a bucket of water near to his body, but not with his arm at full stretch horizontally. This happens because:

(a) When near the body, the moment of the force is large.

(b) The moment of the force near the body is smaller than the moment when stretched horizontally.

(c) The moment of the force near the body is greater than the moment when stretch horizentally.

(d) When stretched horizentally the moment of the force is small.



29. George lifted a block at A and moved it to the mason at the point C and Shehu lifted an identical blook at B and also moved it to the same mason at C. Which of the following statements is correct?

(a) George's block did more work.

(b) Shehu's block did more work.

(c) George's and Shehu's block did equal amount of work.

(d) No work was done at all.

30. An example of a process in which chemical energy is converted to heat energy is: i.e Chemical ⟶ Heat.

(a) A hammer hitting a nail

(b) A full petrol tank

(c) A torch battery

(d) Lighting a match.

KEY TO APPENDIX D

(1)	C	(17)	b
(2)	a	(18)	a
(3)	c	(19)	c
(4)	c	(20)	c
(5)	a	(21)	b
(6)	d	(22)	c
(7)	c	(23)	(d)
(8)	b	(24)	a
(9)	(b)	(25)	c
(10)	b	(26)	c
(11)	a	(27)	d
(12)	a	(28)	(b)
(13)	d	(29)	c
(14)	d	(30)	d
(15)	c		
(16)	d		

APPENDIX E

QUESTIONNAIRE ON SOCIO-ENCONOMIC AND BACKGROUND INFORMATIONS ABOUT PHYSICS STUDENTS

Section A

1. Sex /Male/Female/

2. Did you attend a nursery school /Yes/No/

3. If you stay with your father, uncle, brother, sister or some other relation or friend, state where the house is located /Township/Village/

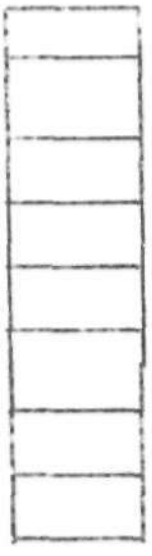
4. Name of town _____
   e.g. Kawo Kaduna.

5. State the profession or the occupation of the person you stay with _____

   Note: Do not write Civil Servant, State whether he is a cleaner, typist, accountant or Secretary etc. Do not write businessman, state whether he is a petty trader, textile dealer, building contractor food contractor etc. Father or mother here should refer to the people you spend most of your time with.

6. How much education has your father?

☐	Attending a literacy class now
☐	Did not go to a primary school.
☐	Had some primary school.
☐	Finished primary school
☐	Had some secondary school



Finished secondary school.

Spent some years in a Grade II Teachers College

Finished Grade II Teachers' College

Spent sometime in Advance Teachers College (ATC) or Polytechnic.

Finished in ATC or Polytechnic

Holds a professional Certificate read through tuition e.g. A.C.C.A.

Went to a University for sometime

Finished in a University

7. What is your mother's occupation? _____ e.g

Full-time housewife, Petty trader, Teacher, Typist

Food Contractor, Secretary etc.

8. How much education has your mother?

Attending a literacy class now.

Did not go to a primary school

Had some primary school

Finished primary school

Had some secondary school

Finished secondary school

Spent some years in a Grade II Teachers' College.

Finished Grade II Teachers' College

Spent sometime in Advanced Teachers' College (ATC) or Polytechnic.

Finished ATC or Polytechnic

Holds a professional certificate read through tution e.g. A.C.C.A.

Went to a University for sometime.

Finished in a University.

APPENDIX F

SCHOOL FACTOR IN THE UNDERSTANDING OF PHYSICS CONCEPTS. IN THE STATEMENTS BELOW, STATE WHETHER YOU STRONGLY AGREE, AGREE, UNDECIDED, DISAGREE OR STRONGLY DISAGREE INDICATE YOUR RESPONSES BY CHECKING ONE OF THE FIVE COLUMNS USING A TICK (✓) MARK

Example: We have the best physics tutor in Nigeria.

		Strongly Agree	Agree	Undecided	Strongly Disagree	Strongly Disagree
1.	My school lacks physics tutors	---	---	---	---	---
2.	We have had steady physics tutors in our school.	---	---	---	---	---
3.	Most of our physics tutors teach physics with difficulty.	---	---	---	---	---
4.	Most of our physics tutors are non Graduates (holders of B.Ed & B.Sc are graduates)	---	---	---	---	---
5.	My physics tutor speaks English very well.	---	---	---	---	---
6.	The physics WASC results in my school have been discouraging.	---	---	---	---	---
7.	The school library lacks a good collection of physics reference books.	---	---	---	---	---
8.	Physics has one of the highest number of hours per week on the school time-table.	---	---	---	---	---
9.	The school authorities always give prizes to the best students in physics every year.	---	---	---	---	---
10.	The tutor does not often correct the carry hom assignments he gives us.	---	---	---	---	---

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
11. The physics tutor encourages hard work, healthy competition and excellence among stuents.					
12. Our tutor knows a lot of physics.					
13. The school is always very noisy throughout the day when the lesson are going on.					
14. Difficult physics calculations are often worked out step by step for us by the tutor.					
15. The school authorities always encourage students to work hard in physics.					
16. The teacher hardly speaks loud enough for us to hear.					

G. Lábratory Factor

1. We do not have a proper physics laboratory in my school.					
2. The physics tutor organizes the practical work properly.					
3. The physics classes are very many for the single physics laboratory we have.					
4. The physics tutor often supervises our work during practical classes.					
5. The physics laboratory is filled with the basic equipment we need for our practicals.					
6. During practical classes the tutor often carries out the experiments by himself while we merely watch.					
7. We do practical physics very regularly in my school (at least once a week).					

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
8.	The groupings for practical physics are always large.					
9.	We often find that the equipment we need for our experiment is not available.					
10.	The teacher tries to relate the practical work to the topic we are discussing now in the class.					

In Sections B and C indicate your responses to the following statements by checking one of the columns using a tick (✓) mark.

Example: Kaduna State is a technologically developed State. Yes ☐ No ☑

H. Capital Cultural Factor

		Yes	No
1.	Some of my elder brothers/sisters have done physics at WASC.	☐	☐
2.	I am the only child going to school in our house.	☐	☐
3.	We speak English most of the time in our house.	☐	☐
4.	I find it difficult to study alone at home.	☐	☐
5.	My parents/guardians often advise me to listen to science programme in radio and television.	☐	☐
6.	My parents/guardians supply me with other physics books, pamphlets and magazines that are not the school textbooks.	☐	☐

		/Yes/	/No/
7.	My elder brothers/sisters do not help me with my study of physics at home	☐	☐
8.	During the holidays my parents/guardians hire a teacher who teaches me physics.	☐	☐
9.	At times I discuss scientific events with my parents brothers and sisters.	☐	☐
10.	My parents/guardians do not care whether I do physics at school or not so long as I get promoted every year.	☐	☐
11.	My parents/guardians often inspect my physics assignment book.	☐	☐
12.	My parents/guardians would like me to do such courses like medicine, engineering which involve physics.	☐	☐
13.	No body helps me at home when studying physics.	☐	☐
14.	My parents/guardians never check whether I study at home or not	☐	☐
15.	My parents/guardians often engage me in other activities (like farming trading etc) rather than allowing me to study after school hours.	☐	☐
16.	We speak the local language most of the time in our house.	☐	☐

	I. Environment And Peer Factor	/Yes/	/No/
1.	We live in a crowded and noisy area.	☐	☐
2.	Many who come to our house are scientists, doctors and engineers.	☐	☐
3.	I find it difficult to read in our crowded and noisy home.	☐	☐
4.	There is no space for placing a table and a chair for reading in our house.	☐	☐

		Yes	No
5.	I sometimes visit some areas of scientific interest around the place I live.	☐	☐
6.	Ideas and beliefs in my area make it difficult for me to accept some physics explanations.	☐	☐
7.	I hear visitors to our house state that physics is important for understanding modern technology.	☐	☐
8.	Physics is regarded as a very difficult subject by most students in my area.	☐	☐
9.	My study of physics gives me courage in operating radio, television, musical instruments in our house.	☐	☐
10.	I study physics at home with other students from my area who are doing physics.	☐	☐
11.	Most of my friends with whom I read at home have dropped physics at school.	☐	☐
12.	I use drums, clay pots, flutes etc. to verify some physics ideas at home.	☐	☐
13.	My friends often advise me to drop physics.	☐	☐
14.	I construct things at home with which I use to verify some physics ideas.	☐	☐
15.	There are no industries, dams, mechanical workshops etc. around my home	☐	☐
16.	We live in a quiet area of the town	☐	☐

APPENDIX J

HERE ARE SOME QUESTIONS ABOUT THE WAY YOU BEHAVE FEEL AND ACT AFTER EACH QUESTION IS A SPACE FOR ANSWERING 'YES' OR 'NO'

Remember To Answer Each Question	YES	NO
1. Do you like plenty of excitment going on around you?	☐	☐
2. Do you often need kind friends to cheer you up?	☐	☐
3. Do you nearly always have a quick answer when people talk to you?	☐	☐
4. Do you sometimes get angry?	☐	☐
5. Are you moody(ie.emotional)?	☐	☐
6. Would you rather be alone insted of meeting others?	☐	☐
7. Do ideas run through your head so that you cannot sleep?	☐	☐
8. Do you always do as you are told at once?	☐	☐
9. Do you like practical jokes?	☐	☐
10. Do you ever feel "just miserable" for no good reason?	☐	☐
11. Are you rather lively?	☐	☐
12. Have you ever broken any rules at school?	☐	☐
13. Do lots of things annoy you?	☐	☐
14. Do you like doing things where you have to act quickly?	☐	☐
15. Do you worry (think) about awful (bad) things that might happen?	☐	☐
16. Can you always keep every secret?	☐	☐
17. Can you get a party going?	☐	☐

		YES	NO
18.	Do you get heavy beatings in your heart?	☐	☐
19.	When you make new friends do you usually make the first move (ie. do you greet them first before they greet you?)	☐	☐
20.	Have you ever told lie?	☐	☐
21.	Are you easily hurt when people find fault with you or the work you do?	☐	☐
22.	Do you like telling jokes or funny stories to your friends?	☐	☐
23.	Do you often feel tired for no good reason?	☐	☐
24.	Do you always finish your homework before you play	☐	☐
25.	Are you usually happy and cheerful?	☐	☐
26.	Are you touchy (sensitive) about some thing?	☐	☐
27.	Do you like mixing with other children?	☐	☐
28.	Do you say your prayers regularly?	☐	☐
29.	Do you become anxious from time to time?	☐	☐
30.	Do you like playing prank on others?	☐	☐
31.	Do you often feel fed-up?	☐	☐
32.	Do you sometimes boast a little?	☐	☐
33.	Are you mostly quiet when you are with others?	☐	☐
34.	Do you sometimes get so restless that you cannot sit in a chair long?	☐	☐
35.	Do you often make up your mind to do things suddenly?	☐	☐

		YES	NO
36.	Are you always quiet in class, even when the teacher is out of the room?	☐	☐
37.	Do you have many frightening dreams?	☐	☐
38.	Can you usually let yourself go and enjoy yourself at a gay party?	☐	☐
39.	Are your feelings rather easily hurt?	☐	☐
40.	Have you ever said anything bad or nasty about anyone?	☐	☐
41.	Would you call yourself happy-go-lucky (ie. always happy in work and play?)	☐	☐
42.	Do you worry for a long while if you feel you have made a fool of yourself?	☐	☐
43.	Do you often like a rough and tumble game?	☐	☐
44.	Do you always eat everything you are given at meals?	☐	☐
45.	Do you find it very hard to take 'no' for an answer?	☐	☐
46.	Do you sometimes feel life is just not worth living?	☐	☐
47.	Have you ever been rude to your parents?	☐	☐
48.	Do other people think of you as being very lively?	☐	☐
49.	Does your mind often wonder off when you are doing a job?	☐	☐
50.	Would you rather sit and watch than play at parties?	☐	☐
51.	Do you find it hard to get to sleep at nights because you are worried about things?	☐	☐
52.	Do you usually feel fairly sure (ie. confident) you can do the things you have to?	☐	☐

		YES	NO
53.	Do you like going out a lot?	☐	☐
54.	Do you often feel lonely?	☐	☐
55.	Are you shy of speaking first when you meet new people?	☐	☐
56.	Do you often make up your mind when it is too late?	☐	☐
57.	When children shout at you do you shout back?	☐	☐
58.	Do you sometimes feel specially cheerful and at other times sad without any good reasons	☐	☐
59.	Do you find it hard to really enjoy yourself at a lively party?	☐	☐
60.	Do you often get into trouble because you do things without thinkinf first?	☐	☐

Please check to see that you have answered all the questions.

Junior Eysenck Personality Inventory.

APPENDIX K

THESE STATEMENTS DESCRIBE YOUR PERSONAL ATTITUDES MOTIVATIONS TOWARDS STUDYING PHYSICS. TICK ONLY FOR EACH QUESTION DEPENDING ON WHETHER YOU STRONGLY AGREE, AGREE, NOT SURE, DISAGREE OR STRONGLY DISAGREE

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree.
E. G. Physics makes life more pleasant.		✓			
1. I find it interesting to attend physics lessons.					
2. I get bored in physics practical classes because it is difficult and plotting graphs waste a lot of time.					
3. Physics is full of problems and abstract ideas. I will drop it at the earliest opportunity.					
4. I enjoy solving physics problems on my own without any help.					
5. I continue to search for the correct solution to a physics problem till I get it right.					
6. I do not waste my time studying physics because the teacher often says that the subject is for those who do well in mathematics.					
7. I get worried when I do badly in physics test.					
8. I feel happy setting up physics practical and doing the experiment to obtain results					

		Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
9.	Physics text-books are very difficult to understand and I do not need to read such books before I survive in life.	---	---	---	---	---
10.	Physics Lessons are the most uninteresting and boring. Lessons I attend in the school	---	---	---	---	---
11.	I will do everything to do physics in West Africa School Certificate (WASC) examination because I want to be a scientist.	--	---	---	---	---
12.	I always feel like walking out of the class when the teacher starts to write some formula as part of the physics lesson.	---	---	---	---	---
13.	Physics has many technical terms which are hard to remember	---	---	---	---	---
14.	Physics helps me to develop good reasoning ability.	---	---	---	---	---
15.	Physics is making us slaves to machine.	---	---	---	---	---
16.	Physics is not good for people.	---	---	---	---	---
17.	All young Nigerians should take physics at school.	---	---	---	---	---
18.	I like the way physics challenges us to find out why things happen.	---	---	---	---	---
19.	Learning about the sort of things that anyone can see happening makes physics boring for me.	---	---	---	---	---
20.	Physics is worth doing whether you want to be a scientist or not.	---	---	---	---	---

APPENDIX L

READING COMPREHENSION TEST Time: 35 mins

Read the text carefully and answer the questions that follow:

Nairobi
5th July, 1969.

Tom Mboya, Kenya's Minister for Economic planning and one of African's outstanding leaders, was shot dead in a shop doorway in a crowded Nairobi street this afternoon. His assassin, believed to be a young African, shot him twice in the chest from a car outside the shop in Government Road. The gunman escaped in his car as Mr. Mboya fell. Police said tonight that they were trying to find two men who had been speaking to 38 - year - old Mr. Mboya before he went into a chemist's shop to buy a bottle of oil for dry skin.

Mrs. Mohani-Sehini-Ghani, a middle-aged Kenya, whose husband runs the shop, said with tears streeming down her face: 'I had known him for years we walked to the door and I opened it for him and then I suddenly saw him slump backwards and I heard these shots. I said to him, "Tom. Tom, what's wrong" He didn't answer, but just slumped against the wall. It was all so confusing. I dragged him into the shop and then I looked at my hands and saw the blood on them. I then knew what had happened. I poured water over his face because I didn't know what to do. He was an old friend, a regular customer and always came into our shop to buy things.'

As Mr. Mboya fell, his lone bodyguard, Mr. Joseph Ouma Nisa, ran forward, but the assassin's car pulled rapidly away past Mr. Mboya's parked Mercedes and disappeared. There were screams. Crowds ran to the spot. An Asian doctor called by one of the shop's staff tried to revive Mr. Mboya with artificial respirations. Some 30 police with drawn batons tried to cordon off the road but the crowd pressed in around them. Half an hour after the shooting about 2,000 people were standing silently around the area.

Mr. Mboya's body was taken by ambulance to Nairobi Hospital. Riot police ringed the building as crowds shouting "We want to see Mboya's body' tried to force their way in. Police dispersed them with clubs and teargas and the crowd stoned passing cars. Shocked politicians arrived at the hospital to see the body. Mr. Mboya's bodyguard arrived and collapsed in the road crying: "It's not true, it's not true." Mr. Achieng Oneko, publicity secretary of Kenyans opposition party KPU, arrived in tears saying, "This is not a political assassination. There is no question of parties here. He belonged to us all". Witnesses in the chemists's and people in adjoining shops were taken to police headquarters for questioning. An assistant from the chemist's went to Mboya's wife, Pamela. The assistant said: 'When I got there she had

already been informed by someone that Mr. Mboya had been in a car accident. I asked her to come with me to Nairobi Hospital. She was very quiet and extremely worried on the way. On arrival she burst into tears and went into the hospital.

Sporadic rioting broke out in Kenya tonight. In Kisumu, head quarters of Mboya's Luo tribe, people stoned stores run by Kikuyus, the largest tribe in Kenya and the majority tribe in the government. At Homa, Bay, South Kisumu, police guarded the Kikuyu population after Luo tribesemen attacked them. President Jomo Kenyatta expressed grief and sorrow at the loss of a man of his calibre and resources. Mr. Mboya who married in 1962, leaves four young children... a boy and three girls. It was the second attempt on his life in two years. In December, 1967 a Kenya policeman on guard outside his home fired four shots at him. The man, who had a personal grudge, was jailed for two years.

Read the following questions carefully then tick (✓) the option that answers best each question. No 1 has been done for you.

1. According to the first sentence which of the following statements is true:

   (a) Tom Mboya was Kenya's only Minister

   ✓(b) Tom Mboya was a great African leader

   (c) Tom Mboya was the leader of Africa

   (d) Africa has had many outstanding leaders.

2. The statement: The gunman escaped in his car as Mr. Mboya fell, suggests that:

   (a) The attacker escaped just before Mboya collapsed

   (b) Mboya immediately collapsed before the attacker escaped

   (c) The two actions occurred at the same time

   (d) Mboya fell because the gunman had escaped.

3. From the statement: "We walked to the door and I opened it for him and then I suddenly saw him slump backward and I heard these shots," we understand that Mboya was shot.

   (a) - in a Nairobi street

   (b) - in a shop doorway

   (c) - in a crowded place

   (d) - in a parked car.

4. From the statement: "I then knew what happened", it is clear

   (a) The Indian lady was in fact a dishonest person.

   (b) The Indian lady discussed with Mboya in the shop.

   (c) The Indian lady knew something about Mboya's shooting.

   (d) The Indian lady realized only later Mboya's shooting.

5. The line "As Mr. Mboya fell, his lone bodyguard, Mr. Nisa, ran forward", suggests that:

(a) Mr. Mboya had a lonely bodyguard.

(b) Mr. Mboya alone had a bodyguard.

(c) Mr. Nisa didn't know his work.

(d) Mr. Mboya had only one bodyguard.

6. The statements: "It's not true" _____

"We want to see his body", _____and

"Mr. Mboya had been in a car accident," all

suggest that

(a) Nobody know whether Mboya was dead or alive.

(b) People didn't belive that Mboya could die like that

(c) People were shocked to hear Mboya was shot dead

(d) In Kenya people usually argue about the dead.

7. From the passage we know that Mrs. Mboya was told of her husband's terrible condition by /

(a) Someone unnamed in the passage

(b) the shop assistant from the chemist's

(c) the police on duty that day.

(d) somebody from the traffic division.

8. Before she arrived at the hospital we can conclude that:

(a) Mrs. Mboya was totally ignorant of her husband's state.

(b) Mrs. Mboya did not have any love for her husband.

(c) Mrs. Mboya did not know where her husband was

(d) Mrs. Mboya suspected the worst might have happened.

9. "People stoned stores run by Kikuyus" because

(a) The Kikuyus had killed Tom Mboya

(b) The Kikuyus were hated in Kenya.

(c) The Kenyans could not be controlled.

(d) The Luos highly suspected the Kikuyus.

10. "A man of his calibre and resources" means

(a) a man of outstanding qualities

(b) a man from a good tribe

(c) a man of high class.

(d) a man never in trouble.

11. The most suitable title for his passage is

(a) President Jomo Kenyetta Mourns

(b) Crowd behaviour in Kenya

(c) Assassination of Tom Mboya

(d) Performance of Kenya Police.

KEY TO APPENDIX L

(1)	b
(2)	c
(3)	c
(4)	d
(5)	d
(6)	a
(7)	a
(8)	d
(9)	d
(10)	a
(11)	c

APPENDIX M

NON-VERBAL REASONING TEST (AH4 PART II)

In the test that follows you will find some items which are in the form of pictures. The items are there to test your understanding of some sort of relationships between the pictures of every item. The right answer is one of the five alternatives given for every question. These alternative marked 1, 2, 3, 4 and 5. When you find the correct answer, write the NUMBER of the correct alternative in the space provided at the right hand margin of the test. The test is not difficult; though the questions become difficult gradually. If you find any item to be difficult, then do not waste time on it; proceed to the following ones. There will be 10 minutes only for you to complete this test, Please remember that very few can complete the test in 10 minutes. So do not worry.

Now turn the page and let us look at the examples.
Item No 1 has the correct answer as No 4.
Item No. 2 has the correct answer as No 2
DO YOU UNDERSTAND ?
Will you now work out the items 3 to 10. When you finish I shall tell you the correct answers and please check.

Student's Name: _____

Form or Class: _____

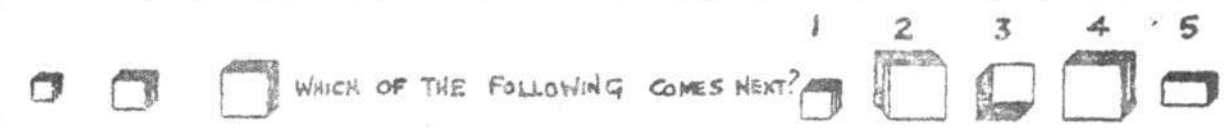
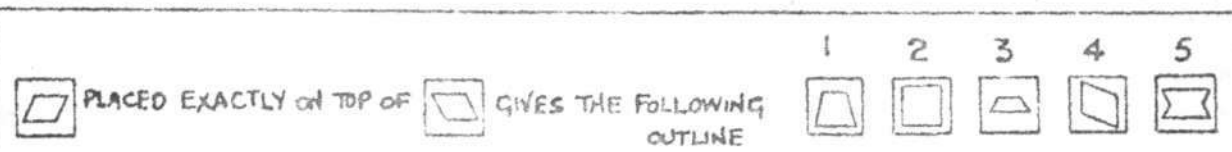
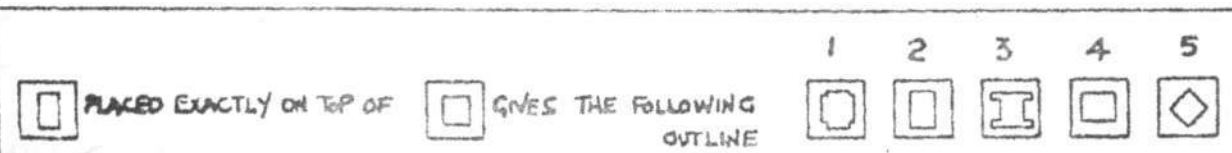
Sex:_____Age:_____

School:_____

_____

234

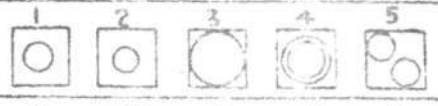
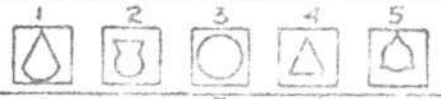
PART I.
EXAMPLES.

QU. Nº	DO NOT WRITE ANYTHING ON THIS PAPER.	QU. Nº.
1		1
2		2
3		3
4		4
5		5
6		6
7		7
8		8
9		9
10		10

DO NOT TURN OVER UNTIL YOU ARE TOLD TO DO SO.

QU. Nº	DO NOT WRITE ANYTHING ON THIS PAPER.	QU. Nº
1	□ IS TO □ AS ○ IS TO	1
2	IS THE SAME AS	2
3	FROM △ TAKE △ AND THERE IS LEFT	3
4	WHICH OF THE FOLLOWING COMES NEXT?	4
5	PLACED EXACTLY ON TOP OF GIVES THE FOLLOWING OUTLINE.	5
6	IS TO AS IS TO	6
7	IS THE SAME AS	7
8	FROM TAKE AND THERE IS LEFT	8
9	WHICH OF THE FOLLOWING COMES NEXT?	9
10	PLACED EXACTLY ON TOP OF GIVES THE FOLLOWING OUTLINE.	10
11	□ IS TO AS IS TO	11
12	IS THE SAME AS	12
13	FROM TAKE AND THERE IS LEFT	13
14	WHICH OF THE FOLLOWING COMES NEXT?	14
15	PLACED EXACTLY ON TOP OF GIVES THE FOLLOWING OUTLINE	15
16	IS TO AS IS TO	16
17	IS THE SAME AS	17
18	FROM TAKE AND THERE IS LEFT	18
19	WHICH OF THE FOLLOWING COMES NEXT?	19
20	PLACED EXACTLY ON TOP OF GIVES THE FOLLOWING OUTLINE.	20
21	IS TO AS IS TO	21
22	IS THE SAME AS	22

GO ON TO THE NEXT PAGE.

QU. Nº	DO NOT WRITE ANYTHING ON THIS PAPER.	QU. Nº
23	FROM  TAKE  AND THERE IS LEFT 	23
24	 WHICH OF THE FOLLOWING COMES NEXT? 	24
25	 PLACED EXACTLY ON TOP OF  GIVES THE FOLLOWING OUTLINE 	25
26	 IS TO  AS  IS TO 	26
27	 IS THE SAME AS . 	27
28	FROM  TAKE  AND THERE IS LEFT 	28
29	 WHICH OF THE FOLLOWING COMES NEXT? 	29
30	 PLACED EXACTLY ON TOP OF  GIVES THE FOLLOWING OUTLINE 	30
31	 IS TO AS IS TO 	31
32	 IS THE SAME AS 	32
33	FROM  TAKE  AND THERE IS LEFT 	33
34	 WHICH OF THE FOLLOWING COMES NEXT? 	34
35	 PLACED EXACTLY ON TOP OF  GIVES THE FOLLOWING OUTLINE 	35
36	 IS TO  AS  IS TO 	36
37	IS THE SAME AS	37
38	FROM TAKE AND THERE IS LEFT	38
39	WHICH OF THE FOLLOWING COMES NEXT?	39
40	PLACED EXACTLY ON TOP OF GIVES THE FOLLOWING OUTLINE	40
41	IS TO AS IS TO	41
42	IS THE SAME AS	42
43	FROM TAKE AND THERE IS LEFT	43
44	WHICH OF THE FOLLOWING COMES NEXT?	44

GO ON TO THE NEXT PAGE.

DO NOT WRITE ANYTHING ON THIS PAPER.

			N°
5	PLACED EXACTLY ON TOP OF	GIVES THE FOLLOWING OUTLINE	45
6	IS TO	AS IS TO	46
7	IS THE SAME AS		47
8	FROM	TAKE AND THERE IS LEFT	48
9		WHICH OF THE FOLLOWING COMES NEXT?	49
10	PLACED EXACTLY ON TOP OF	GIVES THE FOLLOWING OUTLINE	50
1	IS TO	AS IS TO	51
2	IS THE SAME AS		52
3	FROM	TAKE AND THERE IS LEFT	53
4		WHICH OF THE FOLLOWING COMES NEXT?	54
5	PLACED EXACTLY ON TOP OF	GIVES THE FOLLOWING OUTLINE	55
6	IS TO	AS IS TO	56
7	IS THE SAME AS		57
8	FROM	TAKE AND THERE IS LEFT	58
9		WHICH OF THE FOLLOWING COMES NEXT?	59
0	PLACED EXACTLY ON TOP OF	GIVES THE FOLLOWING OUTLINE	60
1	IS TO	AS IS TO	61
2	IS THE SAME AS		62
3	FROM	TAKE AND THERE IS LEFT	63
4		WHICH OF THE FOLLOWING COMES NEXT?	64
5	PLACED EXACTLY ON TOP OF	GIVES THE FOLLOWING OUTLINE	65

END OF PART II.

APPENDIX N

BOYS: TEST SCORES.

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
001	Male	08	03	13	09	51	32	15	15	78	18	06	10
002	"	15	07	15	11	40	26	05	11	77	22	04	15
003	"	04	02	08	08	54	33	14	13	74	51	08	19
004	"	01	00	08	08	46	30	11	11	79	45	05	20
005	"	15	15	13	13	41	26	21	12	37	41	7	15
006	"	6	2	13	12	54	35	18	15	82	35	7	22
007	"	15	2	10	13	48	28	19	14	90	44	7	18
008	"	1	0	5	5	30	21	11	11	69	25	2	6
009	"	5	5	6	5	50	31	10	12	70	29	5	20
010	"	5	3	9	8	45	29	18	17	76	54	8	23
011	"	15	7	12	7	44	30	10	16	87	33	8	15
012	"	15	6	14	10	53	35	15	15	73	47	5	18
013	"	11	7	12	9	48	34	17	11	89	57	6	22
014	"	8	0	9	6	37	26	8	2	84	50	7	16

S/No.	Sex	1	2	3	4	5	6	7	8	9	10	11	12
015	Male	6	3	12	0	36	28	15	13	75	37	6	14
016	"	4	2	9	12	49	35	9	15	83	36	5	19
017	"	15	10	13	12	47	28	12	17	83	45	6	19
018	"	1	0	12	9	32	26	13	16	85	40	8	13
019	"	4	1	10	12	50	33	18	11	82	40	7	19
020	"	4	3	5	6	32	26	6	15	70	38	4	14
021	"	10	8	13	13	53	23	15	21	87	41	8	22
022	"	13	9	15	12	54	33	5	19	88	31	3	17
023	"	15	2	15	13	40	19	12	17	81	35	5	9
024	"	4	3	8	13	52	30	5	13	79	25	7	21
025	"	3	0	12	8	53	26	11	13	87	27	6	23
026	"	1	1	1	9	52	27	8	13	64	19	2	09
027	"	1	0	5	8	50	26	6	16	73	14	8	10
028	"	2	0	4	10	44	27	7	14	74	21	5	15
029	"	8	5	13	12	48	30	7	14	80	38	5	19
030	"	1	0	3	8	46	32	10	11	73	24	3	12

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
031	Male	2	1	2	11	54	34	10	15	58	27	6	17
032	"	2	1	12	11	60	33	10	16	85	34	7	26
033	"	3	0	9	12	50	28	13	11	80	24	6	23
034	"	3	3	13	10	42	25	12	20	68	19	6	11
035	"	1	1	1	3	44	30	10	14	68	14	4	14
036	"	1	0	3	8	52	26	9	12	77	13	6	16
037	"	15	15	15	14	68	29	6	21	69	44	8	21
038	"	1	1	4	9	56	35	14	15	80	32	4	17
039	"	15	15	13	11	59	31	6	14	84	43	8	24
040	"	2	1	11	7	42	30	12	11	64	19	2	13
041	"	1	0	6	10	54	32	6	12	89	26	7	16
042	"	1	2	8	12	56	32	16	14	72	32	4	17
043	"	2	2	11	11	48	35	9	15	83	21	8	12
044	"	3	2	8	13	47	27	14	17	83	35	6	16
045	"	1	0	3	8	47	29	5	12	59	07	3	07
046	"	15	3	12	13	60	30	11	15	73	30	5	17

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
047	Male	7	5	10	8	52	26	6	14	81	37	7	18
048	"	3	0	8	9	42	27	20	19	58	7	2	10
049	"	5	2	4	7	42	26	8	15	66	24	4	6
050	"	1	0	8	12	54	37	13	21	74	10	5	9
051	"	1	0	8	12	51	37	5	17	67	20	8	13
052	"	4	0	11	7	43	26	15	15	80	34	6	16
053	"	2	0	0	9	41	28	11	15	50	4	4	9
054	"	15	7	10	9	45	33	9	19	73	25	6	19
055	"	1	0	10	10	61	30	11	1	71	23	3	10
056	"	1	0	8	6	53	32	13	14	73	9	2	13
057	"	12	7	13	13	42	22	14	17	87	33	5	18
058	"	1	1	9	7	50	28	13	15	67	9	1	11
059	"	1	0	9	10	66	34	8	15	68	12	2	12
060	"	6	0	11	10	46	24	14	17	62	15	2	14
061	"	1	0	10	4	31	30	11	15	66	31	6	16
062	"	15	5	13	14	43	32	17	16	79	21	8	19

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
063	Male	1	2	4	6	36	28	10	15	71	9	2	13
064	"	1	0	9	5	30	25	13	13	86	15	2	16
065	"	8	2	8	9	53	35	8	16	85	30	6	15
066	"	4	0	11	10	39	30	9	17	74	23	3	11
067	"	1	1	5	7	47	32	19	14	73	9	1	14
068	"	1	1	14	10	49	31	8	16	69	34	7	20
069	"	1	0	9	9	38	25	22	14	57	12	2	13
070	"	1	1	3	3	50	31	7	9	76	26	5	13
071	"	9	0	8	2	42	30	16	11	62	24	6	18
072	"	4	1	9	7	43	25	14	14	65	21	2	9
073	"	4	4	7	6	54	29	17	13	75	9	5	16
074	"	1	1	10	5	56	27	15	13	76	17	5	16
075	"	6	4	15	10	61	31	4	18	73	34	7	22
076	"	6	3	14	14	60	29	5	15	79	23	7	21
077	"	6	4	9	5	61	31	12	20	52	29	7	18
078	"	4	6	9	9	62	34	13	17	92	27	7	19
079	"	4	0	6	8	40	28	2	11	77	9	3	10

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
080	Male	1	[illegible]	[illegible]	[illegible]	54	26	9	15	70	22	6	11
081	"	1	0	5	5	51	28	[illegible]	15	[illegible]	21	6	15
082	"	1	0	7	11	37	20	7	13	59	8	2	8
083	"	4	0	5	7	43	32	14	23	79	27	5	14
084	"	4	6	11	13	42	28	13	16	75	17	7	17
085	"	15	8	15	14	57	28	12	15	70	26	6	18
086	"	11	3	13	10	57	28	5	11	55	9	9	16
087	"	3	1	11	11	47	29	15	19	79	17	5	13
088	"	1	0	9	9	51	28	18	14	85	7	2	15
089	"	7	3	9	10	58	27	15	14	85	17	5	17
090	"	10	0	9	10	63	35	20	13	84	29	8	25
091	"	15	15	13	13	62	33	14	15	88	50	8	24
092	"	2	[illegible]	11	7	42	31	15	16	74	19	5	15
093	"	15	5	13	15	53	29	6	13	76	29	6	19
094	"	4	0	6	10	56	31	10	13	77	25	4	19
095	"	8	3	3	7	38	20	10	[illegible]	68	4	1	6
096	"	6	2	10	5	45	38	12	10	75	17	5	16

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
097	Male	15	1	14	10	49	27	4	12	67	33	7	20
098	"	6	3	12	8	54	27	17	15	79	25	6	18
099	"	15	5	13	13	51	26	15	11	62	34	6	18
100	"	4	4	14	13	50	29	14	11	79	13	5	18
101	"	1	0	9	8	39	21	5	13	62	3	3	10
102	"	12	5	13	13	60	25	14	19	81	31	6	20
103	"	12	10	13	11	55	24	9	13	74	25	6	17
104	"	1	0	10	10	44	23	13	17	80	37	5	18
105	"	14	3	9	11	42	30	11	15	73	36	6	18
106	"	4	0	8	11	45	32	14	15	81	21	3	12
107	"	2	0	6	4	46	28	10	21	77	11	1	9
108	"	6	5	4	9	39	23	8	11	80	24	4	12
109	"	2	2	3	5	46	30	17	16	57	21	2	9
110	"	2	0	8	7	49	29	9	12	87	25	5	15
111	"	2	0	9	13	45	30	17	14	72	22	3	13
112	"	3	0	7	7	50	28	14	17	81	12	4	11
113	"	2	1	9	5	39	34	10	12	54	7	1	10

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
114	Male	2	1	12	13	45	27	6	16	79	13	2	11
115	"	1	0	6	13	48	24	6	14	84	10	5	17
116	"	2	[illegible]	8	9	44	31	11	15	63	13	2	12
117	"	5	3	10	13	48	26	16	15	78	20	7	19
118	"	2	1	9	7	45	29	11	11	82	29	5	16
119	"	4	1	6	8	50	28	14	17	68	34	6	18
120	"	4	1	10	9	55	30	11	16	82	18	6	15
121	"	5	4	3	5	52	25	13	15	74	19	5	13
122	"	1	0	3	7	52	24	15	16	77	15	3	14
123	"	2	0	[illegible]	[illegible]	36	29	8	15	73	24	3	10
124	"	5	5	5	9	45	31	7	20	43	11	5	18
125	"	2	0	9	9	50	27	10	17	79	20	5	15
126	"	2	0	8	8	54	29	17	15	79	23	5	18
127	"	3	2	10	8	45	32	5	11	83	19	5	14
128	"	1	[illegible]	9	9	50	32	14	12	78	25	6	18
129	"	1	0	7	7	40	27	7	16	88	26	3	12
130	"	1	0	9	8	46	22	9	11	78	25	2	14

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
131	Male	1	0	7	7	35	21	10	14	86	5	6	11
132	"	4	3	12	7	41	35	7	11	74	23	5	15
133	"	4	3	11	11	52	27	8	19	85	27	6	20
134	"	3	3	10	7	53	22	12	16	75	26	3	19
135	"	1	0	8	7	45	29	17	12	67	21	1	17
136	"	6	8	11	8	48	29	13	15	81	18	5	21
137	"	8	4	11	6	54	28	10	18	72	17	2	10
138	"	6	4	13	8	55	21	11	15	72	18	5	24
139	"	1	1	11	9	60	30	7	13	72	21	2	15
140	"	1	0	5	6	54	26	13	14	86	34	5	19
141	"	2	0	9	9	51	28	13	14	84	30	4	13
142	"	2	1	7	8	46	27	11	13	82	15	2	17
143	"	1	0	4	4	55	22	7	9	68	13	3	16
144	"	1	0	5	5	48	28	8	9	65	30	2	8
145	"	8	2	4	10	41	29	7	18	75	4	4	15

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
146	Male	12	8	9	8	55	30	17	6	79	24	6	20
147	"	2	1	12	10	48	28	11	15	80	21	4	14
148	"	1	4	9	12	51	28	9	14	80	14	4	18
149	"	8	6	13	11	50	25	11	18	80	48	8	21
150	"	4	0	11	10	55	27	6	18	74	36	6	18

Key:

1. Fathers' Background
2. Mothers' Background
3. Capital Cultural Factor
4. Environment/Peer
5. Tutor/Administration
6. Laboratory
7. Neuroticism
8. Extroversion
9. Attitude
10. Reasoning Ability
11. Reading Comprehension
12. Physics Concepts.

APPENDIX O.

GIRLS: TEST SCORES.

S/No.	Sex	1	2	3	4	5	6	7	8	9	10	11	12
151	Female	15	15	10	10	38	30	12	12	60	18	7	20
152	"	15	10	13	09	36	33	11	15	61	17	5	20
153	"	15	4	13	11	31	34	21	9	70	13	5	16
154	"	15	9	13	9	34	35	16	12	87	17	6	16
155	"	6	0	7	03	32	38	16	18	45	22	6	16
156	"	13	0	6	05	38	37	15	10	77	24	6	18
157	"	12	0	12	10	37	40	9	15	81	32	6	19
158	"	3	0	6	03	32	29	10	14	68	18	3	19
159	"	15	15	7	06	28	34	15	15	64	25	8	24
160	"	15	13	14	7	41	35	17	12	77	23	9	23
161	"	15	5	14	10	32	27	10	16	76	19	6	15
162	"	15	7	11	6	44	35	19	13	70	18	7	19
163	"	14	12	10	5	38	22	17	13	79	27	4	15
164	"	1	0	1	2	39	27	8	11	64	21	7	10
165	"	15	5	9	6	21	34	22	9	76	26	8	20
166	"	15	11	10	8	42	38	18	20	75	23	6	18

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
167	Female	15	5	13	8	47	34	20	16	78	34	7	20
168	"	13	1	11	10	40	32	16	14	74	15	5	17
169	"	4	2	4	7	43	29	18	13	71	20	4	13
170	"	15	3	9	6	36	28	20	13	72	31	5	18
171	"	7	3	7	7	45	35	20	13	51	17	6	14
172	"	1	0	8	5	34	24	13	18	64	18	4	10
173	"	3	2	5	6	40	37	10	11	90	23	5	14
174	"	6	2	8	6	34	34	19	14	67	16	5	12
175	"	1	0	2	4	42	32	16	14	65	18	6	15
176	"	4	8	8	10	36	30	19	15	52	22	5	10
177	"	15	15	15	13	51	34	19	17	62	22	5	16
178	"	7	3	10	11	43	27	11	17	74	17	5	12
179	"	15	11	11	8	42	26	12	18	71	20	7	16
180	"	15	4	13	10	40	28	18	18	80	22	6	15
181	"	13	0	12	6	46	43	16	19	83	20	6	20
182	"	15	0	10	7	36	24	12	16	66	20	8	16
183	"	15	6	13	9	56	38	10	16	80	32	7	18

S/NO	Sex	1	2	3	4	5	6	7	8	9	10	11	12
184	Female	15	5	14	9	59	40	11	16	71	28	7	18
185	"	15	3	13	9	62	37	10	14	76	23	7	17
186	"	12	6	14	9	55	41	13	12	74	32	8	19
187	"	3	2	11	10	55	41	15	14	76	36	8	18
188	"	15	11	12	10	45	40	10	14	74	44	8	21
189	"	1	0	11	13	40	37	9	12	77	26	5	15
190	"	12	0	12	10	38	42	5	10	51	24	6	17
191	"	2	1	12	10	53	40	4	14	68	23	5	17
192	"	10	9	11	13	47	41	9	13	70	25	7	18
193	"	5	4	10	10	40	32	20	16	63	24	5	14
194	"	2	0	8	8	46	37	10	15	69	20	7	15
195	"	6	3	14	11	49	39	15	14	74	20	7	17
196	"	5	4	10	11	51	44	15	18	75	27	6	16
197	"	10	10	15	12	49	36	13	17	74	31	6	19
198	"	10	10	12	8	50	36	14	16	75	34	6	15
199	"	2	0	13	13	48	40	12	12	76	44	8	18
200	"	6	4	13	8	48	32	9	10	81	32	8	16

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
201	Female	6	1	6	6	58	35	18	17	78	25	6	15
202	"	5	4	8	6	47	31	19	16	84	12	3	9
203	"	2	0	10	8	50	34	15	16	67	28	4	12
204	"	2	0	9	7	42	32	17	15	76	23	4	16
205	"	4	3	13	9	41	30	16	16	74	19	6	13
206	"	4	4	8	8	45	35	9	16	84	21	7	17
207	"	10	9	7	7	31	32	13	16	70	32	3	10
208	"	15	5	12	9	41	31	10	16	75	33	7	18
209	"	15	5	13	11	53	37	15	21	68	27	7	20
210	"	15	5	12	11	54	38	7	14	84	28	6	18
211	"	12	12	15	8	38	15	13	17	65	39	7	20
212	"	8	6	10	9	30	30	7	14	78	32	5	15
213	"	12	2	9	8	38	28	20	14	76	25	7	15
214	"	8	8	10	6	42	34	13	13	74	36	8	18
215	"	1	0	8	8	49	24	12	17	75	19	1	13
216	"	7	3	11	8	39	27	16	19	79	07	1	10
217	"	8	0	8	7	40	24	10	16	75	14	3	12

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
218	Female	8	7	11	8	48	19	12	17	74	25	8	16
219	"	4	3	12	10	50	26	11	15	74	25	8	14
220	"	12	1	9	5	48	30	15	12	64	36	7	22
221	"	11	0	9	10	50	29	16	16	81	33	6	18
222	"	15	11	13	10	52	31	12	15	82	35	7	18
223	"	15	12	12	12	60	30	14	16	92	39	7	17
224	"	10	15	12	12	47	26	11	17	93	25	4	9
225	"	9	7	12	9	44	30	10	11	58	13	1	15
226	"	11	9	14	12	57	35	7	14	84	30	7	15
227	"	1	1	14	11	50	35	9	15	82	24	6	11
228	"	8	0	12	8	38	23	11	14	66	13	1	4
229	"	5	3	11	10	51	34	16	18	73	22	4	17
230	"	7	3	9	10	49	33	11	14	74	12	3	10
231	"	15	8	8	10	59	32	13	15	77	16	4	16
232	"	1	0	7	10	52	31	17	15	78	25	3	12
233	"	8	5	15	13	52	34	20	17	84	33	4	16
234	"	12	8	13	9	51	34	9	17	91	30	6	13

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
235	Female	15	15	8	9	59	38	14	18	93	30	6	16
236	"	4	4	12	8	54	38	11	16	74	19	5	14
237	"	6	3	12	10	46	31	9	20	93	12	4	9
238	"	14	5	15	12	57	33	12	17	7	12	4	5
239	"	1	1	12	9	41	32	15	20	72	17	5	10
240	"	13	12	13	9	55	35	17	15	90	20	4	15
241	"	1	0	12	9	46	33	12	12	72	21	6	13
242	"	13	12	14	11	60	32	20	15	79	26	5	12
243	"	10	10	13	9	56	33	15	15	72	10	3	12
244	"	9	2	10	10	60	36	16	15	93	37	6	21
245	"	4	4	8	13	47	32	10	16	91	13	2	13
246	"	5	3	12	7	39	37	17	13	55	18	4	11
247	"	15	10	14	11	54	40	14	17	78	20	6	18
248	"	15	15	13	15	50	38	15	14	77	32	8	20
249	"	8	2	10	9	60	41	12	13	83	33	8	21
250	"	15	5	14	7	57	40	19	19	82	30	4	22

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
251	Female	2	5	15	13	54	36	9	14	88	33	4	16
252	"	4	2	15	8	52	40	14	16	71	16	4	16
253	"	15	15	14	8	47	35	18	15	85	20	2	12
254	"	12	6	13	11	32	32	17	9	79	30	2	11
255	"	13	13	14	11	59	29	9	17	84	37	8	24
256	"	15	15	15	12	44	34	10	16	81	27	6	9
257	"	4	3	14	14	52	35	12	11	67	38	7	19
258	"	4	2	12	10	52	30	14	17	76	36	7	18
259	"	3	3	14	16	50	38	11	14	75	39	7	19
260	"	11	15	15	15	60	30	3	13	76	31	7	20
261	"	2	3	5	9	42	35	22	17	80	33	6	19
262	"	2	2	14	14	37	30	12	12	60	13	3	10
263	"	2	1	8	8	44	29	16	15	55	34	7	11
264	"	4	7	10	10	45	37	11	13	85	36	8	18
265	"	15	3	11	11	56	32	12	15	66	31	6	18
266	"	15	15	12	9	56	31	12	16	70	40	7	20

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
267	Female	1	0	13	8	46	30	13	16	73	23	6	12
268	"	5	0	10	9	55	31	14	16	78	23	5	15
269	"	12	0	11	11	54	31	14	16	77	26	6	20
270	"	4	2	15	10	56	35	15	14	83	21	7	17
271	"	4	0	10	9	50	31	13	14	83	16	4	15
272	"	7	5	10	13	55	31	8	12	79	23	4	17
273	"	6	0	9	10	47	32	14	15	60	14	4	18
274	"	4	1	9	9	52	21	4	18	75	14	3	10
275	"	9	1	7	11	56	29	10	14	87	22	6	16
276	"	8	8	15	8	49	32	10	16	85	19	5	12
277	"	10	3	15	12	48	33	10	15	85	38	8	19
278	"	15	15	12	15	52	34	6	14	59	32	8	20
279	"	4	4	13	11	51	30	14	15	59	20	6	15
280	"	6	0	13	10	52	28	17	14	63	14	3	12
281	"	1	0	9	8	43	32	16	13	64	29	5	18
282	"	14	6	13	11	55	34	13	18	92	39	7	22
283	"	9	9	0	0	53	29	12	14	85	26	6	20

S/No	Sex	1	2	3	4	5	6	7	8	9	10	11	12
284	Female	8	9	5	5	57	30	9	15	76	22	5	18
285	"	15	8	13	8	51	31	14	17	74	21	5	18
286	"	15	15	12	15	53	29	12	22	73	28	5	13
287	"	15	11	13	15	53	34	13	21	73	41	8	21
288	"	7	9	7	7	42	27	10	15	72	18	4	08
289	"	2	2	5	6	45	26	14	15	78	30	7	11
290	"	4	3	10	8	51	30	17	14	90	20	6	14
291	"	5	4	5	6	47	37	14	16	54	15	6	16
292	"	2	1	7	5	35	26	15	15	64	7	2	8
293	"	1	0	8	5	35	39	9	11	81	9	4	10
294	"	1	0	8	9	40	32	7	13	79	23	4	15
295	"	1	0	6	9	43	30	13	19	68	23	5	15
296	"	9	3	10	13	52	25	11	14	94	31	6	16
297	"	2	1	10	10	54	30	16	17	77	23	8	19
298	"	7	0	12	10	56	25	14	13	58	19	4	11
299	"	4	2	12	9	52	29	17	15	91	16	7	14
300	"	3	2	12	7	50	25	17	15	71	21	6	14