UNIVERSITY OF IBADAN

THIS DISSERTATION SUBMITTED BY

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WAS ACCEPTED IN PART FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION OF THIS UNIVERSITY

THE DATE OF AWARD IS

26th September, 1973

31/12/73
DATE

REGISTRAR

INDICATORS OF SCIENCE APTITUDE IN SOME NIGERIAN SECONDARY SCHOOL GIRLS

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in partial fulfilment of the requirements
for the degree of
Master of Education
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June 1973

DEDICATION

To my parents

ABSTRACT

This thesis investigated some mental, personality and environmental variables among Form One girls in a secondary school as possible predictors of science aptitude. The variables were mental abilities, scholastic ability, interest in science, reading habits, personality traits and home environment.

The variables were measured by using selected I-D aptitude tests from Test Development and Research Office, West African Examinations Council, Lagos, a modified Edwards Personality Preference Schedule (EPPS) and a home background questionnaire. Science achievement was measured by a Science Achievement test, of the multiple-choice objective type, based on the science syllabus of the school for the year, and the normal school examinations. Correlations between the variables and science achievement were computed.

Verbal ability, ability to grasp science information, mechanical reasoning, reading ability, ability to do graph work, and high achievement in other school subjects correlated positively and significantly with science achievement in the first year while arithmetical ability, ability to read tables, the environment, parents' professions, personality traits, and interest in science did not. Beyond the first year, correlations became insignificant.

The results are explained in terms of the equalising effects of the school environment which tends to overshadow differences due to home environment and previous schooling.

CONTENTS

	Page
Acknowledgement	i
List of Appendices	ii
List of Tables	iii
CHAPTER I - BACKGROUND AND PROBLEM	1
(a) The Concept of Scientific Aptitude and its Importance in Educational Guidance	1-6
(b) Previous Studies on the Identification of Science Aptitude	6-20
(c) The present Study	20-22
CHAPTER II - DESIGN AND PROCEDURE	23
(a) The design	23
(b) The Sample	23-25
(c) Instruments of Research	25-29
(d) Procedure	29-31
(e) Analysis of Results	31-32
CHAPTER III - RESULTS	
(a) Data Collected and Analysis of Results	33-34
(b) Relationship of Aptitude Test Scores and Scholastic Ability Scores to Achievement in Science	35-36
(i) Individual Aptitude Test Scores	
(ii) Composite test-scores	
(iii) Scholastic ability scores	

Page

(c) Relationship between Teacher-made Tests, Aptitude Tests, and Science Achievement Test Scores. ... 41

(d) Relationship of Background Variables to Achievement in Science. ... 44-47

(i) Pupils' interest in Science and Parents' Professions.

(ii) Reading Habit and Science Achievement.

(iii) Environment and Science Achievement.

(iv) Personality Traits and Science Achievement.

(v) Personality Traits and Scholastic Ability.

CHAPTER IV - DISCUSSION 52

CHAPTER V - SUMMARY 57

BIBLIOGRAPHY 60

APPENDIX 62

ACKNOWLEDGEMENTS

I am greatly indebted to my supervisor, Dr. E. A. Yoloye, Professor of Education, for his professional guidance during my five years as part-time student. His great help and words of encouragement during moments of despair and frustration inspired me to press on till the end.

I am grateful to Dr. C. G. M. Bakare, for his assistance when my supervisor was away from the country for a while. I am also grateful to the Test Development and Research Office of the West African Examinations' Council, Yaba, Lagos for granting me permission to use their Ability Tests, giving me reduced charges, and for their help in computing my data.

I appreciate the moral support and encouragement given by some of my colleagues in the post-graduate class, and some friends. I thank the pupils of my alma mater, St. Anne's School, who were my experimental subjects, and Mrs. C. F. Bullock, the school Principal, and my science teacher when at the school, for their co-operation during my visits to the school to conduct tests.

List of Appendices

		Page
I.	Blueprint of Achievement Test in Science	62
II.	The Achievement Test in Science	64
III.	The Predictor Aptitude Tests	74
IVa.	The Personality Test Questionnaire.	80
IVb.	Personality Test-Answer Sheet	95
V.	Interest Inventory	96
VI.	Inventory For Environmental Study	98
VII.	Teacher's End of the Year Science Examination - 1st Year - 1969	101
VIII.	Teacher's End of the Year Science Examination - 2nd Year - 1970	103
IXa.	Teacher's End-of-the-year Examination in Biology - 3rd Year - 1971 -	111
IXb.	Teacher's End-of-the-year Examination in Chemistry - 3rd Year - 1971	113

LIST OF TABLES

Page

1. Linear Correlation Between Aptitude Test Scores And Science Achievement Test Scores. 37

2. (A) Linear Correlation Between Aptitude Tests and Teachers' Science Marks. 38

   (B) Linear Correlation Between Teachers' Marks and Science Achievement Test Scores. 39

   (C) Intercorrelations Between The Teachers' Marks in Science. (1st, 2nd and 3rd Year Examinations). 40

3. Linear Correlation Between Composite Scores of Predictor Tests and Science Achievement Test Scores. 42

4. Intercorrelations Between Some Predictor Test Scores. .. 43

5. Correlation Between Composite Predictor Tests And Scholastic Ability. 43

6. Correlation Between Science Achievement Test Scores Science Teachers' Marks And Scholastic Ability. 45

7. Relation Between Students' Interest In Science And Parents' Profession. 45

8. Test of Significance Between Science Interest And Achievement In Science. 48

9. Test of Significance Between Reading Habit And Achievement In Science. 48

10. Linear Correlation Between The Environment Scores And Science Achievement Scores. 49

11. Intercorrelation Between The Personality Traits Scores. .. 50

12. Correlation Between Personality Traits Scores And Science Achievement Scores. 50

13. Correlation Between Scholastic Ability And Personality Trait Scores. 51

CHAPTER ONE

BACKGROUND AND PROBLEM

(a) The Concept of Science Aptitude and Its Importance In Educational Guidance

"Aptitude" means a person's readiness to learn to do certain types of things. The degree of readiness could be brought about through "hereditary determination" or through environmental determination but usually by an interaction of the two.

R. L. Thorndike and E. P. Hagen in their book "Measurement and Evaluation in Psychology and Education" define aptitude as follows: "Aptitude implies some natural or innate capacity for a particular type of performance, for example, scholastic aptitude, or artistic aptitude." They say that aptitude tests tend to base their items upon experience, mostly out of school, but overlapping to some extent with those provided in school, that are uniformly provided for individuals growing in Society.

The tests use these present abilities based on a variety of past learnings as indicators of what the individual could learn to do in the future. The difference between aptitude and achievement measures is one of degree and emphasis. Any test of ability is to some extent an aptitude test, and to some extent an achievement test. A test could be thought of as an achievement test when one wishes to draw conclusions about past progress, and

an aptitude test when one wishes to estimate future potentialities.

Some teachers overrate the intelligence of children who are neat, pretty, obedient, friendly and talkative, whereas a child who is independent in his thought or behaviour, or asks embarrassing questions, or antagonizes the teacher is under-rated; yet originality and curiosity are characteristics of superior intelligence. Teachers who have studied modern psychology are aware that in any group of children, individuals differ from one another in capacity as well as in performance. Teachers can make good judgement of pupils' abilities by supplementing their observations with evidence obtained from objective tests. A lot of such tests have been designed in the past fifty years to measure or at least indicate the relative abilities of an individual with respect to a variety of traits.

There are different types of aptitudes, for example, artistic, musical, mechanical, poetry, mathematics, science, oratory, linquistics. Psychologists regard them as functions of general intelligence channelled into specific areas by environmental circumstances, emotional conditioning, special interest, and training. For example, a child who is in the lowest 10% of a population in an intelligence test is not likely to become a great musician; but it is not possible to predict with assurance that a child who is in the top 10% or even 1% on the same test will develop a high

proficiency in music.

The study of science in schools by every pupil to a considerable extent is now accepted to be a necessity all over the world, as we are now in a scientific and technological age. There is a sort of technological revolution in many parts of the world, and so there is great need to train more scientists, technologists, engineers, etc. There is, therefore, a great need to recognise potential scientists from an early age and to give them encouragement and opportunities to develop their talents to the maximum. Among these young ones may evolve future geniuses if they are well guided.

The problem that bothered the advanced countries was how to detect those people who had scientific aptitude and interest. These ones are the type of people who would become innovators in science and technology; the type who can work indefatigably in pursuit of scientific knowledge and progress, the type who would not mind a mission to the moon or Mars.

In U.S.A., in the early 1950's attempts were made to identify potential scientists on a national basis. This was recorded by Paul Witty in his book: "The Gifted Child"*. A survey was done on

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* See bibliography No. 13.

on older students who were requested to write essays on some scientific topics and to present original work done on some scientific projects. Grading was done, and those who were regarded as the best and hence the potential scientists were given scholarships by some interested companies and investors. Follow up studies were done on them to see whether indeed they became accomplished scientists in any field like medicine, engineering, technology, etc.

Nowadays the more advanced countries feel that early identification of such people is necessary before diversion takes place into other fields of interest, since it is believed that such students usually find themselves in a dilemma, because they are usually good in many subjects, and their intelligence is usually above average. A lot of work has been done and is being done to identify potential scientists at an early age.

Nigerian children especially, are not exposed to the type of environment found in advanced countries like Britain, U.S.A., etc. where technical and mechanical toys, scientific gadgets, radios, television sets, cameras, etc. are common place things and are freely handled and used. At present, in Nigerian homes where some of these things are available, children are denied the opportunity of using or handling them freely, and thus appreciating their

ingenuity. Parents cannot be blamed for doing this. They fear that these things (which are still luxury items in the poorer, developing countries like Nigeria) may get damaged. Such damage means one being deprived of things one has previously enjoyed and this can be disheartening.

In the elementary schools pupils are usually taught all subjects, geography, history, mathematics, science, English language, etc. by the same teacher. Usually a child is not equally good in all subjects yet he must learn them all. It would be comforting for him to know that he is good in a few of them and to be made aware of the fact that although he needs some knowledge of all these subjects, yet he has greater aptitude in specific ones. In the first three forms of a secondary school also, a pupil is a "Jack of all Trades" being taught a multitude of subjects. From the age of about twelve, children have already started to think of what they would like to be when they are old: an engineer, a nurse, a doctor, a teacher, a baker, a secretary, a journalist, etc. They ask elders about the professions of their uncles, aunties and friends. Anything that would indicate to some degree whether they have great aptitude in science, mathematics, or languages and the arts would go a long way to help them in choosing the right profession. This would give an

ideal and most satisfying goal to their educational experiences and pursuits.

(b) Previous Studies on the Identification of Science Aptitudes

In recent decades extensive work had been done at secondary school and college levels (in U.S.A. etc.) on the identification and training of students with superior ability in science.

Davies[1], Guilford[2], and others describing the abilities of secondary school children, said that there was a clearly defined trait of science aptitude, analogous to musical and artistic aptitudes. They emphasized sensitivity to problems, ability to develop new ideas, and ability to evaluate. They however, disagreed on what the components of scientific aptitudes really were.

Howard, H. Fehr[3] of Teachers College, Columbia University, New York city concluded that the task of identifying gifted

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1 Davies, W. "Search for Talent in Science" in Paul Witty "The Gifted Child". Boston; Heath and Company. 1951.

2 Guilford, J.P. Creativity. American Psychologist, 1950. Vol. V, pp. 444-454.

3 Fehr, H. N. General Ways of Identifying Students with Mathematical and Science Potential. Mathematics Teacher, 1953. Vol. XLVI, pp. 230-234.

students was not an easy one. He defined the gifted child as "One who shows the ability to work with ideas to an exceptionally high degree. He is exceptionally capable in thinking, that is in the manipulation and creation of abstractions of word and number". He said the teacher should be able to identify children with "space perception abilities" which were essential in modern engineering and technological design; and that this identification should not be through formal testing alone, but observational methods, through interviews, and reports from parents and associates. Teachers tended to bring in the personal equation, likes and dislikes. Friendliness, conformity, obedience, were confused with talent in science. They had no estimate of memory, curiosity, abstractions thinking, with which to compare these qualities in the students' classroom performance. The reasons he gave for teachers' inability to select talented youth was that they might lack psychological knowledge and basis for making judgements. Teachers should, therefore, be trained to be observers of essential traits that mark genuine talent.

Fehr listed some traits as follows:-

1. The most significant is extraordinary memory, which may be due to "relational thinking". "The gifted child seems never to forget".

2. The ability to do abstract thinking at a high level. Brilliant students make generalizations quickly and accurately.
3. Application of knowledge in their environment.
4. Intellectual curiosity.
5. Persistent goal-directed behaviours.
6. Intuition. The talented student has insight and penetrability to problems under consideration.
7. High vocabulary, and facility of expression in scientific matters.
8. The talented child usually has a hobby "which is hard ridden". He works hard on a special interest and constantly relates everything that goes on in class to it.

Such summaries of traits as these were what some younger researchers condemned as of little value to science aptitude.

W. W. Cooley[1] suggested that there was no isolated unitary set of characteristics which distinguished science aptitude, and recommended multivariated, longitudinal analysis of personality and motivational variables in the study of science ability. He

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1 Cooley, W. W. Attributes of Potential Scientists. Harvard Educational Review. 1958, Vol. XXVIII, pp. 1-18.

suggested that this study should be done in five stages from pre-school to college. He observed that research concerning the determination of characteristics of scientists and potential scientists could be categorized into three general types:

1. comparison of the high school or college students who plan on or show promise of becoming scientists with those not intending to go into science;
2. comparison of previously determined antecedent characteristics of those who have become scientists with men who have gone into other fields (longitudinal studies);
3. comparison of practising scientists with non-scientists.

He said, in an effort for the researchers to add meaning to the many and varied tests of significance, chi square, probabilities, etc. they had usually presented a portrait of the typical scientist, an example of which he quoted as follows:-

"The natural scientist generally has good spatial visualization, high mechanical comprehension, superior manual dexterity and manipulative ability. He possesses such complex mixtures of aptitudes, personality traits and experience as scientific judgement, originality, adaptive and spontaneous flexibility, ability to redefine and to formulate problems, the abilities to plan and design an

investigation, to conduct the investigation, and to prepare appropriate reports". According to him, this summary portrayed not just the ideal scientist, but the ideal; and most summaries of abilities end up with similar difficulties, and sometimes contain contradictions.

He said the reason why these summaries often concluded with some sort of superman, when dealing with abilities, or divine when dealing with personality traits was that the attributes, included in the lists were based on studies, using tests of significance for individual items. Even though control groups were used, the composite was distorted. Cooley suggested new directions which involved the goal of understanding the process of becoming a scientist, and hence the attributes which students who became scientists had. He said it was necessary to use multivariated techniques in analyzing the variables under study, similar to those being used in the study of vocational choice. For the problem of identifying scientists, the battery would concern specific abilities needed by practising scientists. One of the methods of statistical analysis he suggested was a factor analysis which analysed the interrelationships among a battery of tests and presented a possible model for conceptualizing the attributes of the potential scientist, as well as telling the

variables which were involved in "Science Talent" and their relative importance.

He made important distinction between what he termed "External variables" - religion, Socio-economic status, ethnic background, geographical position, sex, race, number and relative ages of siblings, economic conditions, home and relative climate, etc. and "Attribute variables" - ability structure, achievement motivation, self-concept, interest pattern etc. He said previous studies concentrated on the external variables with the exception of mental abilities; and so he suggested emphasis on "attribute variables".

Cooley believed that identification could start at pre-school years, and could be divided into five stages. The "pool" became smaller and smaller from stage to stage due to selection factors and failure to develop the necessary attributes which he listed at every stage, as follows:-

STAGE I is the Pre-school age when genetic factors are predominant. Home and environmental motivations come into play also.

STAGE II is elementary school level, at which positive direction towards science begins. The attributes affected are the following:

(i) High verbal ability.

(ii) Ability and desire to work with numbers.

(iii) No negative attitude development toward formal science work.

Stage III is the Junior High School level.

Stage IV is the Senior High School.

Stage V is the College (University).

All through the Stages III to V the most important attributes are high mathematical ability, desire for, and ability to obtain high scholastic achievement, high interest in science as indicated by the time he is willing to spend on science activities, and having science hobbies.

Another interesting study was that of Harold A. Edgerton[1]. He constructed two tests for the identification of science potential in the sixth* and seventh** grade levels, which, according to him, teachers with little or no background in science could use, and which was based on a hypothesis which needed not be acceptable to all the teachers.

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1 Edgerton, Harold, A. Two Tests for Early Identification of Science Ability. Educational and Psychological Measurement. 1959, Vol. XIX, Number 3. Pages 299-304.

* Sixth grade - 2-year old - last year in elementary school in U.S.A.

** Seventh grade - 12-year olds - first year in Junior High School in U.S.A.

The first of these tests he called "Science Background IA, Things Done", and it consisted of 258 activities related to science, and which would have been done by sixth and seventh grade students. These tests contained items like:-

(a) Read magazines about science.

(b) Seen dry ice.

(c) mixed colours.

(d) collected shells

(e) used a magnifying glass

(f) used a magnet

(g) used a made up code

(h) seen an eclipse of the moon

(i) collected rocks etc.

The test was built on the hypothesis that those boys and girls who had done more things related to science were more likely to continue such activities and eventually become scientists than those who had participated in fewer activities. The testees were asked to tick right those activities they had done or observed.

The second test he called "Science Background 2A, Vocabulary test" which contained 75 multiple choice questions built on a similar hypothesis as above. He argued that this hypothesis was well accepted and of wide use in studying fields of interest etc.

In this test he assumed that those who were interested in any field of activity would learn more of the terms and concepts of that field than would others having less interest. Each question in the test consisted of very simple definition of some science concept or term followed by three possible answers, with only one of the three answers being correct e.g.

(a) a greenish coloured gas used to kill bacteria.

1. Chlorophyll, 2. Chlorine, 3. Sulphur dioxide.

(b) a heavy liquid metal used in thermometer.

1. lead, 2. tar, 3. mercury.

(c) to force into smaller space.

1. Surpress, 2. Condense, 3. Compress.

The testees were to indicate the correct answers.

The results were as follows:- In Test IA he found that only 3 boys scored over 200 out of 258, and no girls. The scores ranged from 15 to 222; 121 out of a total of 185 students were between 40 and 119, and the average was between 60 and 70 scores.

He found that boys knew more concepts in Test 2A than girls but the difference was not statistically significant. In both tests he did not find much difference between scores of boys and girls, that is, he found no sex difference.

He, therefore, recommended that teachers should encourage boys and girls in this range of 60 to 70, the average scores in

tests IA.

Judging this study, with reference to the plan laid down by Cooley, this type of tests especially at this level, will produce a large pool of students with scientific potential. Further observation and testing would be required at a later stage when they would be a bit older. This was supported by Bradwein[1] in his book that at a lower level than the ninth* grade it was difficult to differentiate between science potential and science interest.

In 1968, J. K. Majasan[2] of West African Examinations' Council, Test Development and Research Office, wrote a report on the Predictive Validity of the I-D+ tests for Selecting Candidates into Technical and Commercial Courses. In it he computed correlation co-efficients from the I-D test scores and the terminal grades, and overall grades at the end of the year. The I-D tests

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1 Bradwein, P.F. The Gifted Child as a Future Scientist. New York, Harcourt Brace and Coy, 1955.

* Ninth grade - (13 to 14 years old) End of Junior High School in U.S.A.

2 Majasan, J.K. A report on the Predictive Validity of the I-D Tests for Selecting Candidates into Technical and Commercial Courses. West African Examinations' Council. T.E.D.R.O., Yaba, Lagos. April 1968.

\+ See Appendix III.

were ability tests used in the selection of students into Engineering courses and Secretarial courses in the Technical College, Ibadan. The terminal and end of year grades gave a measure of their performances in the courses.

A test which correlated significantly for at least two terms, or with the overall grade for the end of the year he regarded as a good predictor. He concluded that a good battery for the selection of candidates into civil, mechanical and electrical Engineering technician's course consisted of the following ability tests: Reading, Graph, World Information, Manual dexterity, Tables, Arithmetic, Mechanical reasoning and Coding tests. These tests he found predicted course grades very well.

Another study was reported by S.A. Akeju[1] and B. Axtell which modified the battery of tests selected by Majasan. This study resulted from the decision of the Ministry of Education[2], Mid-Western State of Nigeria to initiate personnel counselling as well as Educational and technical, vocational guidance in all its

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1 Akeju, S. A. and Axtell, B. A Study of the Validity of some I-D tests for streaming Pupils in Mid-Western State (Nigeria) Schools. W.A.E.C., T.E.D.R.O., Yaba Lagos.

2 Ministry of Education, Benin City. Aptitude Testing Programme in Mid-Western Secondary Schools. A proposal to Ford Foundation. Benin City. Nigeria 1967.

secondary schools, conscious of wastage and misdirection of energy consequent upon the present educational procedures and practices in its secondary level institution.

One of the major goals of this programme was to improve the selection process, as the methods used in the past had led to conspicuous waste of talent. The ministry decided that aptitude testing would yield the kind of information needed to channel youngsters into different ability areas - academic, commercial and vocational technical. It also saw that all secondary schools were to become comprehensive.

The specific purpose of the study was to identify the aptitude test batteries that would best predict success in each of the streams that were available in the Mid-Western Secondary Schools, namely, Secretarial, Clerical, Academic, Accounting, Engineering, Commerce and General streams.

The subjects were 561 students drawn from Form I and II of 32 secondary schools in the Mid-West, and 41 students from the post-secondary Technical College, Ibadan. The 561 students were divided into five groups, Secretarial, Academic, Accounting, Commerce, General, while the 41 students from Ibadan Technical College constituted the Technical Group. This was because the Mid-West data were not complete for the Technical group. This group was originally studied by Majasan (1968).

The 561 students, who were in Form I or II, in 1968 academic year completed 10 or 11 of the 1-D Aptitude Tests, and their scores were available for use as predictor variable. At the end of the second year following administration of the I-D tests, the classroom marks awarded to the students were collected as the criterion scores for academic success. The Technical group completed nineteen I-D tests and their overall grades at the end of the first year of school were used as the criterion of academic success. On the basis of the classroom marks, all subjects were ranked within each class. The ranks assigned were subsequently reconverted to class marks following a procedure suggested by Duggan and Hazlett[1], to allow grades awarded by different teachers to be compared. The test scores and classroom marks for each of the six educational groups were analysed using a step - wise multiple regression procedure. Multiple correlations of the group of tests with the criterion were also obtained, by adding the scores of the test that correlated highest with the criterion to the next best, and so on. As each test was added, new weights were computed for each of the tests included.

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1 Duggan, J. M. and Hazlett, P. H. Predicting College Grades. College Entrance Examination Board. New York, 1963.

On the basis of the multiple correlations computed and the amount of increase in the correlation which the addition of tests contributed, the best tests for inclusion in the battery was prepared for each of the educational groups studied. The tests recommended were as follows:-

Secretarial	TAB, VAL.	Validity Coefficient,	R = 0.46
Academic	RTH, COD, RDL,	"	R = 0.37
Accounting	RTH, BOX, VAL, FIG,	"	R = 0.37
Technical	GPH, MEC, MEM, SCI, COD, RDH, FIG.	"	R = 0.80
Commerce	NONE*		
General	GPH, BOX, MRK, RDH,	"	R = 0.33

The Maximum multiple correlation value found for commercial group was 0.26 using all the ten administered I-D tests. It was not sufficiently high to predict success in courses in the commercial programme. Re-analysis of the 1968 data, the only source of information for the Technical or Engineering group yielded the high validity coefficient of 0.8 (N=41) for the group, thereby making Engineering the most predictable, using I-D tests. This was taken as an indication that the I-D tests must be valid for secondary-school, technical selection.

The Majasan's (1968) analysis recommended nine tests for predicting Engineering success. They were VAH, RDH, GPH, RTH,

MEC, MAN, SCI, TAB, WLD, whilst the Akeju and Axtell (1970) re-analysis recommended seven RDH, GPH, COD, MEC, SCI, MEM, FIG, with only four tests being common to both groups.

In the conclusion of this study, it was stated that it seemed safe to conclude that TEDRO tests were reasonably valid and usable for guidance in the Secondary School System. All tests recommended should be applied to all candidates at the beginning of the term. The scores should then be combined using differential weights recommended, and an order of merit list of candidates should be compiled for each stream. Pupils would be guided into streams in accordance with their standing on the lists. A few pupils might rank for all lists, and these all-rounders would require other considerations for their final decision on the choice of a stream.

(c) The present study

There is still a lot of scope for pioneering work in developing science aptitude tests at various levels of primary and secondary education that would be of great use in selection for guidance purposes. There is, however, a great difficulty in checking the predictive validity of any such aptitude test for all the schools in a state; a greater difficulty will be encountered for all schools in the whole country. This is because the school science syllabuses vary from school to school between forms one and four, that is, during the first three years

of secondary education before they all embark on the school certificate examination syllabuses.

Many problems come into identifying science aptitude, and some questions need to be answered. Some of the questions are as follows:-

What special abilities in a battery of ability tests predict science aptitude best? Are reading and arithmetic abilities related to science aptitude? Does the environment affect science aptitude in Nigerian children? Is there a relationship between science interest and science achievement at early secondary school level? Has personality trait anything to do with science aptitude? The present study attempts to answer some of these questions.

W. W. Cooley gives a wide spectrum of ideas and suggestions, described earlier, which are all-important to the overall task of identification of science aptitude. In Nigerian grammar schools, the selection of subjects for the school certificate examination usually takes place in Class IV which is equivalent to the end of subjects, the attributes at Stage II and Stage III are the ones relevant to justify selection of Science Subject. These ones are as follows:

(i) high verbal ability,

(ii) ability and desire to work with numbers,

(iii) no negative attitude developed toward formal science work,

(iv) high mathematical ability,

(v) desire for, and ability to obtain high scholastic achievement,

(vi) high interest in science as indicated by the time willing to spend on science activities,

and (vii) having science hobbies.

This study attempts to identify attributes that are related to science aptitude in the early period of Stage III, that is, in the first year of secondary grammar school. The attributes investigated include mental ability, science interest, reading habit, home environment, personality trait, and the profession of pupils' parents.

If simple tests can identify pupils with specific aptitudes, then parents, teachers, and guidance counsellors can be helped by them, in planning the pupils' vocational pursuits in their own interest, as well as in the nation's interest.

CHAPTER TWO

DESIGN AND PROCEDURE

(a) Design

Data on a number of background and personal variables about a sample of secondary school pupils including most of Cooley's suggested variables were collected and the relationship between these data and the pupils' achievement in science from tests were investigated.

The extent of relationship should give some insight as to what variables are likely to be indicators of science aptitude.

(b) The Sample

The subjects in the study were pupils in Form 1A and 1B of St. Anne's Secondary School, Ibadan, Nigeria, who were in their first year in secondary school. Their average age was twelve years. At the beginning of the project the total population was 58, but 51 students who completed all the various tests at the end of the year were used in the statistical analysis of the results.

The school chosen is one of the oldest and best secondary schools in the country, and it attracts intelligent pupils from many parts of the country. The selection into the first year was stiff, and all candidates had to take the Common Entrance

Examination set by the West African Examinations' Council, and used by many of the best secondary schools in the country. The examination consisted of objective, multiple-choice type questions based on the 3R's. Those candidates whose average scores are very high are usually called for interview before a final selection is made.

In this study it is assumed that talent or giftedness of any kind is a function of general intelligence. In previous similar studies on this topic, many researchers assumed or proved it. It was, therefore, also assumed that due to the satisfactory method of selection in this school, at least 75% of the pupils in the experimental group was average and above-average in general intelligence.

Intelligence tests which are culture-free and had been validated for the Nigerian population were not available, and so I.Q's could not be used as a predictor of science ability in this study. Science aptitude tests were also not available for the same reasons.

This study was limited to one school in order to control for (i) Syllabus, (ii) Teacher and (iii) Facilities.

(i) The general science syllabus vary from school to school in the first year, and the pupils in the first year

secondary did not have formal science-teaching before. In their primary school years they learnt nature study and elementary health science. Therefore, the Achievement Test constructed, based on the school science syllabus for that year, would vary from school to school. If there was no uniformity, it would be difficult to use it as one of the criteria.

(ii) The teacher-factor would be difficult to eliminate if various teachers handled the same syllabus, even if the syllabus was the same for all schools. The teacher's end-of-the-year test which constituted another criterion would not be uniform too.

(iii) Other things, like different laboratory facilities, text-books exposed to pupils, number of periods for lessons per week etc. could affect achievement scores from school to school.

(c) Instruments

(i) Eight aptitude tests measuring various intellectual abilities or skills, were selected from the TEDRO Batteries. They are the following:-

Verbal Analogies	-	VAL & VAH (lower and higher levels)
Reading Test	-	RDL (lower level)

Memory Test	- MEM
Mechanical Reasoning	- MEC
Graph	- GPH
Arithmetic Test	- RTH
Tables	- TAB
Science Information	- SCI

These tests developed for the African people had been widely used in Nigeria by the Test Development and Research Office, West African Examinations' Council, Lagos, Nigeria. Details about the aptitude tests, validity, reliability, etc. are given in the appendix. They are pencil and paper tests consisting chiefly of objective questions with multiple choice items. All the tests are timed, but VAL, RDL, MEC, SCI, are power tests, while MEM, RTH, GPH, & TAB are speed tests. The author underwent a period of training at TEDRO in order to be able to administer the tests according to the specifications. Each test was preceded by a period of learning to do the tests, say 10-20 minutes, followed by a period of practice on a few examples before the testing period.

(ii) A Science Achievement Test* was constructed. The content was based on the general science syllabus of the pupils for the year.

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* See Appendix I and II.

It consisted of forty-five objective questions of the multiple-choice type testing chiefly, Knowledge of facts, terms etc.; Comprehension of principles, laws, etc., and Application of principles, laws, etc. These are the first three levels of the six levels into which Benjamin S. Bloom[1] and his associates classified cognitive behaviour. The other three and higher levels are namely, Analysis of materials etc. Synthesis and Evaluation of elementary data etc. Testing could not be done at the higher levels because the science topics in the syllabus were not treated to sufficient depth in class to warrant such testing. The topics were treated in ways that did not emphasize the higher process because the subjects had no previous studies in science and mathematics.

The class teacher was requested to check the content of the Science Achievement Test before the construction of the test was satisfactorily completed. She also looked out for difficult terms and ambiguous expressions that could affect the testing, in all the items.

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1 Bloom Benjamin, S. Taxonomy of Educational Objectives. The Classification of Education Goals. Handbook I Cognitive Domain. New York and London. Longman's Green & Company. 1956.

(iii) The class teachers conducted their own end-of-year examinations and these were not of the objective multiple-choice type, but were based on the school science syllabus they used for each year. The marks obtained by the subjects for three consecutive years were recorded to be used in the study.

(iv) The personality test was an abridged form of the EPPS*. It was made up of six sets of fifteen items each measuring the following personality traits:- Achievement, Order, Autonomy, Succurance, Change and Endurance. Each item consisted of a pair of statements about things that one might like or not like; about ways in which one might feel or not feel. An example is as follows:

A - I like to talk about myself to others.

B - I like to work towards some goal that I have set for myself.

One had to decide and take A or B. Where both were liked one had to choose which one liked better. If one disliked both one had to choose which one disliked less. The same rule applied to statements about how one felt.

The scores of the personality test items were adapted from the

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* Edwards Personality Preference Schedule, Revised 1959 Manual. See Appendix IV(a) and IV(b), and bibliography.

technical manual of Edwards Personality Preference Schedule.

(v) The interest inventory shown in Appendix V was to give indication of the interests of the individual students and distinguish between science-orientated and non-science orientated ones. The inventory also sought information on parents' professions and the reading habit of the pupils.

(vi) Another inventory* was filled by them to give information about their home environment, and the technical gadgets they were exposed to and could operate.

(d) Procedure

A battery of ability tests, specially selected was given to the experimental group in their first term at school. The various abilities tested may be related to science aptitude, and on this assumption they were used as predictors of science aptitude.

This experimental group was then exposed to formal science teaching by the regular class-teacher, both oral and experimental work being done for three terms of twelve to thirteen weeks per term. During this period they learnt scientific language - terms and definitions, scientific principles and facts.

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* See Appendix VI.

Towards the end of the third term they were given three questionnaires to fill. The first sought information on the students' interest in science as well as their parents' occupations. The second sought information about their home environment. The third questionnaire sought information about some personality traits.

A month before the end of the school-year they were given a multiple-choice Science Achievement test based on their science syllabus for the year. This was used as the first criterion of science achievement. Without making any alterations to the test, a retest was given after a month, and two sets of scores on the same test were recorded for statistical work.

A second criterion of science achievement was the end of the year science examination given by their science teacher.

The pupils' average percentage scores in all subjects studied during the year, from their end of the year examination marks in these subjects were used as a measure of their "scholastic ability". The scores were correlated with Science Achievement test scores, and used as a predictor of science aptitude.

A follow up study was done by collecting the science examination marks of the pupils at the end of the second and

third years in school. These marks were correlated with the previous data collected in their first year in school.

(e) Analysis of Results

Raw scores of the eight predictor ability tests, the Science Achievement test, and teachers' end-of-year examination marks were all recorded for each pupil, who completed all the tests. The test-retest reliability of the Science Achievement test constructed was found by correlating the marks scored on the first testing with those of the second testing.

The maximum marks for each personality trait was fifteen marks, and six sets of marks were recorded for the six traits tested in the questionnaire. The "Environmental Inventory" was rather difficult to grade. A mark was awarded for each technical gadget available. Frequency of use of these gadgets was scored by awarding three marks for every gadget used daily, two marks for that used weekly, and one mark for that used sometimes. A part of this same inventory measured manipulation of gadgets like alarm clock, sewing machine, record-changer, electric iron, etc. A mark was awarded for every skill the subject could perform (e.g. set an alarm clock at 6 o'clock.).

Intercorrelations were worked out between all the sets of scores, and tables were drawn up from the computer results. This will be discussed in the next chapter, in detail.

Summarizing, one might state that the predictor test scores were the TEDRO ability tests, eight in all, described under "Instruments". The other independent predictor in the study was the "Scholastic ability" measured by the average percentage scores of the pupils' scores in different subjects at the end-of-year examination. The first criterion was the Science Achievement test, and the second was the teacher's end of year science examination. The science examination scores at the end of the second and third years, i.e. forms II and III were collected for follow up studies. However, there were different teachers from one year to the other, and only in the first year was the teacher who taught the pupils throughout consulted especially in constructing the Science Achievement test.

Scores obtained from the personality traits, environmental and interest inventories were correlated with Science Achievement test scores to give indications of relationships with science achievement.

CHAPTER THREE

THE RESULTS

(a) Data Collected and Analysis of Results

The data collected from the various tests and questionnaires already described in chapter two were the following:

(i) A set of nine raw scores from the Predictor Tests, consisting of nine aptitude tests, and their stanines, for each of the 51 students who completed all the tests.

(ii) Science Achievement Test Scores, two sets of scores for test and retest given at the end of one month interval.

(iii) The Science Teacher's marks in the end of the year school examination, in the first form.

(iv) The average percentages in all the various subjects taken by students at the end of the year examination. This was taken as the scholastic grades of the students.

(v) From the interest inventory given to the students data was collected, grouping them as follows:- those with science interest, and those having non-science interest; habitual and non-habitual readers; those whose parents' professions were science-orientated, and

those non-science orientated.

(vi) From the questionnaire given to investigate the environment of the students, marks were given and were totalled under three headings, as follows:-

Home-environment with respect to technical gadgets available; frequency of use of technical gadgets, and degree of manipulation of the technical home gadgets.

(vii) Composite scores of RDL, VAH, SCI, MEC, GPH, taken in pairs were computed. The nine pairs are shown in table V.

(viii) Six sets of scores were recorded for the personality test questionnaire.

(ix) The pupils' marks in general science examination at the end of second year were obtained.

(x) The pupils' marks in physics, chemistry, and biology at the end of the third year examinations were obtained.

Intercorrelations were computed between the raw scores of all the Predictor Tests, criteria scores, environmental scores and personality trait scores. Computer results were later tabulated for clarity.

(b) Relationship of Aptitude Tests, and Scholastic Ability Scores to Test of Achievement in Science

The value of correlation coefficient between any two sets of scores should show relationship between them.

(i) Individual Aptitude Test Scores

The results of linear correlation between the aptitude test scores and science achievement test scores are shown in Table I. Five ability tests namely, Reading, Verbal Analogies, Science Information, Mechanical Reasoning and Graph, gave high correlation coefficients significant at P = 0.05% level. It was observed that the Arithmetic test scores did not seem to indicate science aptitude, from the low correlation coefficient value, with Science Achievement test scores. However, this test was found to be merely a speed test of simple addition, subtraction, multiplication and division of small and large numbers of a few digits. The emphasis is on speed and accuracy rather than power.

(ii) Composite test-scores

Composite scores of aptitude tests were correlated with Science-achievement test scores, and the correlation coefficients obtained are shown in Table 3. The values were very low and not significant at P = 0.05% level. The reading test and Science Information test scores, separately with science achievement

test scores, gave correlation coefficients of 0.455 and 0.307 respectively, both significant at P = 0.05% level while the composites of these two tests (RDL and SCI) yielded a correlation coefficient of 0.150 with the science achievement test, not significant at P = 0.05% level. The possible explanation was that the students who did well in the reading test did not do so well in the science information test and vice versa. This suggestion was confirmed by the fact that the reading test scores, and the science information test scores had a correlation coefficient of 0.281 between them (See Table 4), significant at P = 0.05% level.

(iii) Scholastic Ability Scores

A high correlation coefficient was obtained between scholastic ability and science achievement test scores. The value is 0.687, significant at P = 0.05% level, as shown in Table 4.

TABLE 1

Linear Correlation Between Aptitude Test Scores
And Science Achievement Test Scores

Description of Test	Correlation Coefficient	Level of Significance
RDL	0.466	P = 0.05%
VAH	0.329	P = 0.05%
SCI	0.307	P = 0.05%
MEC	0.284	P = 0.05%
GPH	0.244	P = 0.05%
TAB	0.217	N.S*
MEM	0.147	N.S
RTH	0.089	N.S
VAL	0.056	N.S

* not significant

TABLE 2(A)

Linear Correlation Between Aptitude Tests and Teachers' Science Marks

		1st Year	2nd Year	3rd Year		
No.	Aptitude Tests	General Science		Biology	Chemistry	Physics
1.	VAL	0.234*	-0.121	-0.029	-0.239	-0.046
2.	VAH	0.169	-0.061	-0.113	-0.117	-0.129
3.	RDL	0.165	0.015	-0.015	-0.152	-0.200
4.	MEM	0.016	-0.128	-0.374	-0.165	-0.232
5.	MEC	0.205	-0.098	-0.029	-0.151	-0.211
6.	GPH	0.328*	0.024	0.108	-0.227	-0.065
7.	RTH	0.214	0.063	-0.040	-0.200	0.009
8.	TAB	0.375*	0.003	-0.093	-0.222	-0.185
9.	SCI	0.090	-0.017	-0.131	0.027	-0.195

* significant at P = 0.05% level

TABLE 2(B)

Linear Correlation Between Teachers' Marks And Science Achievement Test Scores

Teachers' Marks	Correlation Coefficients
General Science 1st Year	0.339*
General Science 2nd Year	0.194
Biology 3rd Year	0.226
Chemistry 3rd Year	-0.013
Physics 3rd Year	-0.124

* Significant at P = 0.05% level

TABLE 2(C)

Intercorrelations Between The Teachers' Marks - (1st, 2nd and 3rd Year Examinations) In Science

Teachers' Marks	1st Year General Science	2nd Year General Science	3rd Year Biology	3rd Year Chemistry	3rd Year Physics
1st Year General Science	1.000	0.020	-0.037	-0.122	0.007
2nd Year General Science		1.000	0.276	0.471	0.547
3rd Year Biology			1.000	0.143	0.254
3rd Year Chemistry				1.000	0.593
3rd Year Physics					1.000

(c) Relationship Between Teacher-made Tests, Aptitude Tests And Science Achievement Test Scores

Table 2A, gives the results of linear correlation between another criterion, science-teachers' marks at the end-of-year examinations, and predictor aptitude test scores. With the first year examination marks, the following tests: tables, graph and verbal analogies (lower level), gave correlation coefficients which were significant at P = 0.05% level. These three ability tests, however, had low correlations with the first criterion - the science achievement test. This might be due to the fact that these two criteria, science achievement test, and teacher's science examination in the first year which had a correlation coefficient of 0.339 (Table 6) were measuring largely, different aspects of science achievement or science ability, since the two science tests had different formats (see appendix).

Correlation coefficients obtained between aptitude tests and the second and third end-of-year examinations were very low and not significant at P = 0.05% level; some of the values were found to be negative as shown in Table 2A. The pupils had different teachers every year, and this brought in a complication of the teacher-factor.

TABLE 3

Linear Correlation Between Composite Scores
Of Predictor Tests and Science Achievement Test Scores

Test	Correlation Coefficients	Level of Significance
RDL & VAH	0.084	N.S.
RDL & MEC	0.056	N.S.
RDL & GPH	0.081	N.S.
RDL & SCI	0.150	N.S.
MEC & GPH	0.123	N.S.
MEC & VAH	0.022	N.S.
SCI & MEC	0.050	N.S.
SCI & VAH	0.017	N.S.
VAH & GPH	0.061	N.S.

N.S. - not significant

TABLE 4

Intercorrelations Between Some Predictor Test Scores

Tests	VAH	MEC	GPH	SCI
RDL	0.209	0.363*	0.100	0.281*
VAH		0.595*	0.320*	0.258*
MEC			0.111	0.099

* These ones are significant at P = 0.05% level

TABLE 5

Correlation Between Composite-Predictor Tests And Scholastic Ability

Tests	Correlation Coefficient	Level of Significance
MEC & SCI	0.273	P = 0.05%
MEC & GPH	0.269	P = 0.05%
VAH & SCI	0.242	P = 0.05%
RDL & SCI	0.160	N.S.
RDL & MEC	0.165	N.S.
RDL & VAH	0.150	N.S.
MEC & VAH	0.079	N.S.
VAH & GPH	0.052	N.S.
RDL & GPH	0.028	N.S.

(d) Relationship of Background Variables To Achievement In Science

(i) Pupils' Interest in Science and Parents Professions

Table 7 was obtained from the interest inventory given to the students to fill. The students could be grouped into four categories as shown in the table; twenty-four students had science interest even though their parents were in non-science professions, whilst twelve with science-interest had parents in non-science orientated professions. The relationship between pupils' interest and parents' professions was estimated by calculating X^2 (chi-square). The value obtained was $X^2 = 2.20$, and the value was found to be insignificant. Also, from the values of percentages, using the figures in the table, one could infer that the professions of the parents had no effect on the interest of the pupils in science.

The science achievement test scores were divided into two groups - those for pupils with science-interest and for pupils with non-science interest. t-value was worked out to investigate any significant difference between science interest and achievement in science. The value obtained was $t = 0.914$, as shown in Table 8. The value was not significant at $P = 0.05\%$ level. However, in Table 8 it was observed that the mean of scores of the science orientated pupils was greater than those with non-science interest in the science achievement test.

TABLE 6

Correlation Between Science Achievement Test, Science Teacher's Marks and Scholastic Ability

Test	Correlation Coefficient	Level of Significance
1st Year Teacher's Science Marks	0.339	P = 0.05%
Scholastic Ability	0.678	P = 0.05%

TABLE 7

Relation Between Students' Interest in Science and Parents' Profession

Parents Profession

Students' Interest	Science Orientated	Non-Science Orientated	Total
Science Interest	12	24	36
Non-Science Interest	3	16	19
Total	15	40	55

(ii) Reading Habit and Science Achievement

The interest inventory also grouped the pupils into habitual readers and non-habitual readers, and this enabled the science-achievement test scores to be grouped into two according to type of reading habit. t - value was worked out to investigate whether the difference between the two sets was significant. t - value obtained was 0.618 as shown in Table 8 and the value showed that there was no significant difference between the sets of scores. Moreover in Table 9 non-habitual readers scored a higher mean than habitual readers in the group. This result seemed peculiar, but it means that their reading habit had no relationship with their achievement in science.

(iii) Environment and Science Achievement

Table 10 showed that the environment of the pupils correlated negatively with their science achievement test scores. An explanation for this was that the children gave information about their home environment, but they were almost all boarders, and so their boarding house environment provided a uniform surrounding. It might, on the other hand, mean that the home environment had no effect on the pupils' achievement in science.

(iv) Personality Traits and Science Achievement

Table 11 gave intercorrelations between the personality trait scores and they are all negative. In Table 12 is shown the correlation

between the personality trait scores and science achievement test scores. The correlation coefficients were almost all negative, which means there was no relationship between these two variables.

(v) Personality Traits and Scholastic Ability

Table 13 showed the correlation coefficients between personality trait scores and scholastic ability of the pupils. The correlation coefficients were negative, showing that there was no relationship between them.

TABLE 8

Test of Significance Between Science Interest And Achievement In Science

Interest	Number of Subjects	Mean of Scores	Standard Deviation	t
Science Orientated	33	22.91	4.45	0.914
Non-Science Orientated	18	22.78	3.49	
Total	51	22.51	4.18	

TABLE 9

Test of Significance Between Reading Habit And Achievement in Science

Reading Habit	Number of Subjects	Mean of Scores	Standard Deviation	t
Habitual Readers	29	21.21	3.90	0.618
Non-habitual Readers	21	22.91	4.59	
Total	51	22.51	4.18	

TABLE 10

Linear Correlation Between The Environment Scores And Science Achievement Scores

Analysis of Environment	Correlation Coefficient	Level of Significance
Exposure to Technical Home Gadgets	-0.06	Not significant at P = 0.05% level
Frequency of Use of Gadgets	-0.18	- do -
Manipulation of Gadgets	-0.07	- do -

TABLE 11

Intercorrelation Between The Personality Traits Scores

Personality	Achievement	Order	Autonomy	Succorance	Change	Endurance
Achievement	1.00					
Order	-0.08	1.00				
Autonomy	-0.36	-0.03	1.00			
Succorance	-0.06	-0.12	-0.11	1.00		
Change	-0.04	-0.05	-0.09	0.04	1.00	
Endurance	0.13	0.29	-0.33	-0.02	-0.16	1.00

TABLE 12

Correlation Between Personality Trait Scores And Science Achievement Scores

Personality Traits	Correlation Coefficient	Level of Significance
Achievement	0.03	Not significant at P = 0.05% level
Order	-0.04	Not significant at P = 0.05% level
Autonomy	-0.02	- do -
Succorance	-0.14	- do -
Change	-0.16	- do -
Endurance	-0.09	- do -

TABLE 13

Correlation Between Scholastic Ability And Personality Trait Scores

Personality Traits	Correlation Coefficient	Level of Significance
Achievement	0.06	Not significant at P = 0.05% level
Order	-0.10	- do -
Autonomy	-0.06	- do -
Succorance	-0.007	- do -
Change	-0.099	- do -
Endurance	-0.021	- do -

CHAPTER FOUR

DISCUSSION

The purpose of this study was to investigate the variables that could indicate science aptitude at an early age in school. These variables were established and measured by means of a few questionnaires and simple objective aptitude tests given to the experimental group. The main findings of the study from the results already stated in the last Chapter are summarized below:

1. Five aptitude tests, RDL, VAH, SCI, MEC and GPH correlate significantly with science achievement.
2. Composite scores of the five aptitude tests above correlate less highly and not significantly with science achievement.
3. Scholastic ability as measured by the average of scores on all school subjects correlate highly and significantly with science achievement.
4. Three tests, namely, TAB, VAL, GPH correlate significantly with teacher-made test in science. Thus, only GPH correlates significantly with both criteria, science achievement test and teacher-made test at the end of first year in secondary school.
5. Beyond the first year, none of the aptitude tests correlates significantly with teacher-made tests in science at the end of the year.

6. Parents' profession (science orientated/non-science orientated) is not significantly related to achievement in science.
7. Science interest of the pupils is not significantly related to achievement in science.
8. Reading habit is not significantly related to achievement in science.
9. Correlations between home environment and achievement were low, negative and insignificant.
10. Personality traits were not significantly related to achievement in science.

Three broad generalisations can be made from these results:

(i) Home environment, parents' professions, and personality traits of pupils are not indicators of science aptitude. These variables are however not cognitive.

(ii) Achievement in other school subjects seems to be the highest predictor of aptitude in science.

(iii) Some I-D tests predict science aptitude reasonably up till the end of the first year in the secondary school. At the end of the 2nd year and 3rd year of schooling they are not useful as predictors.

Although home environment, exposure to good reading materials, in form of relevant books, and magazines, the calibre of the parents who can generate the right incentive, and give financial support and

useful guidance have been known to influence achievement generally, the subjects in this study are almost all boarders, and their uniform boarding-house environment may have neutralized all these background variables, as shown by the negative correlation coefficients obtained.

I-D aptitude tests predicted science achievement up to the end of the first year, but failed to do so beyond it. This is probably because the common teaching environment after two years has neutralized the previous instructional advantages that children from the better schools might have had. Therefore the rank order in ability may now be different from that indicated by these aptitude test scores at the beginning of their secondary school course.

Science interest is not significantly related to science aptitude. This result tends to agree with what P. F. Bradwein suggested in his book "The Gifted Child as a Future Scientist", that it was difficult to differentiate between science potential and science interest below fourteen years old, that is, the fourth year in a secondary school. However, Bradwein wrote his book in 1955, and more recent schools of thought think that this may be earlier if pupils are exposed to science teaching earlier, that is, in primary schools. This is supported by the useful results

of a more recent study in 1962, on identification of gifted children with science talent, among six to seven year olds in a junior school in America (see bibliography No. 10), using I.Q. tests, science aptitude tests and achievement tests. Such tests are likely to give indication of science aptitude in Nigerian children when the teaching of science and mathematics in primary schools is more firmly established than at present.

The experimental group in this study is a bit small, since a modified pattern of the recent study, mentioned above, was used. Two arms of a class of about fifty-eight students were used in both studies so as to eliminate some factors which may complicate the designing of science achievement test, and other variables. These are the teacher-factor, differences in syllabuses from school to school, etc.

Further research may be done on larger experimental groups using those ability tests which indicate science ability. Since these tests are multiple-choice type, a science teacher can easily use them as indicators of science aptitude in the first form of a secondary school. A science aptitude test based on the general science syllabus in that school may be used at the beginning of the second year, since the pupils are now more settled to secondary method of instruction in science. Any observation or indication

gathered by the teacher should be used for guidance purposes only and not for selection purposes, or streaming, since every pupil needs some science education in this modern technological age up to the end of secondary school.

CHAPTER FIVE

SUMMARY

This thesis investigated some indicators of science aptitude. The variables considered in the study were mental abilities, interest, reading hanits, the environment, personality traits, and to what degree these variables indicated science aptitude.

Ability tests that had been extensively used in Nigeria were applied to an experimental group to estimate their reading, memory, verbal, arithmetical abilities, etc. Each of these mental abilities was used as predictor of science aptitude. The second predictor was the scholastic grade obtained from performance in all subjects taught in school during the year.

The scores from these ability tests were correlated with science aptitude measured by science achievement tests scores. The reliability of the Science Achievement test was found by the test-retest method given at one month interval.

The experimental group was also made to fill a few questionnaires in order to obtain various informations about the interests, reading habit, parents' profession, the personality traits and the environment of each person.

The data collected were used to find out any relationship between these variables and science aptitude. Inter-correlations

were computed between the various scores from tests, and questionnaire data. Some deductions were made from the statistical analysis of data.

The mental abilities that indicated science aptitude in the first year of secondary school were verbal ability, ability to grasp science information, mechanical reasoning, and ability to do graph work. Memorising ability, arithmetical ability and ability to read tables did not seem to have a direct relationship with science aptitude.

There seemed to be no direct relationship between science interest and science aptitude at this stage. The reading habit, personality traits and the environment could not be easily established, and from all indications did not have a direct effect on science achievement and hence science aptitude of the experimental group. The members of experimental group were almost all boarders and this seemed to have created a uniform surrounding which did not allow for much discrimination among the pupils.

In conclusion, one may generalise as follows:

(a) The following non-cognitive variables, namely, home environment, parents' professions, personality traits of the pupils are non-indicators of science aptitude.

(b) High achievement in other school subjects seems to be the best predictor of science aptitude.

(c) Some I-D ability tests can indicate science aptitude up till the end of the first year in the secondary school.

(d) Science interest does not indicate science aptitude at this stage, to a marked degree.

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APPENDIX I

BLUEPRINT OF ACHIEVEMENT TEST IN SCIENCE

CONTENT	PROCESS					
Outlines of School Science - Syllabus for Form 1, A & B Jan. - Dec. 1969	Knowledge of facts, terms, etc.	Comprehension of Principles, laws, etc.	Application of Principles to new situations	Analysis of Material, etc.	Synthesis of facts, data, etc.	Evaluation of data, etc.
1. Scientific Method Scientific terms	1, 2, 3					
2. Characteristics of living and non-living things, plant growth, matter, states of matter, plants and animals.	4, 5 20, 28	19, 21	6			
3. Energy - different forms. The Bunsen-burner		14, 15				
4. Temperature. Fixed points of water. Uses of the thermometer.	11, 13					
5. Distillation of water. Formation of rain. Water Cycle, Evaporation and Condensation	7, 8 16, 34	9 18				
6. Solutions, solvents, solutes Crystallization, Filtration. Crystal shapes	24	32	25			
7. Separation of mixtures. Fractional distillation.	26	33	23			
8. Effect of heat on chemicals. Formation of compounds. Decomposition. Sublimation.		44				

CONTENT	PROGRESS					
Outlines of School Science - Syllabus for Form 1, A & B, Jan. - Dec. 1969.	Knowledge of facts, terms, etc.	Comprehension of Principles, laws, etc.	Application of Principles to new situations	Analysis of Material, etc.	Synthesis of facts, data, etc.	Evaluation of data, etc.
9. Gaseous elements and their relative densities. Family of elements.			35			
10. Physical properties of elements and compounds.	36, 37 40	41				
11. Chemical properties of elements. Burning elements in oxygen. Heating metals in chlorine. Displacement of elements by elements	22 29, 30 31	42	30			

APPENDIX II

THE ACHIEVEMENT TEST IN SCIENCE

Answer the following objective questions, or complete the statements by writing down the correct letter only. There is only one correct answer to every number.

1. Scientists most often learn new facts by .....
   A - working hard alone
   B - debating with their friends
   C - making observations and doing experiments
   D - writing down everything they do
   E - looking through an encyclopaedia.
2. Which is NOT a branch of science?
   A - biology
   B - linguistics
   C - zoology
   D - physics
   E - chemistry
3. The study of plant is .....
   A - biology
   B - geology
   C - zoology
   D - botany
   E - astronomy

4. Which is a non-living thing?

A - leaf

B - fruit

C - insect

D - water

E - fish

5. Which is a living thing?

A - wood

B - air

C - water

D - germ

E - sand

6. Ice floats on water because it is .....

A - denser

B - purer

C - soluble

D - solid

E - transparent

7. When water changes from liquid state to gaseous state it is said to ...../.....

A - disappear

B - liquefy

C - freeze

D - vaporize

E - leak

8. Water that forms dews on the grass before morning breaks comes from the .....

A - soil

B - air

C - grass

D - mist

E - sky

9. Evaporation of water will take place fastest on a day that is .....

A - hot and dry

B - hot and moist

C - cold and dry

D - cold and moist

E - freezing cold

10. A thermometer is used to measure .....

A - volume of a liquid B - degree of coldness

C - speed of wind D - pressure of air

E - height of rainfall

11. At what temperature is water a solid?

(A) $10^{\circ}C$; (B) $4^{\circ}C$; (C) $0^{\circ}C$; (D) $3^{\circ}C$; (E) $100^{\circ}C$.

12. Which is the highest temperature of a substance?

A - melting point; B - breaking point;

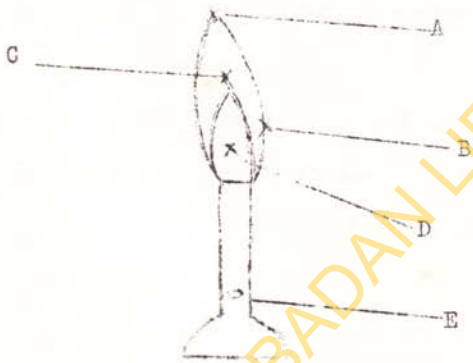
C - boiling point; D - freezing point;

E - transition point.

13. Which is the boiling point is pure water?

(A) 90°C; (B) 95°C; (C) 110°C; (D) 105°C.

14. Which is the latest part of the bunsen flame?

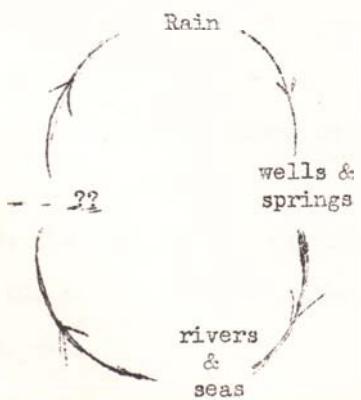


15. Which is not a form of energy?

A - light; B - force; C - heat; D - electricity;

E - sound.

16. What is missing in this rain cycle?



A - gas; B - water; C - clouds; D - air; E - lightning.

17. Which group of foods would give the widest range of necessary food values?

A - meat, vegetable, fruit; B - meat, egg, bean;

C - milk, ice-cream, vegetable; D - rice, cassava, fruit;

E - yam, fruit, vegetable.

18. If you camp out in a bush and you are not sure the water available is save to drink, it would be safest to:

A - hold it up to light to see if it is clear;

B - boil it for half an hour;

C - see if it tastes alright before you drink it;

D - filter it through an handkerchief;

E - see if an animal will drink it first.

19. Which of these statements will be UNTRUE to complete the following sentence?

"Plants keep themselves from being eaten by ....."

A - giving off a bad smell; B - moving away to a safer place;

C - being harmful to eat; D - growing thorns and needles;

E - having bitter taste.

20. If you want to know whether an animal is an insect what would you look for?

A - head, mouth, gills; B - colour, size, sound;

C - mouth feelers, gills; D - head, thorax, abdomen;

E - tails, legs, eyes.

21. Which of these substances come from a different part of the plant?

A - oranges; B - corn; C - cassava; D - beans,

E - sugar-cane.

22. If iodine solution is dropped on cooked white yam, what colour would the stain be?

A - brown; B - greenish-blue; C - greyish-black;

D - blue-black; E - purple.

23. How can one separate a mixture of iron filings and sulphur?

A - using a seive; B - heating the mixture;

C - picking with hand; D - dissolving in water;

E - using a magnet.

24. Which of the following is insoluble in water?

A - sugar; B - sulphur; C - common-salt;

D - alum; E - alcohol.

25. How can you recover salt from its solution? By .....

A - evaporating; B - boiling; C - filtering;

D - condensing; E - solidifying.

26. Which is a mixture?

A - kerosine; B - palm-oil; C - carbon dioxide;

D - ink; E - water.

27. A bowl of water on a scale weighs 8 lbs. A girl puts a live 3 lb. fish in the water and it can swim about in the water.

What will the scale read now?

A - 8lbs; B - 11lbs.; C - 10lbs.; D - 12lbs.; E - 5lbs.

28. Which of these diseases is caused by an insect?

A - cancer; B - heart disease; C - tuberculosis;

D - pneumonia; E - malaria.

29. Which is a solid among these elements?

A - oxygen; B - iodine; C - nitrogen; D - hydrogen;

E - chlorine.

30. Which of these substances is NOT affected by hydrochloric acid?

A - zinc; B - magnesium; C - aluminium; D - carbon;

E - iron.

31. Which is NOT a member of a "family" of elements?

A - bromine; B - fluorine; C - chlorine; D - quinine;

E - iodine.

32. Kerosine removes grease from your hands better than tap-water does because .....

A - tap water is not as pure as kerosine.

B - water only cleans well with soap.

C - anything will dissolve in kerosine.

D - some things dissolve better in kerosine than in water.

E - water is not a good solvent.

33. How would you separate a mixture of table salt and palm oil?

A - remove the salt with kerosine.

B - filter through a cloth.

C - dissolve palm-oil in water.

D - separate the salt with water.

E - heat the mixture.

34. You feel cool on a hot day after a cold bath because the water .....

A - is colder than the air.

B - evaporates from your body.

C - cleans the skin.

D - remains on the body.

E - enters your body.

35. When you suck coca-cola with a straw the liquid enters your mouth because .....

A - your lips force it up; B - of bubbles above the liquid;

C - you take a deep breath; D - the air inside the straw is removed;

E - the straw is long and narrow.

36. Which of these substances has no mass?

A - wood; B - water; C - feather; D - air; E - light.

37. The geometrical shape of the crystals of table-salt is like a .....

A - cube; B - square; C - cuboid; D - rectangle; E - cylinder.

of these elements?

A - zinc, copper, iron, lead; B - copper, iron, lead, zinc;

C - zinc, iron, lead, copper; D - lead, zinc, copper, iron;

E - iron, zinc, lead, copper.

44. Which of the following is an example of the decomposition (breaking down) of a substance?

A - heating iodine crystals in a test-tube;

B - adding water to white copper sulphate powder;

C - heating water in a test-tube;

D - burning sulphur in air;

E - passing electricity through concentrated solution of hydrogen chloride.

45. Which of these reactions is an example of replacement of one element by another?

A - heating calcium in air;

B - reacting zinc with copper sulphate solution;

C - heating potassium permanganate in a test-tube;

D - heating together iron-filings and sulphur;

E - burning sodium in chlorine.

APPENDIX III

THE PREDICTOR APTITUDE TESTS

The predictor tests for science ability used in this study are a battery of eight aptitude tests obtained from the Test Development and Research Office, West African Examinations Council, Yaba, Lagos. They are called I-D tests, specifically designed for use in Africa. They were developed during 1960-64 in a project supported by the U.S. Agency for International Development, which gave the contract to the American Institute for Research.

Information about the development of the I-D tests is given in the following publications:

(a) American Institute for Research. Testing Notes - Number 1. Lagos December 1963.

(b) American Institute for Research. Testing Notes - Number 2. Lagos. February 1963.

(c) Schwarz, P. Adapting tests to the cultural setting. Educational Psychology and Measurement 1963, 23, 673, 686.

(d) Schwarz, P. Aptitude Tests for use in the Developing Nations. Pittsburgh: American Institute for Research, 1961.

DESCRIPTION OF THE APTITUDE TESTS USED

(i) Verbal Analogies (VAL) is a verabal reasoning test for people with six to eight years of formal education. It is used to predict success in school or in a job requiring formal studies. It is a power test that most examinees complete in the allotted time.

It contains 8 sample, 6 practice and 40 test problems.

Sample: Mark one of the five alternative words that completes the analogy: air and bird

water and ___?___ (fish, man, cow, monkey, pig)

Verbal Analogies High. (VAH) is a more advanced form of the above test intended for people with nine to twelve years of formal education.

(ii) The Reading Comprehension (RDL) is a test of ability to read and understand written material. It is used to predict academic potential for examinees with six to eight years of formal education. It contains 40 problems to be done in 30 minutes.

Sample: Mark the one of the five alternative words that best completes each sentence.

This is a test of your ability to __1__ and understand sentences written in English. A number of __2__ have been left out of each sentence, but if you .....

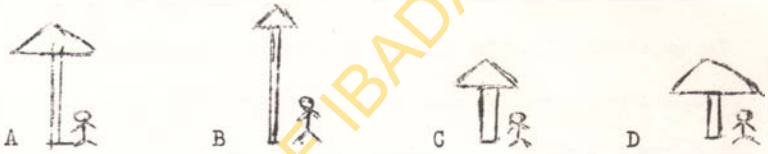
1. know, write, read, learn, copy.
2. spaces, words, sentences, letters, things.

(iii) The Memory Test (MEM) is a test of the ability to learn and remember material organised in a meaningful way, used for selection of secondary school students.

It contains 9 sample, 30 practice and 80 test problems. Total time to administer the test is 20 minutes.

(iv) Mechanical Information (MEC) is an interest and aptitude test for technical occupations. It measures how much the examinee has learned from the mechanical and scientific phenomena in his everyday life. The test is given orally one question at a time. It contains 3 sample, 3 practice and 56 test problems. Total time to administer the test is 35 minutes.

Sample: Four boys are standing under 4 different trees. It is raining. Which boy will remain the most dry while it rains?



Answer = D

(v) GRAPHS - (GPH) is a test of facility in working with complex graph and thereby measuring ability to cope with a problem in which a number of variables must be considered and interrelated.

(vi) ARITHMETIC (RTH) is a test of speed and accuracy in doing simple computations. Used whenever general facility with numbers is required. It is a speeded test with separately timed halves. It contains 8 sample, 12 practice and 150 test problems. Total time to administer the test is 20 minutes.

Sample: Mark the correct answer for each problem.

10 + 20 = 40 30 5 12 21

180 ÷ 6 = 240 24 36 38 30

(vii) TABLES (TAB) Test is a test of speed and accuracy in obtaining data presented in tabular form. Used for selection into clerical occupations. It is a speeded test with separately timed halves. It contains 6 sample, 8 practice and 80 test problems. Total time to administer the test is 20 minutes.

(viii) SCIENCE INFORMATION -(SCI) is a test of interest in science as shown by the examinee's knowledge of basic facts about a wide range of scientific topics. Used mainly for selection or guidance into post secondary science training. It is a power test, and contains 3 sample and 40 test problems. Total time to administer test is 30 minutes.

Sample: "Orion" and "Big Dipper" are names of star

groups families classes constellations clusters

ESTIMATES OF TEST RELIABILITY
FOR EXAMINEES WHO HAVE COMPLETED 6-7 YEARS OF PRIMARY EDUCATION

	BOYS				GIRLS			
	r	N	Mean	S.D.	r	N	Mean	S.D.
VAL*	.87	378	13.60	7.9	.86	58	14.36	8.3
RDL*	.73	1572	14.24	5.6	.72	563	14.07	5.5
MEM	.90	2771	15.54	11.5	.92	440	16.33	12.5
MEC*	.79	2033	29.06	9.5	.68	730	24.40	7.9
GPH	not estimated							
RTH	.88	3684	131.9	21.3	.89	835	127.45	20.6
TAB	.91	362	124.9	14.3	.83	50	125.34	14.2
VAH	Not done							
SCI	Not done							

* Estimated KR-20 Coefficients.

Others are separately timed halves,

Spearman-Brown adjusted.

TEST RELIABILITY

Tests that are speeded are given in two separately timed parts, so that the examinee is in effect tested twice. The reliability can therefore be estimated, based on the correlation between the two sets of scores.

For the unspeeded tests, the appropriate estimate is obtained by regarding each test problem as a separate form of the test, and checking the consistency of the examinees' performance from problem to problem. The coefficients of correlation obtained are similar to those from the split-half technique.

STANDARDIZATION DATA

Final year students in 67 schools from various provinces and types of schools in Northern Nigeria were used to obtain data - 2364 males and 356 female examinees also from schools in Eastern Nigeria, a total of 2516 boys and 761 girls were tested to obtain data for working out Reliability Coefficients and Validity Coefficients. Data was also collected from children in Liberia.

APPENDIX IV(a)

THE PERSONALITY TEST QUESTIONNAIRE

THE DIRECTIONS

This schedule consists of a number of pairs of statements about things that you may or may not like; about ways in which you may or may not feel. Look at the example below.

A I like to talk about myself to others.

B I like to work toward some goal that I have set for myself.

Which of these two statements is more characteristic of what you like? If you like "talking about yourself to others" more than you like "working toward some goal that you have set for yourself", then you should choose A over B. If you like "working toward some goal that you have set for yourself" more than you like "talking about yourself to others", then you should choose B over A.

You may like both A and B. In this case, you would have to choose between the two and you should choose the one that you like better. If you dislike both A and B, then you should choose the one that you dislike less.

Some of the pairs of statements in the schedule have to do with your like, such as A and B above. Other pairs of statements have to

do with how you feel. Look at the example below.

A I feel depressed when I fail at something.

B I feel nervous when giving a talk before a group.

Which of these two statements is more characteristic of how you feel? If "being depressed when you fail at something" is more characteristic of you than "being nervous when giving a talk before a group", then you should choose A over B. If B is more characteristic of you than A, then you should choose B over A.

If both statements describe how you feel, then you should choose the one which you think is more characteristic. If neither statement accurately describes how you feel, then you should choose the one which you consider to be less inaccurate.

Your choice, in each instance, should be in terms of what you like and how you feel at the present time, and not in terms of what you think you should like or how you think you should feel. This is not a test. There are no right or wrong answers. Your choices should be a description of your own personal likes and feelings. Make a choice for every pair of statements; do not skip any.

The pairs of statements on the following pages are similar to to the examples given above. Read each pair of statements and pick out the one statement that better describes what you like or how you feel. Make no marks in the booklet. On the separate answer

sheet are numbers corresponding to the numbers of the pairs of statements. Check to be sure you are marking for the same item number as the item you are reading in the booklet.

1. A I like to help my friends when they are in trouble.
   B I like to do my very best in whatever I undertake.
2. A Any written work that I do I like to have precise, neat, and well organized.
   B I would like to be a recognized authority in some job, profession, or field of specialization.
3. A I like to be able to come and go as I want to.
   B I like to be able to say that I have done a difficult job well.
4. A I like to solve puzzles and problems that other people have difficulty with.
   B I like to follow instructions and to do what is expected of me.
5. A I like to plan and organize the details of any work that I have to undertake.
   B I like to follow instructions and to do what is expected of me.
6. A I like to avoid situations where I am expected to do things in a conventional way.
   B I like to read about the lives of great men.

7. A I would like to be a recognized authority in some job, profession, or field of specialization.

   B I like to have my work organized and planned before beginning it.

8. A I like to finish any job or task that I begin.

   B I like to keep my things neat and orderly on my desk or workspace.

9. A I like to be independent of others in deciding what I want to do.

   B I like to keep my things neat and orderly on my desk or workspace.

10. A I like to be able to do things better than other people can.

    B I like to tell amusing stories and jokes at parties.

11. A I like to have my life so arranged that it runs smoothly and without much change in my plans.

    B I like to tell other people about adventures and strange things that have happened to me.

12. A I like to criticize people who are in a position of authority.

    B I like to use words which other people often do not know the meaning of.

13. A I like to accomplish tasks that others recognize as requiring skill and effort.

    B I like to be able to come and go as I want to.

14. A I like to keep my letters, bills, and other papers neatly arranged and filed according to some system.

    B I like to be independent of others in deciding what I want to do.

15. A I get so angry that I feel like throwing and breaking things.

    B I like to avoid responsibilities and obligations.

16. A I like to be successful in things undertaken.

    B I like to form new friendships.

17. A Any written work that I do I like to have precise, neat, and well organized.

    B I like to make as many friends as I can.

18. A I like to be able to come and go as I want to.

    B I like to share things with my friends.

19. A I like to solve puzzles and problems that other people have difficulty with.

    B I like to judge people by why they do something - not by what they actually do.

20. A I like to have my meals organized and a definite time set aside for eating.

    B I like to study and to analyze the behaviour of others.

21. A I like to feel to do what I want to do.

    B I like to observe how another individual feels in a given situation.

22. A I like to accomplish tasks that others recognize as requiring skill and effort.

B I like my friends to encourage me when I meet with failure.

23. A I like to have my life so arranged that it runs smoothly and without much change in my plans.

B I like my friends to feel sorry for me when I am sick.

24. A I like to avoid situations where I am expected to do things in a conventional way.

B I like my friends to sympathize with me and to cheer me up when I am depressed.

25. A I would like to write a great novel or play.

B When serving on a committee, I like to be appointed or elected chairman.

26. A I like to keep my letters, bills, and other papers neatly arranged and filed according to some system.

B I like to be one of the leaders in the organizations and groups to which I belong.

27. A I like to avoid responsibilities and obligations.

B I like to be called upon to settle arguments and disputes between others.

28. A I would like to be a recognized authority in some job, profession or field of specialization.

B I feel guilty whenever I have done something I know is wrong.

29. A I like to plan and organize the details of any work that I have to undertake.

B When things go wrong for me, I feel that I am more to blame than anyone else.

30. A I like to plan and organize the details of any work that I have to undertake.

B I feel timid in the presence of other people I regard as my superiors.

31. A I like to do my very best in whatever I undertake.

B I like to help other people who are less fortunate than I am.

32. A I like to make a plan before starting in to do something difficult.

B I like to do small favours for my friends.

33. A I like to say what I think about things.

B I like to forgive my friends who may sometimes hurt me.

34. A I like to be able to do things better than other people can.

B I like to eat in new and strange restaurants.

35. A I like to have my work organized and planned before beginning it.

B I like to travel and to see the country.

36. A I like to be independent of others in deciding what I want

to do.

B I like to do new and different things.

37. A I like to be able to say that I have done a difficult job well.

B I like to work hard at any job I undertake.

38. A If I have to take a trip, I like to have things planned in advance.

B I like to keep working at a puzzle or problem until it is solved.

39. A I like to do things that other people regard as unconventional.

B I like to put in long hours of work without being distracted.

40. A I would like to accomplish something of great significance.

B I like to kiss attractive persons of the opposite sex.

41. A I like to keep my things neat and orderly on my desk or workspace.

B I like to be in love with someone of the opposite sex.

42. A I like to do things in my own way and without regard to what others may think.

B I like to read books and plays in which sex plays a major part.

43. A I would like to write a great novel or play.

B I like to attack points of view that are contrary to mine.

44. A I like to have my life so arranged that it runs smoothly and without much change in my plans.

    B I get so angry that I feel like throwing and breaking things.

45. A I like to avoid responsibilities and obligations.

    B I feel like making fun of people who do things that I regard as stupid.

46. A I like my friends to encourage me when I meet with failure.

    B I like to be successful in things undertaken.

47. A I like my friends to be sympathetic and understanding when I have problems.

    B I like to accept the leadership of people I admire.

48. A I like my friends to treat me kindly.

    B I like to have my work organized and planned before beginning it.

49. A I like my friends to make a fuss over me when I am hurt or sick.

    B I like to talk about my achievements.

50. A I like my friends to feel sorry for me when I am sick.

    B I like to avoid situations where I am expected to do things in a conventional way.

51. A I like my friends to help me when I am in trouble.

    B I like to do things for my friends.

52. A I like my friends to do many small favours for me cheerfully.

B I like to judge people by why they do something - not by what they actually do.

53. A I like to have my life so arranged that it runs smoothly and without much change in my plans.

B I like my friends to feel sorry for me when I am sick.

54. A I like my friends to sympathize with me and to cheer me up when I am depressed.

B When with a group of people, I like to make the decisions about what we are going to do.

55. A I like my friends to feel sorry for me when I am sick.

B I feel better when I give in and avoid a fight, than I would if I tried to have my own way.

56. A I like my friends to help me when I am in trouble.

B I like to treat other people with kindness and sympathy.

57. A I like my friends to be sympathetic and understanding when I have problems.

B I like to meet new people.

58. A I like my friends to do many small favours for me cheerfully.

B I like to stay up late working in order to get a job done.

59. A I like my friends to show a great deal of affection toward me.

B I like to become sexually excited.

60. A I like my friends to make a fuss over me when I am hurt or sick.

B I feel like blaming others when things go wrong for me.

61. A I like to travel and to see the country.

B I like to accomplish tasks that others recognize as requiring skills and effort.

62. A I like to work hard at any job I undertake.

B I would like to accomplish something of great significance.

63. A I like to experience novelty and change in my daily routine.

B I like to tell my superiors that they have done a good job on something, when I think they have.

64. A I like to stay up late working in order to get a job done.

B I like to praise someone I admire.

65. A I like to meet new people.

B Any written work that I do I like to have precise, neat, and well organised.

66. A I like to finish any job or task that I begin.

B I like to keep my things neat and orderly on my desk or workspace.

67. A I like to try new and different jobs - rather than to continue doing the same old things.

B I sometimes like to do things just to see what effect it will have on others.

68. A I like to stick at a job or problem even when it may seem as if I am not getting anywhere with it.

B I like people to notice and to comment upon my appearance when I am out in public.

69. A I like to eat in new and strange restaurants.

B I like to do things that other people regard as unconventional.

70. A I like to complete a single job or task at a time before taking on others.

B I like to feel free to do what I want to do.

71. A I like to do new and different things.

B I like to form new friendships.

72. A When I have some assignment to do, I like to start in and keep working on it until it is completed.

B I like to participate in groups in which the members have warm and friendly feelings toward one another.

73. A I like to eat in new and strange restaurants.

B I like to put myself in someone else's place and to imagine how I would feel in the same situation.

74. A I like to stay up late working in order to get a job done.

B I like to understand how my friends feel about various problems they have to face.

75. A I like to experiment and to try new things.

B I like my friends to be sympathetic and understanding when I have problems.

76. A Like to keep working at a puzzle or problem until it is solved.

B I like my friends to treat me kindly.

77. A I like to try new and different jobs - rather than to continue doing the same old things.

B When serving on a committee, I like to be appointed or elected chairman.

78. A I like to finish any job or task that I begin.

B I like to be able to persuade and influence others to do what I want.

79. A I like to move about the country and to live in different places.

B If I do something that is wrong, I feel that I should be punished for it.

80. A I like to stick at a job or problem even when it may seem as if I am not getting anywhere with it.

B I feel that the pain and misery that I have suffered has done me more good than arm.

81. A I like to do new and different things.

B I like to treat other people with kindness and sympathy.

82. A When I have some assignment to do, I like to start in and keep working on it until it is completed.

B I like to help other people who are less fortunate than I am.

83. A I like to conform to custom and to avoid doing things that people I respect might consider unconventional.

B I like to participate in new fads and fashions.

84. A I like to work hard at any job I undertake.

B I like to experience novelty and change in my daily routine.

85. A I like to move about the country and to live in different places.

B I like to put in long hours of work without being distracted.

86. A If I have to take a trip, I like to have things planned in advance.

B I like to keep working at a puzzle or problem until it is solved.

87. A I like to meet new people.

B I like to kiss attractive persons of the opposite sex.

88. A I like to keep working at a puzzle or problem until it is solved.

B I like to be in love with someone of the opposite sex.

89. A I like to participate in new fads and fashions.

B I feel like criticizing someone publicly if he deserves it.

90. A I like to avoid being interrupted while at my work.

B I feel like telling other people off when I disagree with them.

APPENDIX IV(b)

PERSONALITY TEST - ANSWER SHEET

AGE: _____ NAME: _____ DATE: _____

Achievement	1 A/B	4 A/B	7 A/B	10 A/B	13 A/B	16 A/B	19 A/B	22 A/B	25 A/B	28 A/B	31 A/B	34 A/B	37 A/B	40 A/B	43 A/B
Order	2 A/B	5 A/B	8 A/B	11 A/B	14 A/B	17 A/B	20 A/B	23 A/B	26 A/B	29 A/B	32 A/B	35 A/B	38 A/B	41 A/B	44 A/B
Autonomy	3 A/B	6 A/B	9 A/B	12 A/B	15 A/B	18 A/B	21 A/B	24 A/B	27 A/B	30 A/B	33 A/B	36 A/B	39 A/B	42 A/B	45 A/B
Succurance	46 A/B	47 A/B	48 A/B	49 A/B	50 A/B	51 A/B	52 A/B	53 A/B	54 A/B	55 A/B	56 A/B	57 A/B	58 A/B	59 A/B	60 A/B
Change	61 A/B	63 A/B	65 A/B	67 A/B	69 A/B	71 A/B	73 A/B	75 A/B	77 A/B	79 A/B	81 A/B	83 A/B	85 A/B	87 A/B	89 A/B
Endurance	62 A/B	64 A/B	66 A/B	68 A/B	70 A/B	72 A/B	74 A/B	76 A/B	78 A/B	80 A/B	82 A/B	84 A/B	86 A/B	88 A/B	90 A/B

APPENDIX V

INTEREST INVENTORY

DATE ..... NAME.....
(Block Letters)

Please fill this FULLY AND HONESTLY

1. The subject I find most difficult at school is .....
2. My favourite subject is .....
3. The subjects I find most useful in everyday life are
   (i) ..... (ii) .....
4. When I leave school I would like to train to become a
   ..... or a .....
5. The subjects I would like to study when I leave school are
   (i) ..... (ii) .....
   (iii) ..... (iv) .....
6. My hobby is .....
7. The game/s I am good at is/are .....
8. My father's work is .....
9. My mother's work is .....
   Or is she a house wife only? Yes/No (strike one out).
10. I schooled as shown in the table below:-

	Name of School	Town	Dates
(i)	.....	.....	Jan.19..Dec.19..
(ii)	.....	.....	Jan.19..Dec.19..
(iii)	.....	.....	Jan.19..Dec.19..
(iv)	.....	.....	Jan.19..Dec.19..

11. In a month I usually read ..... (number) story books or library books (do not include text-books).

12. The society/societies/clubs I am a member of is/are

(i) ..... (ii) .....

(iii) ..... (iv) .....

(v) .....

APPENDIX VI

INVENTORY FOR ENVIRONMENTAL STUDY

Date _____ Name _____

1. Read the following list of household items.

   (a) Put a tick (✓) in front of those you have in your house.

   (b) Indicate how often you use each item by putting a tick (✓) in the appropriate column.

Items	Those in my house	Used How Often			
		Daily	Weekly	Sometimes	Never
(a) Electric-fan					
(b) Gas-cooker					
(c) Electric Stove					
(d) Electric-cooker					
(e) Fridgedaire					
(f) Radiogram					
(g) Gramaphone					
(h) Radio					
(i) Wireless-set					
(j) Rediffusion set					
(k) Water-heater					
(l) Electric kettle					
(m) Electric iron					

Items	Those in my house	Used How Often			
		Daily	Weekly	Sometimes	Never
(n) Immersion-heater					
(o) Television					
(p) Electric-mixer or grinder					
(q) Air-conditioner					
(r) Kerosine stove					
(s) Bicycle					

2. Tick (✓) any of the following you can peform:

(a) Set an alarm clock at 6 o'clock.

(b) Repair a leaking water-tap.

(c) Set the radio to get N.B.C., Lagos.

(d) Set the television to pick Channel 4.

(e) Set the electric iron at "cool" to iron a silk cloth.

(f) Change a burnt electric-bulb (globe) with a new one.

(g) Fix electric-wire (flex) in a new plug (e.g. an electric iron plug).

(h) Bake a cake with a gas oven or an electric oven.

(i) Use the sewing machine to run gather stitches.

(j) Play a record of 33⅓ r.p.m. with the record-changer (radiogram).

APPENDIX VII

TEACHER'S END OF THE YEAR SCIENCE EXAMINATION - 1ST YEAR

ST. ANNE'S SCHOOL, IBADAN

November, 1969

General Science Form I

A. List 10 parts of a flowering plant:

1. _____ 6. _____
2. _____ 7. _____
3. _____ 8. _____
4. _____ 9. _____
5. _____ 10. _____

B. Fill in

1. The five brightly coloured structures of hibiscus flower are called _____.
2. The calyx is made up of _____ (number) green sepals.
3. The male part of the flower is called _____ and it consists of _____ and _____ which contains the _____.
4. The female part of the flower is called _____, and it consists of _____, _____ and that contains the _____.

C. Draw the bean seed showing all its structures

D. Below is the list of the functions of the root, stem, leaves and fruit. Pick and write the numbers (1, 2, 3, etc.) of the functions of each part under that part to which they belong.

1. It sends out excess water from the plant.
2. It absorbs water and mineral salts from the soil.
3. It makes food because of its green colour.
4. It conducts water and mineral salts.
5. It may store food.
6. It conducts food to all parts of the plant.
7. It helps to scatter seeds to places where they can grow.

Root	Stem	Leaves	Fruit

APPENDIX VIII

TEACHER'S END OF YEAR EXAMINATION - 2ND YEAR

ST. ANNE'S SCHOOL, IBADAN

November 1970.

Form II General Science Time: 1½ hrs.

Answer All Questions in the space provided

Part 1

1. (a) Respiration is the act of .....

.....

(b) The organs of respiration are:

....

....

....

....

(c) Respiration is divided into (i) .....

(ii) ..... The movements in (i) are

.....

.....

.....

2. (a) The conditions necessary for germination are .....

.....

(b) The ..... covers and ..... the seed.

(c) Radicle is the ..... which later grows into the .....

(d) ..... is the point where the seed is attached to the fruit case.

(e) ..... is the ..... through which water enters the seed.

(f) When a growing plant is kept away from light, it .....

.....

3. How does the ovary of a flower grow into a fruit?

.....

.....

.....

4. (a) For an electric torch to work, it must have a ..... and .....

(b) The battery is made of ..... can on outside and ..... in the centre.

5. (a) Draw the male reproductive organ in the space below and label its parts.

(b) The female reproductive organ in mammals consist of two .....

(c) The oval testes in man lie in the ....

(d) The ..... produce sperms which are released down the ..... through the ..... to the penis.

(e) The two kinds of reproduction are ..... and .....

(f) What is the difference between these two kinds of reproduction?

.....

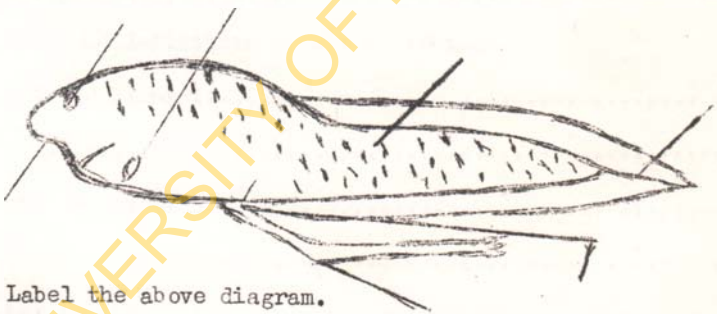
.....

6. (a) The joining of sperms and eggs is called .....

(b) Girls begin to produce eggs at the age of .....

(c) An embryo receives water and oxygen from the mother through the .....

7. (a)



Label the above diagram.

(b) This is the ..... stage in the reproduction of toads.

(c) The female toad lays her eggs on .....

The Jelly shed on the eggs serves some useful functions:

(i).....

(ii).....

(iii) .....

(iv) .....

(d) First, the eggs are ..... on top and .....below.

(e) The male toad can be recognised by the ..... skin below its chin and its .....

8. Describe how you will separate the mixture of iron and sulphur?

.....

.....

.....

.....

9. Give the definition of the following:

(a) An Element:.....

.....

(b) Mixture: .....

.....

(c) An Atom: .....

.....

(d) Molecule: .....

.....

(e) Coumpound:.....

.....

10. Classify the following into compounds, elements and mixtures:

    Copper; air; Zinc; Oxygen; Water; Sodium Chloride; Mercury Oxide; Salt water; sand; Mercury. (Do No. 10 at the back page).

11. When sugar is dissolved in water, a ..... change has taken place.

12. The soil tends to be thinner on hill tops than on lower slopes of hills because .....
    .....

13. Soil erosion is dangerous to farmers because .....
    .....
    .....

14. Soil erosion is .....
    .....

15. Soil erosion is caused by:-
    (i)
    (ii)
    (iii)
    (iv)

16. The types of erosion are:

(i)	(iv)
(ii)	(v)
(iii)	(vi)

17. Soil erosion can be prevented in the following ways:

(i) (iv)

(ii) (v)

(iii) (vi)

18. .... are the weeds planted at the top edge of hills to hold the soil together.

19. Air is a ..... which consist of:

(i) (iii) (v)

(ii) (iv) (vi)

20. Air can be divided principally into ..... and ..... air.

21. When a candle burns ..... and ..... are produced.

22. ..... is used to test for carbon dioxide.

23. The fraction of air used up in burning is .....

24. Phosphorus and Magnesium ribbon were burnt over water to find out the fraction of air used in burning because .....
.....

25. Air consist of ..... by volume which is active and ..... by volume which is .....

PART II

Underline the most correct word or statement from the following:

26. Which of the following constituents of the soil is lost or diminished considerably by exposure to direct sunshine or high temperature?

(a) Humus (b) clay (c) salt (d) mineral salt (e) air.

27. The removal of soil particles from their position by the beating effect of raindrops is:

(a) Gully erosion; (b) Splash erosion; (c) Sheet erosion; (d) Rill erosion.

28. Which one of the following processes does not help to conserve soil fertility?

(a) Contour ploughing; (b) Planting less cover crops;

(d) Irrigation; (d) Shifting cultivation.

29. Which of these best describe the soil?

(a) The mineral of the earth.

(b) The medium in which plants grow.

(c) The environment or media for the growth of roots of plants.

(d) The environment that breeds bacteria.

30. In an experiment to determine the quantity of water retained by equal amount of dry clay and sand, it is seen that greater quantity of water drained through the sand than did the clay particles. This was due partly to:

(a) The fact that sand is hydrophobic

(b) The fact that clay particles attract water.

(c) The fact that water cannot stick to sand particles.

(d) None of these reasons.

APPENDIX IX(a)

TEACHER'S END-OF-YEAR EXAMINATION - 3RD YEAR
ST. ANNE'S SCHOOL, IBADAN

Form III — Biology — November 1971
Time: 1½ hrs.

Answer Question 1 and any three others

1. Draw and label the specimen provided.
2. What are the functions of living things? Compare the ways in which they are carried out in Amoeba and spirogyra. Use diagram to help.
3. Define the following terms giving an example to illustrate the meaning:

Survival of the fittest,	Involuntary organ
Fossil	Reflex are
Protective Colouration	Cell
Carnivore	Extinct
Vestigial organ	Bacterium

4. Show by good diagrams only
   (a) The structure of man's digestive system
   (b) How the arm is bent
5. Make a list of: (a) Kinds of plants
   (b) Kinds of animals in order of their evolutionary complexity. Write a sentence giving the special characteristics of each group.
6. Explain shortly the four lines of evidence for biological evolution.

APPENDIX IX(b)

TEACHER'S END-OF-YEAR EXAMINATION - 3RD YEAR
ST. ANNE'S SCHOOL, IBADAN.

Form III — November 1971.

Chemistry — Time: 1½ hrs.

Answer all questions. Answers to questions in section A are to be written in the spaces provided.

Section A

1. What is left when an electron is taken away from an atom?

2. Define the atomic number of an element.

3. Draw the structure of the oxygen atom which has atomic number 8 and atomic weight 16.

4. An atom consists of particles called .....

5. Write all that you know about each of the particles in an atom.

6. Is there any fixed position for the particles which are arranged round the nucleus of an atom? .....
.....

7. What is a 'shell' or 'orbit' in an atom? .....

.....

.....

8. Draw the structure of the chlorine atom which has atomic number 17 and atomic weight 35.

9. What is an electrovalent bond ?.....

.....

Illustrate with a simple example.

10. What is a covalent bond?.....

.....

Illustrate with a molecule which has more than 2 atoms.

11. Give 2 properties of electrovalent compounds .....

.....

.....

12. Give 2 properties of covalent compounds .....

.....

13. What do you understand by the term 'variable valency'?

.....

.....

14. Write the symbols of the following elements:

Hydrogen

Chlorine

Sodium

Iron

15. What are isotopes? .....

.....

16. Define an acid and give its properties

17. By what test would you recognise soluble bases? .....

.....

18. The formula of ammonium sulphate is $(NH_4)_2\ SO_4$ because the ammonium redical has valency _____ and the sulphate radical has valency _____.

19. In $FeCl_3$ the valency of os iron is _____ and the valency of chlorine is _____.

20. Draw the apparatus you would use to separate a mixture of powdered chalk and water.

SECTION B.

1. Describe fully how you would prepare pure blue crystals of copper sulphate from a powdered sample of copper sulphate. How would you proceed to obtain the white anhydrous salt from the crystals?

2. How would you compare the solubility of 5 different substances at room temperature?

   52 g. of a certain salt saturate 200g of water at 25°C. Calculate the solubility of the salt at that temperature.