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OUTCOMES OF PATTERNS OF CLASSROOM VERBAL AND NON-VERBAL BEHAVIOUR OF SOME SELECTED SECONDARY SCHOOL CHEMISTRY TEACHERS

BY

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A THESIS IN THE DEPARTMENT OF TEACHER EDUCATION SUBMITTED TO THE FACULTY OF EDUCATION IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY OF THE UNIVERSITY OF IBADAN

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Abstract

This study investigated the teaching behaviours of some chemistry and biology teachers in secondary schools in Ibadan. The verbal behaviours of the chemistry teachers were related to the pupil's outcomes.

A modified Flanders' Interaction Analysis Categories, an 18-category system developed by the researcher was used to observe the teachers in their classrooms.

Teaching profiles of the teachers were obtained from the percentages of time spent in the categories of the instrument. Their teaching styles were derived from the profiles.

t-tests were used to compare the ratios of indirect-direct influence of the chemistry teachers. Relationships between the teaching behaviours of the chemistry teachers and pupil's outcomes were found using linear correlation and multiple regression analysis. The total behaviour patterns of the chemistry and biology groups of teachers were compared using the Darwin's chi-square test, a method developed for Flanders for comparing matrices obtained by use of Flanders' observation instrument.

The following findings emanated from the study:-

1. Indirect method and direct method teachers were identified in the group of eight chemistry teachers, and their indirect-direct verbal influence were significantly different at p = 0.05 level from

the results of t-tests.

2. Teacher's indirect influence correlated significantly at p=0.05 level with chemistry achievement, and with pupils' attitude to chemistry, but not with pupils' attitude to chemistry teachers.

3. A Darwin's chi-square test for comparison of the classroom interaction matrices of the chemistry and biology groups of teachers showed that they were not significantly different in teaching behaviours.

4. A t-test for comparison of teaching profiles of chemistry and biology teachers, showed that there was significant difference in only three out of eighteen categories of the observational instrument at p=0.05 level.

5. Indirect method of teaching has a more positive relationship with achievement in chemistry and attitude of the pupils to the subject.

6. Chemistry teachers lectured for 52.9% of the lesson-period on the average, while the biology teachers lectured for 44.2%, but the difference was not significant at p=0.05 level.

7. For the non-verbal behaviour, 19.89% on the average was spent by chemistry teachers in writing on, and cleaning the blackboard during lesson periods.

Findings in this study have implications for the training procedure of science teachers in pre-service preparation and in-service training for teachers already in the profession in innovations in classroom-teaching processes.

Acknowledgement

I thank my creator for giving me the courage to strive on relentlessly till the thesis was finally completed.

I thank most sincerely my hardworking and very helpful supervisors Professor E.A. Yoloye and Professor T.A. Balogun who in different ways encouraged me, directed and guided the work patiently to the end.

I thank Mrs. A.O. Osofisan of the computer unit of the Department of Mathematics of the Polytechnic Ibadan for helping me cheerfully with the computer work during the analysis of my data.

I thank some lecturers of the Faculty of Education who helped in other ways. They are Dr. M.B. Ogunniyi, Dr. A.A. Adeyinka, Dr. A. Falayajo, to mention a few.

I thank the Polytechnic Ibadan for giving me a year's study leave for my course work.

Finally I thank the principal, teachers and pupils of the schools which I used for my pilot study and final work, for their co-operation during the collection of data.

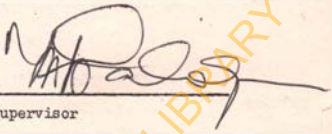
DEDICATION

This study is dedicated to the memory of my late brother

Herbert Adedayo Babaniji

Certification

I certify that this work was carried out by Mrs. Yejide Ayinke Aboaba of the Department of Teacher Education, University of Ibadan.



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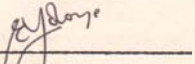

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Abbreviations and Definition of Terms

1. **FIAC** - Flanders' Interaction Analysis Categories
2. ACER - Australian Council for Educational Research Higher tests
3. i/d - indirect-direct ratio
4. I/D - revised indirect-direct ratio
5. DT/ST - direct teacher-talk to student-talk ratio
6. Teacher-behaviour is defined as the pattern of behaviour shown by the profile of the teacher obtained from the results of observation using the modified FIAC or any observational instrument.
7. Teacher style may be defined as pedagogical moves which occur in the classroom discussion in certain cyclic patterns and classified as

   direct and indirect method,

   dominative and integrative method etc.

   to be measured and decided by results of analysis of data from the observational instrument.
8. Teaching effectiveness is the purposeful outcomes of the teaching process and can be measured with pupils' achievement test-scores, pupils' attitude or opinion questionnaires scores, etc.

CHAPTER ONE

INTRODUCTION

1.1 The Nigerian Scene

Schools exist, and teachers are employed for the purpose of promoting learning in pupils. The learning of science subjects is considered to be important to every individual in this technological jet-age in view of level of sophistication of modern living which exposes everyone to all sorts of scientific gadgets. If only for purposes of manipulation, one needs a little scientific knowledge, as this may ensure better and longer usage. Science subjects have therefore become important in the school curriculum from the primary level of the educational system, and it is important that pupils become stimulated in the learning of science as well as other subjects.

A lot of work has been done in Nigeria on Science curriculum and the teaching of science in the lower forms of secondary schools. Most empirical studies were based on the teaching of general science in the first two years of the secondary school and separate science subjects-chemistry, biology and physics in the upper three classes.

Stone[1] conducted a study on science teaching in Nigerian secondary schools. His work was mainly concerned with the r facilities available for science teaching and not with the quality of teaching. He studied the laboratory equipment, number of teachers and their qualifications, science text-books used, libraries available, science societies and government expenditure. Wood-Robinson[2] investigated methods of teaching science throughout the country (1,415 teachers responded to his questionnaire), but his study also had to do with syllabuses used, text-books used, qualifications of the teachers and so on.

Engels[3] carried out a survery of science teaching in Nigerian secondary schools and his findings were based on the teaching experience of teachers, teaching load, laboratory assistants provided and school-journals etc. Yoloye[4] at that period focussed attention on the Science resources (printed matter) used in Nigerian secondary schools

1. Stone, R.H.: A survey of Science teaching in Nigerian Grammar Schools. Occasional Publication, No.1 of the Institute of Education, University of Ibadan, 1960.

2. Wood-Robinson,C.: A survey of General Science teaching in the first two years of the secondary school in Nigeria. S.T.A.N. Publication. 5(3): 15-20, 1966.

3. Engels, C.: A survey of Science teaching in Nigeria in 1967 S.T.A.N. Publication; 1967.

4. Yoloye, E.A.: Some Science Resources in Nigerian Grammar Schools (Text-books, Journals, and Sources of Equipment) Occasional Publications No.7 Institute of Education, University of Ibadan, 1968.

text-books, journals, sources of equipment etc. and found that most books used in science subjects were written by foreigners, and most schools did not subscribe to any journal. Other researches along similar lines were done by Fasemore[1] who did a follow up on Stone's work in 1970. After all these surveys there was a change, and Osiyale[2] worked on the Junior Science curriculum and the use of the Nigerian Integrated Science project course. Later on, Akanbi[3] investigated the adequacy of the Science Teachers Association of Nigeria (S.T.A.N) Integrated science books for the first two years of secondary schools.

More recent researches have focussed attention on classroom activities during science classes and how the teacher attempts to effect learning. Balogun[4] in his examination of verbal interchanges occuring during science classes hypothesized that patterns of communication in the pupil verbal interchange could be used as an

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1 Fasemore, J.A.B., Science facilities and science examination results in secondary grammar schools in the Lagos and Western States of Nigeria. Unpublished M.Ed. Dissertation of the University of Ibadan, 1971.

2 Osiyale, A.O.: An investigation into the adequcy of the S.T.A.N. Integrated Science book for first two years of Nigerian Secondary Schools Mineograph Faculty of Education, University of Ibadan, 1976.

3 Akanbi, T.: An investigation into the adequacy of Science Teachers' Association of Nigeria. Integrated Science book for the first two years of Nigerian Secondary Schools Mimeograph of Education, University of Ibadan, 1976.

4 Balogun, T.A., Classroom thinking of the Nigerian Adolescent. An exploratory Investigation using self instructional technique. A paper presented to the Nigerian Psychological Society Conference in Lagos 1971.

effective means of human behaviour etc. Thus an analysis of aspects of classroom verbal interchange could provide a sensitive means of exposing how specific patterns of interactions could reveal ways in which the teacher stimulates and guides pupil-learning.

A few classroom studies surfaced in Nigeria in the 1970's especially on primary science and the discovery method. At the secondary level were Bajah[1] on student's perception of their science class, and Ogunyemi[2] on teaching approach that encouraged independence and self-direction. At the tertiary level Falayajo[3] enumerated scientific skills developed in Science teacher-trainies.

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1 Bajah, S.T.: SCIS model; Perception of Classrooms environment, Our Science Class - Pilot Study, African Journal of Educational Research. 1(1): 23-29, 1974

2 Ogunyemi, E.O.: Selecting appropriate instructional procedures in high school and college biology teaching West African Journal of Education 14(1): 97-105, 1972.

3 Falayajo, W., The performance of some pre-service science teachers on Science related tests. African Journal of Educational Research.16 (2): 157-167, 1974.

Ogunyemi and Bettie[1] studied emphasis placed on secondary-school Mathematics' instruction. They found that students preferred "formulae mode" of expressing mathematics ideas to "statement mode" or "graphic mode" using an instrument developed by a scholar in U.S.A. Since the students irrespective of sex, achievement level preferred the formula mode of expressing a mathematical idea, indicated that mathematics instruction emphasized the routine use of formula to solve problems.

Another study which could be a reflection on teaching style and emphasis on instruction was done by Ogunyemi and Eboda[2] on Physics pupils in upper classes of secondary schools.

Studies were also found to have been done onpupils in secondary schools relating to science achievement. Aboaba[3] investigated variables that could indicate science aptitude at an early age in school in the lower secondary classes, and found that scholastic ability, measured by the average of scores in all school subjects correlated highly with science achievement.

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1 Ogunyemi, E.O. and J.L. Bettie: An investigation of cognitive preferences in Mathematics among high and low Mathematics achievers in two Nigerian secondary schools. African Journal of Educational Research 1(1): 97-105, April 1974.

2 Ogunyemi, E.O. and F.M. Eboda: Cognitive preferences among high and low Physics achievers in two Nigerian secondary schools. African Journal of Educational Research. 1(1): 107-113 April 1974.

3 Aboaba, Y.: Indicators of Science Aptitude in some Nigerian secondary school girls, Unpublished M.Ed. Dissertation, University of Ibadan, 1973.

Eboda[1] studied reasons why secondary school students in Western Nigeria had aversion for studying physics and asserted that mathematical requirement hindered most of the students from taking up Physics. She found in the same study that students who studied Physics beyond school certificate level were of higher intellectual ability.

All these studies emphasised teacher and pupil characteristics, but did not investigate pupil and teacher behaviours in the classroom.

Classroom observation research in secondary schools started to emerge in the late seventies and early 1980's. Ogunniyi[2] in the study of classroom interactions relative to teacher-student questioning behaviour, categorised teacher's questions in science (Physics, Chemistry and Biology) classes according to a question category, viz, memory, informational, rhetorical leading and probing. He found that science teachers used mainly informational and memory questions in their instructions, and asked more questions then their students. Physics students asked the greatest number of questions

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1 Eboda, F.N.: Some Correlates of low enrolment in Physics in the Western State of Nigeria, Unpublished M.Ed. Dissertation, University of Ibadan, 1974.

2 Ogunniyi, M.B.: Classroom interaction, relative to teacher-pupil questioning behaviour, Journal of Science Teachers' Association of Nigeria 19(1): 116-122, 1981.

per unit, followed by Chemistry teachers and Biology teachers. Odubunmi[1] investigated among other things the methods of teaching integrated science, and attitudes formed by students using classroom observation techniques. He found that teaching in most classrooms was based on the "lecture method". Kubeyinje[2] making use of nine science teachers in three secondary schools in Ibadan, studied patterns of verbal instructions occuring during science classes, and found that science teachers did most of the talking during classes, with little contribution from their pupils.

More classroom observation researches are desirable to study teaching styles and patterns of teacher-behaviour in different subjects in Nigeria. The brief account given above did not even exhaust all the studies done up to date in the field of science subjects, excluding arts subjects which were not considered at all in the account.

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1 Odubunmi, E.O.:Integrated Science teaching strategies and pupil-attitudes to the subject in some secondary schools in Oyo State of Nigeria. Unpublished dissertation M.Phil thesis. University of Ibadan, 1981.

2 Kubeyinje, T. A.: A study of the teacher-pupil verbal interaction during science classes in some secondary schools in Nigeria. Unpublished M.Ed. Disseration, University of Ibadan, 1982.

If classroom proceedings during science instruction are studied by using systematic observation technique, the teacher's skills in managing classroom transactions can be investigated. Teacher-effectiveness can be determined by the extent to which he makes pupils learn what they are supposed to learn. Research findings may lead to establishment of theories of teachings, analogous to theories of learning.

1.2 The Problem and Its Significance

Science teachers, when they are untrained would naturally tend to teach the way they were taught by their own teachers at school. Some out of curiousity, or for progress may decide to go for training, while others may decide that this is not necessary. After all, there is an adage which says "Teachers are born, not made". Methodology comes in here, since methods, whether learned systematically or acquired through trial and error from experiences during teaching years may affect the thinking and performances of pupils, some of whom may become teachers in future. They would wish to know how best to set up their tasks as teachers of science subjects. The problems are (1) "Are there specific behaviour patterns in science teaching?", (2) "Are there specific teacher-behaviour patterns that make for effectiveness in science teaching?". One may solve these problems

by studying science teachers during teaching-learning situations.

1.3 The Present Study

This study attempts to investigate the types of teaching behaviour exhibited by teachers of chemistry in some secondary schools. The study seeks answers to the following questions:-

1. What is the pattern of teaching behaviour exhibited by teachers of chemistry?
2. What are the significant differences, if any, in the behaviour patterns of teachers of chemistry?
3. What are the dominant items of teacher verbal and non-verbal behaviour?
4. How is teacher-style related to pupil-achievement, pupil attitude to chemistry, and pupil-perception of the teacher?

This study employs systematic observation technique to study teacher-pupil interactions in chemistry classrooms and compare them to biology classrooms with the intention of studying verbal and non-verbal behaviours of chemistry teachers. It also investigates the effect of chemistry teachers' verbal behaviour on the outcomes of their pupils. Outcomes are measured in terms of (1) their achievement in chemistry using tests, and questionnaires are used to establish

(2) their interest in the subject, and (3) their perceptions of their teacher, that is, achievement tests are used for the first outcome while questionnaires are used for the second and third outcomes.

1.4 The Hypotheses

The hypotheses to be tested in the study are the following:-

1. There is no significant difference between high scoring and low scoring chemistry teachers in
   (a) the indirect-direct ratio
   (b) the revised indirect-direct ratio
   (c) the direct-student talk ratio.
2. There is no significant relationship between teacher verbal-behaviour (i.e. teacher-style in terms of indirect ratio etc) and pupil outcomes in chemistry.
3. There is no significant difference between chemistry and biology teachers in the amount of time spent in each of the eighteen categories of the observation instrument used.
4. There is no significant difference between chemistry and biology teachers in their total interaction patterns, using the 18-category observational instrument.

1.5 Limitations of the Study

The study was restricted to teachers in a few well-established secondary schools in the urban areas, so as to eliminate intervening "context" variables like school-size, school laboratory facilities, class size etc. Eight chemistry and eight biology teachers completed the procedure of the study, and so the degree of generalisation of the results is not so high. It was not possible for the researcher to employ a trained co-observer during the the observation period due to lack of funds and irregular appointments by the teachers to be observed. However, the reliability of the observational instrument itself was determined using a co-observer during the pilot study.

The teachers observed were not teaching the same topics at the periods of observation although some of the topics were similar. However, each teacher was observed three to four times, and the group data were pooled for analysis. Most of the teachers used had considerable experience in teaching (See Table 1) so their teaching styles were assumed to be fairly set and stable.

The sex of teachers and students were not distinguished in the study, but both girls and boys were in the groups of pupils used although some groups were all girls. The teachers' groups were male and female in unequal numbers. However, the data used in the analysis were a composite for the Chemistry teachers' group and Biology teachers' group.

The study was essentially exploratory and investigated an "ex post facto" situation in which teachers and pupils were not controlled in any way. There might have been other variables interacting with pupil achievement and attitudes which were not measured in the study.

Since there was no manipulation of teacher and pupil variables as in an experimental study the relationships discovered between independent and dependent variables were simple and correlational, and could not be attributed to causal factors.

CHAPTER TWO

LITERATURE REVIEW

2.1 The Concept of Teacher Effectiveness

Research on teaching is quite new, but research on the teacher-effectiveness had been conducted for many years all over the world, that more than 10,000 published studies have appeared for it. Literature on it had been overwhelming and bibliographies on the subject have become unmanageable.

The concept of teacher effectiveness is complex, and the general belief is that it would require several sets of criteria to treat the subject. Teachers are a very important part of the educational system, since successful classroom experiences depend on them. Effective teaching is the ideal to which all educators should aspire.

In the developed countries, earlier work were mainly on teacher characteristics like personality, qualification and experience.

Supervisors' ratings were used to categorize effective and ineffective teachers, and the results were often subjective. The earliest set of criteria established to define teaching - effectiveness was in the form of various adjectives describing desirable teacher characteristics and attributes. According to Ryan[1]

> Effective teachers ... are skilful
> in guiding the learning process,
> are sympathetic and understanding in
> their relationships with children,
> ... know how to motivate children ...
> are intelligent and have a broad
> background of understanding with
> respect to both the subject matter
> they teach and to general cultural materials
> ... the desirable outcomes of education
> are almost certain to be attained.

Researchers like Gage[2] and Ryan consider a teacher who contributes to the overal development of the child to be effective.

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1. Ryan, D.G. Appraising teacher personnel. Journal of Experimental Education (Wisconsin) 16 (1) 1-30, 1947.

2. Cage, N. L., Paradigms of research on teaching In N.L. Gage (ed). Handbook of Research on Teaching, Rand McNally 1963.

In their attempt to investigate this complex subject, Harris and Liba[1] noted that:

> The task of identifying effective teachers (or effective teaching) is crucial to teacher education, certification, selection and promotion, and in so far as teaching contributes to social welfare .... and to the ultimate human survival.

Gage described paradigms as used in therapy in psychoanalyses, and in research in social studies, and showed how paradigms could be used for research on teaching. The idea of effectiveness raised the question of criteria of effectiveness. A paradigm in this field of study could take the following form:- identify or select a criterion (or criteria) of teacher-effectiveness and this criterion becomes the dependent variable. The research task would then be (1) to measure the criterion, (2) to measure the potential correlates of this criterion, and (3) to determine the actual correlation between the criterion and its potential correlates. Simply drawn the paradigms is shown below:-

1. Harris, C.W., and M.R. Liba, Encyclopaedia of Educational Research 3rd Ed. New York, Mc Millan and Co. 1960 p.1486.

He said partial and multiple correlations might be computed between sets of two or more predictor variables and a criterion variable. Factor analysis could be applied to the intercorrelations of the whole battery of variables consisting of sets of predictor and criterion variables.

The question is, what are the criteria of effectiveness? One of early studies which used the criterion of effectiveness paradigms that of the University of Wisconsin Studies which took place over decades, and was led by Barr[1] et al. Barr proposed two sets of criteria: (1) the criteria of overall effectiveness and (2) the criteria for aspects of teaching. He also classified teacher roles for efficiency into four: (1) the teacher as a friend and counsellor of pupils, (2) the teacher as a director of learning, (3) the teacher as a citizen of some school community (4) the teacher as a member of a group of professional workers. The ultimate criterion of teacher's effectiveness was usually considered to be his effect on pupils' achievement of the desired pupil behaviours, abilities, characteristics etc., and indicated by pupils' cognitive and affective growth. Differences between measures of pupil achievement before and

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1 Barr, A.S., The measurement and Prediction of Teacher Effectiveness (Summary and Investigations), Wisconsin, Dembar Pub. 1961.

after coming under the teacher's influence had been used, although researchers like Mitzel[1] and Ryans[2] had elaborated on difficulties both conceptual and practical that beset the use of pupil gain criteria for both research and administrative purposes. Rather than an ultimate criterion, a continuum of the criteria of effectiveness was recommended, from the ultimate to the proximate.

The committee on criteria of Teacher-Effectiveness (American Educational Research Association 1953) in its report distinguished between criteria of effectiveness for teachers already employed and those in training and identified four different stages or levels of a teacher's career as follows:

1. The prospective teacher in training.
2. The student in teacher-education programme.
3. The student completing teacher education programme.
4. The teacher on the job.

The decisions at each level are different, so also are the predictors and criteria.

Mitzel concluded that some disappointing results in the past 50 years or so had been due to not distinguishing between the levels described

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1 Mitzel, H.E., Teacher Effectiveness. In C.W. Harris (Ed.) Encyclopedia of educational research (3rd Ed.). New York, Macmillan, 1960 pp. 1481-1484.

2 Ryan, D.G., Characteristic of teachers, Washington, D.C. American Council on Education 1960 pp.44-45.

above, and not considering the continuum of the paradigm of criteria of teacher-effectiveness. Mitzel therefore refined the paradigm of criteria of effectiveness and described four types of variables which needed to be identified by any researcher on teacher-effectiveness. Type I - human activities, on which teachers differ like personality, attitudes, interests, abilities, skills etc. of the teacher. Type II - contigency factors which modify and influence all the complex behaviours that enter into the educational process. These are pupil variables - attitudes, interest, abilities. Type III variables classroom behaviours of teachers and pupils etc. Type IV - Criteria or standards consisting of measurable outcomes at the end of a period of instruction, as distinguished from the ultimate criterion.

In this type of scheme, Type I and Type II variables are determinants of teacher and pupil behaviours. Also environmental variables under Type II indirectly influence both teacher and pupil - behaviours. Mitzel felt that pupil growth should be investigated in the complex teacher-pupil interaction, in the classroom, and saw the best hope of improvement in research into teacher effectiveness in this area.

The present study concentrates on the Type III Variables involving teacher pupil interaction. Gage[1] therefore suggested a solution to the criterion of effectiveness approach by developing a notion of "micro-

1 "op. cit"

effectiveness". This would analyse the many varied facets of teacher's roles into smaller problems, and less complex variables would emerge leading to more meaningful results. Thus he said,

> ... rather than studies on teacher-effectiveness and criteria, therefore, we may make better progress if we develop "micro-criteria of effectiveness. At the very best such an approach would imply that effectiveness should be sharply specified in terms of subject matter and grade level.

The present study intends to limit itself to a particular subject and a grade level and to investigate teacher pupil interaction in their classrooms over a period of time.

More recent investigations on teacher-effectiveness gave the following views and definitions:-

McNeil and Popham[1] pointed out that the test of a teacher's effectiveness is his or her own accomplishment of the goal of education as displayed in the pupil's behaviour following instruction. They said, "Effectiveness in teaching is best evidenced by criterion measures which detect pupil-growth as a result of teacher's instruction".

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1. McNeil, J.D., and W.J. Popham, The assessment of teacher competence in M.W. Travers(ed.) Second Handbook of Research on Teaching. Chicago Rand McNally, 1972, p218-244

Good,[1] on the other hand defined teacher-effectiveness as

> The ability of a teacher to create a meeting and an interaction, and psychological interests of the student and some given subject-matter content. The ability of the teacher to relate the learning activities to the developmental process of learners, and their current and immediate needs and interests.

One would agree that, (from the discussion above) the important elements in teaching-learning process in classrooms are teachers, pupils, instructions, interaction between physical, intellectual and psychological interests of pupils, subject-matter content, learning activities, desirable outcomes of education, cognitive and affective growth etc. These elements had been grouped into three major categories: (1) personnel variables (teachers, pupils, etc.); (2) task and method cariables (3) environmental variables. The instructional system was considered as consititing of input, process and output. The input consists of the teacher and learner characteristics, the subject-matter content, etc. The process consists of the method variables, and the output are the outcomes (pupil cognitive and affective growth, etc) of the effects of the input and process factors. Effectiveness can be defined here as the extent to which a desired set of effects is achieved.

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1. Good, C.V., Dictionary of Education. Phil. Delta Kappa. New York. McGraw Hill and Co. 1976 p.586.

The difficulty in establishing general criteria for teacher-effectiveness is probably due to the fact that different curricular subjects demand different types of teacher competence.

2.2 Observational Techniques in the description and evaluation of teachers' classroom behaviours

Researchers appeared to have retreated from the study of teacher-effectiveness because they have become aware of substantial difficulties in providing valid information on the teacher-effectiveness problem. Another reason for this retreat was due to developments of a conceptual nature, involving logical relationships between teaching and learning Smith[1] argued that the relationship between teaching and learning is conceptually independent, and established teaching as a phenomenon worth studying in its own right, so that researchers could concentrate on describing and understanding it without becoming involved in the more complicated issues of teaching-learning relationships. Many studies in the last fifteen years reflected this orientation, thus contributing new variables of teaching processes. New questions involving teaching and learning could then be asked and investigated. Therefore most recent researches have focussed on the activities rather than the effects of teaching.

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1. Smith, B.O., A concept of teaching. Teacher's College Record 61(5): 229-241, 1960

Acherman[1] called for research on teaching which would employ systematic observation of specific teaching behaviour and that would correlate these behaviours with measures of pupil-achievement. Research workers pointed out that observations were expensive in terms of time, money and the professional skill demanded of observers; that it constituted an invasion of privacy of teachers and administrators, thus making them resent and resist it. They argued that the presence of an observer in the classroom was so disturbing that the behaviour could not be regarded as typical of the behaviour which would normally go on if the observer were not present. They said most studies in the past which had employed classroom visitation had not been successful in increasing our knowledge about teaching and learning. Finally they pointed out that the number of classrooms that one could economically observe was so small that it was better to omit observation and study a larger sample.

Medley and Mitzel[2] said that although the difficulty and expense of obtaining observational data could not be denied, but it would be a poor excuse to omit observation from a study in which it could play

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1. Acherman, Walter J., Teacher competence and pupil change. Harvard Educational Review, 24, pp.273-259, 1954.

2. Medley, Donald M., and Harold, E. Mitzel. Measuring classroom behaviour by systematic observation. In Hand book of Research on teaching. Rand Mc Nally 1972, pp.247-328.

an important part. They said:

> Direct observation of classroom behaviour was first used in research on teacher-effectiveness, and has been used and misused... None of the procedures so used satisfied the definition of an observational technique ... In most cases, the effects of teaching on pupils cannot be observed directly in normal classroom-behaviour, but must be assessed by other means ... The identification of patterns of behaviour which differentiate effective and ineffective teachers is still a worth-while goal for research, employing direct observation of classroom behaviour.

Therefore, direct observation should play a crucial role in the most fundamental kind of research on teaching; that is, on the search for effective patterns of classroom behaviour. How should a teacher behave in the classroom to achieve more effectively one or more of the goals of instruction?

The term observational technique refers to procedures which use systematic observation of classroom behaviour to obtain reliable and valid measurements of differences in typical behaviours which occur in different classrooms, or in different situations in the same classroom. Two approaches were used by early researchers in the construction of observational instruments, the "category" system

and the "sign" system. Some of the authors of the category system were Anderson and Brewer[1] and Flanders[2]. A category differs from a sign system in that it is supposed to be exhaustive of behaviour of tye type recorded (Withal[3]). The observer using the category system is supposed to record every statement the teacher makes. An example of the sign system is the Morsh[4] instrument, in which an observer only records those statements made by the teacher which fall into one of the categories listed i.e. there will be many statements that will not be recorded at all. Other instruments using the sign system included that of Jayne.[5]

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1 Anderson, H.H. & Brewer, J.E. Studies of teachers' Classroom personalities, II: Effects of teacher's cominating an integrative contacts on children's classroom behaviour. Appl. Psychol. Monograph, 1946, No.8.

2 Flanders, N.A. : Interaction Analysis in the Classroom A Manual for Observers. University of Michigan. Ann Arbor. 1966.

3 Withall, J., Development of a technique for the measurement of socio-economic climate in classrooms. Journal of Experimental Education 1949, 17: 347-361.

4 Morsh, J.E. et al. Student Achievement as a measure of Instructor effectiveness. Journal of Educational Psychology (47): 79-88, 1956.

5. Jayne, C.D.A.: A study of the relationship between teaching procedures and educational outcomes. Journal of Experimental Education, 1945, 14: 101-134.

Both the category and sign systems were combined in the OSCAR technique due to Medley[1] and Mitzel. Medley and Mitzel developed the Observational Schedule and Record (OSCAR) by modifying the classroom observational procedures of Withall[2].

The observer records both teacher and learner behaviours under an "activity section" which identifies 44 possible activities of teacher and pupils. He next employs a "grouping section" of the instrument to identify and list large and small groups, and to note acts of individual pupils. He then notes in the "material section" the type of instructional materials used. Finally he enters in the "sign section" items symptomatic of classroom climate. Differences between classes can be identified with fewer than 14 variables.

A study of the factorial structure of the fourteen scoring keys indicate that the OSCAR technique gives reliable information about three relatively discrete dimensions of classroom behaviour:-

(1) The social emotional climate

(b) Relative emphasis on verbal learnings

(c) The degree to which the social structure centres around the teacher.

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1. Medley, D.M. & Mitzel, H.E., s Some Behavioural Correlates of Teacher Effectiveness. Journal of Educational Psychology 50, 239-246, December 1959.

2. Op.cit.

In subsequent studies, Medley and Mitzel[1] tried to identify the relationship between some measures of teacher effectiveness and teacher-behaviour variables.

Direct observation of the teacher in the classroom has become widely used in research. This is evident from the number of observational instruments that have been devised. Many research workers have had to modify existing ones to suit their needs, while others developed their own for their research work.

The basic purpose of observation is to describe events in the teaching-learning situations, but the use of observational instrument in the evalation of teacher-effectiveness and teacher classroom-behaviour is a common research strategy. Studies had been conducted for purely descriptive purposes e.g. for describing events of a lesson and the types of interaction that occur between teacher and pupils. An example was that of Furst and Amidon.[1] Other studies using observational techniques had focussed attention on relative differencies between teachers in classroom-interaction, and others studied teaching

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1. Furst, Norma, and Edomond, Anudon. Teacher-pupil interaction patterns in the elementary school. In Interaction Analysis: Theory, Research and Application. Wesley Publishing Coy 1967. pp.167-175.

styles. Examples of these ones were in the work of Amidon and Giammatteo[1], and Pankratz[2], Students outcomes had been measured by means of achievement test and attitude test by Flanders[3].

In general, observational systems have several distinct advantages over less structured observational methods. They allow researches in varying situations to produce comparable data with minimum observer bias, less need for observer training, and greater ease of maintaining observer reliability. Some systems are flexible enough to be modified for quite different purposes while retaining the essential nature of the data for purposes of comparison. Flander's system had been modified

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1. Amidon, E.J. and M.M. Giammatteo, The Verbal Behaviour of superior teachers, Elementary School Journal, 65: 283-285, 1965.

2. Pankratz, R., Verbal Interaction Patterns in the Classrooms of selected Physics teachers. In Interaction Analysis: Theory, Research and Application. Amidon-Hough ed. Reading Mess. Addison Wesley Coy. 1967 p.189-209.

3. Flanders, Ned, Some relationships among teacher-influence, pupil attitudes and achievement. In Interaction Analysis, Theory and Research and Application. Amidon-Hough eds. Addison Wesley Publishing Coy. 1967 p.158-166.

by Amidon and Hunter[1] and by Hough[2], for research on teaching. Blumberg[3] modified it for research on supervision and Amidon[4] for research on counselling.

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1. Amidon, E.J. and E. Hunter, Verbal interaction in the classroom. The Amidon System for Interaction Analysis. Temple Univ. Group Dynamic Centre n.d. mimeograph.

2. Hough, J.B. An observational system for the analysis of classroom instruction. Paper. Ohio University 1965. Mimeographed.

3. Blumberg, A.A. System for analysing supervisor-teacher interaction in Mirrors for Behaviour, edited by A Simon and E.C. Boyer, Vol.8 Philadelphia, Research for Better Schools Inc. 1970.

4. Amidon, E.A. Technique for analysing counsellor-counselle interaction in counselling and guidance. A summary view edited by J. Adams, New York. McMillan Co. 1965.

2.3 Teaching Behaviour Patterns in the Classroom

Nineteen century classrooms had cold environments, and teachers were harsh and punitive. There was no room for laughter and the rod was not spared. The classrooms were teacher-centred instead of being learner-centred. The teacher's ability to impart knowledge per se, was considered to be of utmost importance.

During the past thirty years or so the role of the teacher as a director of learning activities had been emphasized, and more attention was being given to those teaching abilities that helped students to think and act like scientists.

In the 1930's Kurt Lewin[1] and his associates at the University of Iowa in their classical study of leadership, the autocracy- democracy study, obtained results which generated enthusiasm and had impact on group dynamics and educational research. It was found that in general autocracy was accompanied by either rebellion or submission. When the autocratic leader was present productivity was high, but in his

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1. Lewin K., Lippit, R., and White, 1936. Patterns of agressive behaviour in experimentally created "Social Climates". Journal of Social Psychology 10 p.271-299. Reprinted E.J. Amidon and J.B. Hough (ed) Interaction Analysis: Theory, Research and Application. Reading Mass Addison Wesley, 1967.

absence productivity gave way to aggression and destructiveness. Under democratic leadership, groups were more task oriented cooperative and friendly, and showed more independence and initiative, especially in the leader's absence. Laissez fair leadership, however, was least conducive to productivity, which tended to be higher in the absence of the leader, and to be accompanied by intra-group hostility and scapegoating.

In the search for progressive education H.H. Anderson[1] and his associates applied similar concepts to those ones above to teaching behaviour in classroom where groups were bigger. They introduced the terms,"dominative" and "integrative" teacher behaviour on pupil classroom performance. Anderson concluded that:

> The use of force, commands, shame, blame, attacks against personal status of an individual is called dominative techniques of responding to others. Dominative is characterised by a rigidity or inflexibility of purpose.
> - - - Domination obstructs the natural growth process - - - Domination is an antithesis of scientific attitude; it is an expression of resistance to change. It is the technique of a dictator.

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1. Anderson, Harold, H., (1939). The measurement of domination and socially integrative behaviour in teachers' contacts with children. Child Development 10, 1939 73-89 - Reprinted Interaction Analysis: Theory, Research and Application. Amidon - Hough (ed.) Addison Wesley Pub. Coy. 1967.

> Integrative behaviour is consistent with in contrast concepts of growth and learning. It is a behaviour that makes the most of individual differences ... it is flexible, adaptive, scientific . It is an expression of a democratic process.

He constructed in his instrument categories that measured these two behaviours. He and his associates demonstrated that dominative teacher behaviour produded less pupil independence, less spontaneity and less initiative etc. The studies found evidence, suggesting that teachers were consistent in their dominative - integrative patterns of behaviour from one class of pupils to another and the effects of these behaviours were similar from class to class. Withall[1] published the results of an attempt to measure "social-emotional climate" of classrooms, which he defined as follows:

> Climate is considered in this study to represent the emotional tone which is concomitant to inter-personal interaction. It is a general emotional factor which appears to be present in interactions occurring between individuals in face-to-face group...

He developed seven categories of teacher verbal behaviour as indicators of classroom climate. He put forward a climate index which was a ratio of "learner-centred" to "teacher-centred" statement.

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1. Withall, J., The development of a technique for measurement of social-emotional climate in classrooms. Journal of Experimental Education 17 1949, 347-361. Reprinted in Interaction Analysis: Theory, Research and Application, E.J. Amidon and J.B. Hough Reading Mass Addison Wesley Pub. Coy. 1967.

In all these studies above, different phrases have been used to describe and classify teacher-behaviour. They are as follows:- autocratic or democratic, (Lewin, Lippit, White); dmominative or integrative (Anderson and Brewer) and teacher-centred or learner centred (Withall). Review of studies based on these concepts seemed to take one type of behaviour as bad and the other as good. However experience in teaching would make one to believe that there must be something in-between the extremes, because under some circumstances in the classroom process, autocracy or dominative behaviour may be more appropriate. R.C. Anderson[1] after a review of such studies called for the abandonment of such research effort on several grounds. According to him findings on them were weak and contradictory. However this research tradition continued to flourish, but had been refined by moderating the extreme belief of "bad" for autocracy and "good" for democracy.

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1. Anderson, R.C. Learning in discussions: A resume of the authoritarian democratic studies Harvard Educational Review; 29: 201-215, 1959.

Flanders argued that flexibility of teacher influence was important. He conceptualized the continuum along which teacher behaviour was hypothesized to vary. The most often used of his terms were "direct" and "indirect" influence. He defined them as follows:-

> Direct influence consists of stating the teacher's own opinions or ideas, directing the pupil's action, criticizing his behaviour, or justifying the teacher's authority, or use of that authority.
>
> Indirect influence consists of soliciting the opinions and ideas of the pupils, applying or enlarging on those opinions or ideas praising and encouraging the participation of pupils, or clarifying and accepting their feeling.

Flanders[1] proposed hypotheses about conditions under which direct influence might be preferred to indirect influence. He introduced an observational instrument called "Flanders Interation Analysis Categories" FIAC (See Appendix I.) The categories of this system were similar to those of Withall. However he added two more categories for judging pupil verbal behaviours student talk-response and student talk-initiation. The other new category was "silence and confusion".

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1. Flanders, N.A., Interaction Analysis in the Classroom. A Manual for Observers. University of Michigan. Ann. Arbor, 1966.

FIAC had been modified and extended by various groups of researchers for their own purposes. The systems were termed "Classroom Interaction Analysis" and were observational instruments for studying and describing teacher-pupil behaviours both verbal and non-verbal. They come into use in the United States of America in the early 1950's and had been used for training teachers as well as for researches on teaching, in various subjects including social studies, arts, music, mathematics, the sciences etc.

Other instruments apart from FIAC include the following:-

(1) Verbal Interaction Category System (VICS) developed by Amidon and Hunter (1967).

(2) An observational system for the Analysis of Classroom Instruction by Hough (1967)

(3) Campbell-Rose Interaction System (CRS) developed by Campbell and Rose (1967)

(4) Science Laboratory Interaction Categories (SLIC) developed by Penick, Skymansky and Kyle (1980).

A book, "Mirrors for Behaviour"[1] contains seventy five different systems which had been developed in the recent years.

The present study investigates the classroom teacher-pupil behaviour patterns in terms of direct and indirect influence as well as other variables.

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1. Simon, A. and G.E. Boyer "Mirrors for Behaviour. Research for Better Schools Philadelphia 1968 and 1970.

2.4 Studies on teaching-process and learning outcomes by classroom observation

The present study centres around teaching activities and behaviour in the classroom. The teacher is expected to provide learning experiences through verbal and non-verbal means to enable pupils develop skills such as observing, hypothesizing, experimenting, classifying and manipulating variables. There is a general belief among educators, especially science educators that verbal skills in conducting stimulating class discussions, and in handling students' questions are important in the development of scientific attitudes, and for successful learning.

2.4.1 The model for classroom teaching

Teaching is a complex activity and research on teaching involves a wide variety of different conceptual schemes for expressing the behaviours of teachers and pupils. Also, many different variables bear relationship with the teaching process. Therefore, Dunkin and Biddle[1] found it necessary to assemble concepts and information by introducing a model for the study of classroom teaching (See Fig.1).

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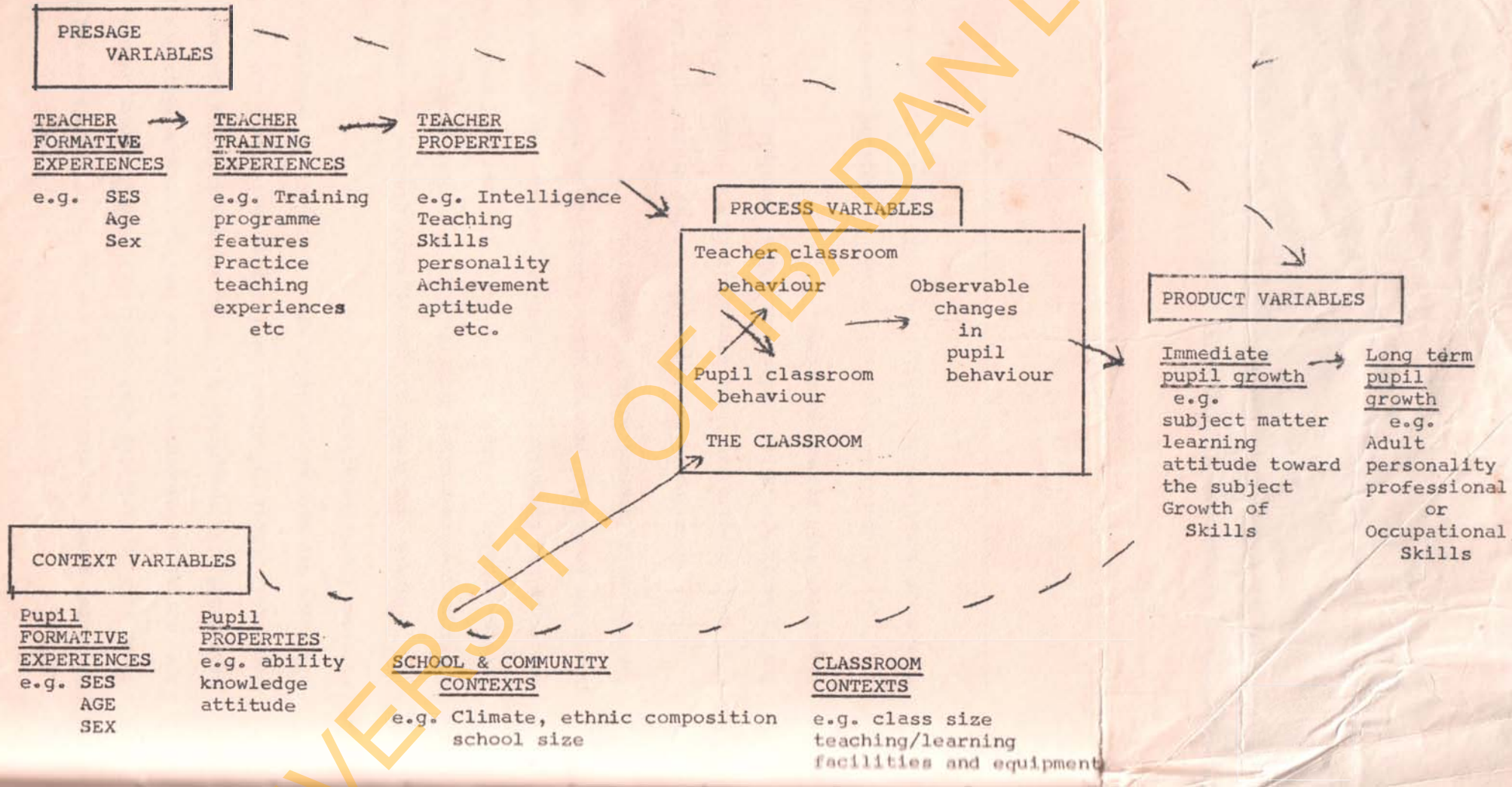
1. Dunkin, M.J., and B.J. Biddle "The Study of Teaching." Holt, Rinehart and Winston Inc. New York, Chicago etc. 1974.

FFIG. I

A MODEL OF CLASSROOM TEACHING



The model shows the classroom as the centre of activities and states three sets of variables that could influence classroom events. These are, variables associated with the teacher (presage variables), variables associated with the pupils and those representing the contexts of community, school and classrooms (context variables); and the effects of all these two sets of variables are the products of education or learning outcomes (product-variables).

Dunkin and Biddle[1] grouped research studies on teaching under the headings presage-product studies, context-product studies and process-product studies, in their book in which they reviewed such studies. Educators had found this convenient and useful. The present study comes under the heading of process-product studies, as this one investigates teacher-pupil interaction in the classroom.

It seems impossible to exclude teacher characteristics, which fall under presage variables especially in the choice of teachers during sampling. Also, context variables, involving pupil-characteristics interferes with process variables.

It is useful to think of outcomes in positive terms, although this might sometimes be negative (when the pupils come out confused),

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1. Dunkin, M. J., and B. J. Biddle, op. cit.

though rare. Product variables are usually subject-matter learning and attitudes towards the subject both of which involve immediate pupil-growth.

2.4.2 The indirect-direct influence

Studies relevant to this present study are those involving the direct and indirect influence of teacher verbal behaviours on pupil learning outcomes in science subjects.

Several dimensions were proposed for teacher's verbal communication by researchers on classroom interaction, namely, Amidon[1], Hough[2], Flanders[3] and Anderson[4]. These dimensions provided information in terms of teacher initiative, teacher-response, teacher-question modes etc. The relevant terms to this study are those due to Flanders, namely: (1) Indirect-direct ratio (I/D), (2) revised indirect-direct ratio (i/d), (3) direct student-talk ratio (DT/ST).

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1. Amidon, E.J., Op cit.
2. Hough, J.B. Op cit.
3. Flanders Ned, Op cit.
4. Anderson, H.H.,Op cit.

The indirect-direct ratio gives an indication of the extent to which the teacher exerts indirect and direct influence. In Flanders' Interaction Analysis Categories (FIAC) (See Appendix 1). Categories 1, 2, 3 and 4 have been referred to by many authors and researchers as indicative of "indirect" teacher influence, and categories 5, 6 and 7 as indicative of "direct" teacher-influence.

I/D ratio is computed thus $\frac{1+2+3+4}{5+6+7}$ Flanders[1], Amidon[2] and others found that the utility value of I/D ratio was limited, considering the fact that the catefories 4 and 5, i.e. asking questions, and lecturing respectively were used, irrespective of whether the teacher was direct or indirect in his approach. A revised ratio termed i/d was thus proposed which eliminated the effects of these two categories. This revised indirect-direct ratio was computed thus:-

$$i/d = \frac{1+2+3}{6+7}$$

This classification of teaching-behaviour under direct and indirect influence indicates the amount of freedom given to the student by the teacher. The direct teacher should have i/d less than one, while the indirect teacher should have i/d greater than one.

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1. Flanders, Ned. Op.cit. p.132

2. Amidon, E.J. Op.cit. p.151

According to Amidon and Flanders, the direct teacher lectures, gives facts and opinions, asks questions, gives directions, criticizes and justifies authority more than average. The indirect teacher accepts feelings, uses pupils' ideas, praises and encourages pupils' responses more than average. Therefore a teacher has a choice to be direct by minimising the freedom of pupils or indirect by maximising the the freedom of the pupils.

2.4.3 The indirect-direct influence and learning outcomes

Flanders[1] found that teachers varied in their approach to activities they engaged in the classroom, and that the effective group of teachers used the indirect methodology during such activities as planning, presentation of materials, and discussion, but a more direct approach during activities involving routine work and evaluation.

Conflicting results had been reported on the findings of the effects of indirect and direct methods on learning-outcomes. According to Dunkin and Biddle[2], this could be explained

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1. Flanders Ned., Teacher influence, pupil attitudes, and achievement. Cooperative Research, Monograph No.12, Washington D.C:U.S. Govt. Printing office, 1965.

2. Dunkin, M.J. and B. J. Biddle, op.cit.

by the fact that the various instruments used in many studies reviewed differed in the categories they featured; and there was no standard way of judging how indirect or direct a lesson might be from categorial influences. Even for, FIAC, the ratio of indirect-direct influence might be calculated differently (i/d or I/D).

Flanders[1] selected sixteen English-Social studies teachers in seventh grade classes for a study of teacher-influence on achievement and pupil attitudes. The teachers were given the same unit of study and instructional materials to use, but were allowed to keep to their natural teaching styles. The teachers were observed using FIAC over and period of three months. Achievement tests were given to the pupils as pre and post-tests. Attitude inventories were also applied to the pupils. A similar procedure was also followed on another group of sixteen eight-grade mathematics teachers. Results of the analyses of the data collected showed for both sets of subject teachers the following findings: (1) the teachers of the high-achieving classes were those with indirect influence; (2) there was a causal relationship between teacher influence and pupil-attitudes since the ratio I/D positively

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1. Flanders, Ned; Some relationships among teacher influence, pupil attitudes and achievement. In Interaction Analysis: Theory, Research and Application Amidon-Hough (ed.). Addison Wesley Publishing Co. Reading Mass. 1967.

correlated with class average on the attitude inventory. In the analysis teacher influence was the independent variable while achievement and attitudes were dependent variables.

Citron and Barnes[1] used Flanders Interaction Analysis Category System in a longitudinal study involving six biology teachers in nine slow-learner classes in four high schools in Berger county in New Jersey. The study was to find more effective methods of teaching high school biology to slow-learners. Results showed that the classes which had teaching by indirect methodology showed significantly better gain in the early stages; and a lower i/d ratio later in the course increased achievement in problem solving and in the total performance of the students.

Campbell[2] investigated the relationship between cognitive and affective process development in 251 Junior High School Science students and the i/d ratios of their ten instructors. Three hundred and sixty minutes of classroom dialogue for each of the ten teachers were

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1.Citron, I., and C. Barnes. The search for more effective methods of teaching high school biology to slow learners through interaction analysis. Journal of Research in Science Teaching 7:9-19, 1970.

2.Campbell, J.R., Cognitive and affective process development and its relation to teachers' interaction ratio. Journal of research in science teaching 8 (4): 317-323, 1971.

tabulated using Flander's Interaction Analysis (FIAC). He applied pretests of scientific attitudes, cognitive development tests at the beginning of the year, and when the curriculum had been completed. The post-test mean of the pupils whose teachers were indirect in methodology was found to be significantly higher at 0.05 level than that of the direct group on the affective measures. Also the students of the indirect group of teachers were found to be different on the cognitive level, the level of significance was at 0.01 level.

Houston[1], using FIAC, identified three teacher styles, direct, indirect, and intermediate. He found that students exposed to indirect teaching performed better than those exposed to the direct teaching method and the intermediate group of teachers, at the higher levels of cognition, and these students did better on objective test items drawn to measure synthesis and evaluation of topics in physics.

Okebukola[2] in a study found that the verbal influence of the teacher significantly favoured achievement of pupils in biology.

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1. Houston, J. The effects of verbal style on physics teaching. Physics Education 1975 10,(1) p.38-41.

2. Okebukola, P.A., Effects of teachers' verbal exposition on students' level of class participation and achievement in biology M.Ed. Dissertation. Department of Teacher Education, University of Ibadan, 1982.

He also found that the students were more involved and participated more actively in lessons taught by indirect method teachers. These results confirmed the results of similar studies mentioned above, in this field.

In the field of the subject chemistry Wolfson[1] concluded that chemistry students taught by teachers with high indirect-direct ratio achieved and retained more information than students taught by teachers with a lower indirect-direct ratio. He also found significant differences in the achievement; and attitudes to the subject seemed to be in favour of the indirect strategy.

Flanders' system that is used in the present study is concerned with verbal behaviour only, and classifies all non-verbal behaviour in a category which includes silence and confusion.

Flanders made assumptions that a teacher's verbal behaviour adequately represented his total behaviour. This assumption had been questioned by many researchers, and by Boyd and De Vault[1] in their article

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1. Wolfson, M.L., A Consideration of direct and indirect teaching styles with respect to achievement and retention of learning in science classes. Journal of Research in science Teaching, 1973 10(4) p.285-290.

2. Boyd, R.D., and De Vault; M.V., The observation and recording of behaviour. Chapter 5 in Review of Educational Research 1966 36 (5) p.529-55)

"observing and recording behaviour". Medley and Mitzel[1] had earlier included verbal and non-verbal categories in their instrument. Also supporting the need to go beyond the verbal activities associated with classroom behaviour were studies of Parakh[2] in which he collected empirical evidence indicating that some biology classes involving laboratory work consisted more than 40% of non-verbal activities. Instruments such as the "Teaching Strategy Observational Differential (TSOD) developed by Anderson, Struthers and James[3] had been designed to collect data on science-teacher behaviour in classrooms and laboratories where learning activities involved non-verbal activities as well.

Hence, after observing in a pilot study that most science classes involved some practical work, such as demonstration of experiments, or observation of materials, the present study modified the Flanders' system (FIAC) like Hough[4] did to include some non-verbal categories.

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1. Medley, D. and Harold E. Mitzel. A technique for measuring classroom behaviour. Journal of Educational Psychology 49 p.86-92, 1958

2. Parakh, J.A. A study of teacher-pupil interaction in high school biology classes. Dissertation Abstracts 26. p.2561A. 1965.

3. Anderson, R.D., James H.H. and Stuthers, J.A., The teaching strategies observational differential in Stanford G. and Roark A.E. Human Interaction in Education: Allyn and Bacon, Inc. 1974.

4. Hough, John, B., An observational system for the Analysis of Classroom Instruction in: Interaction Analysis: Theory, Research and Application: Amidon Hough (ed.) Reading, Mass. Addison-Wesley Pub. Co. 1967.

The modified instrument, a 16-category system by Hough was used by Panktratz[1] to study physics teachers. Thus for the present study FIAC was expanded from ten to eighteen categories, without disrupting the pattern in FIAC that would be required to keep the indirect-direct strategy intact.

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1. Pankratz, Roger., Verbal Interaction Patterns in Classrooms of Selected Physics teachers. In Interaction Analysis: Theory, Research and Application, Addison Wesley Pub. Co. 1967.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

Direct observation of the teacher in the classroom has become popular and is widely used in research methods. This is evident from the large number of observational instruments now available. However many researchers still have to develop their own instruments to suit their needs, as is done in this study.

3.2 Research Instruments

The instruments used in the study are the following:-

1. A modified Flanders' Interaction Analysis - Verbal and Non-verbal - 18 Category System, developed by the researcher.

2. An intelligence-test battery called - ACER Form M, Form ML and Form MQ.

3. A pupils' Opinion Questionnaire titled "My High School Chemistry Instructor".

4. A pupil opinion questionnaire titled "Chemistry as a Subject".

5. A Chemistry, multiple-choice achievement test.

6. Teachers' Personal Information Invetory.

7. Schools Information Inventory.

3.3 Description of Research Instruments

3.3.1 Ned. Flanders developed between 1957 and 1960 an Observational instrument called Flanders' Interaction Analysis Categories (FIAC). The Flanders' system is concerned with verbal behaviour only, primarily because this can be observed with higher reliability than can non-verbal behaviour, and because he assumed that the verbal behaviour of an individual is an adequate sample of his total behaviour.

Flanders' system consists of ten categories. Categories 1-7 record the behaviour of the teacher whilst categories 8 and 9 record the behaviour of the pupils. Category 10, termed "silence and confusion" records all non-verbal behaviour (which must not be longer than two minutes), and all moments of silence and irrelevant behaviour. Categories 1-7 called "Teacher talk" is

further divided into 1-4 for "indirect", and 5-7 for "direct" verbal behaviour of the teacher, these ones are also termed indirect and direct influence. Whenever the teacher is talking the statements must be categorised in one of the seven categories and student-talk in categories 8 or 9. All the categories are mutually exclusive, yet totally inclusive of all the verbal interaction occurring in the classroom. Due to the complexity of problems involved in categorisation, several ground rules have been established. These rules of observation help to develop consistency in trying to categorise teacher behaviour. There are five "ground rules" explained fully by Flanders and Amidon[1] and any researcher learning to use this system must know these rules.

The major instrument of this research, used for observing chemistry and biology classes is a modified Flanders' system expanded from ten to eighteen categories, to include non-verbal behaviour and splitting the "Silence and confusion" category into two, under, non-functional behaviour (see appendix II). The non-verbal behaviour section of this

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1. Amidon, E., and Ned Flanders. Interaction Analysis as a Feedback. In Interaction Analysis: Theory, Practice and Research. Amidon - Hough. Addision Wesley Publishing Company. p. 126-128, 1967.

instrument was worked out bearing in mind the rule that the categories must be mutually exclusive. Categories 12, 13, 14, were for recording students' non-verbal behaviour, while categories 15 and 16 were for recording the teacher non-verbal behaviour. The divisions of some of the categories into (a) and (b) merely helped to spell out what other types of behaviour fall under the same category.

The instrument was developed and tested by using it to observe three live biology lessons and three chemistry lessons at Mount Olivet Baptist Secondary School in Ibadan, bearing in mind Flanders' ground rules of categorisation. Tallies were made at three-seconds intervals during observation. The categories retained were those found to be functional, in that many tallies were recorded under them. It was therefore asumed that the non-verbal categories would contribute to the total behaviour of the teacher from the results of this pilot study.

3.3.2 The Intelligence Test Battery is the Australian Council for Educational Research (ACER) Higher tests, Forms ML, MQ and M constructed by Taylor and Bradshaw[1]. The Battery has been widely used for educational research in Nigeria, for example, by Obeameta[2] and

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1. Taylor, A. and G.D. Bradshaw, Secondary school selection: The development of an intelligence test for use in Nigeria West African Journal of Educafion 9 (1): 6-12; Feb. 1965.

2. Obeameta, J.O., The Predictive Validity of Intelligence tests on M, ML and MQ. African Journal of Educ. Research. 1 (2): 205-211, Dec. 1974.

Balogun[1]. The predictive validity of this intelligence test battery was investigated by Obeameta who worked out correlations between scores in these tests and students' achievement results in the West African School-Certificate examination in various subjects. He, concluded that the test M, and MQ had a high predictive validity. The correlation values for Physics with test M and MQ were 0.45 and 0.72 respectively. For Chemistry the values were 0.19 and 0.67 for Biology 0.20 and 0.32. and for Mathematics 0.31 and 0.51 respectively. He blamed low values on the smallness of the sample.

Test M of the intelligence battery (See Appendix III) is a matrices test with 35 items in which the subject is required to select the item which completes a given pattern. The duration of test was 20 minutes. The second test in the battery, Test MI is a 36 item verbal ability test made up of analogies in the written form, with reasoning problems which do not involve the use of numbers. The time allowed for the test is 15 minutes. The third test MQ. is a test of numerical ability to be completed in 15 minutes, made up of reasoning problems involving the use of numbers and number series,

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1. Balogun, T.A.: Performance of some Nigerian Students in a topography of Instructional control in a Science subject. Unpublished Ed. D. Dissertation Columbia University 1976.

Obeameta recommended that the time allowed for ML & MQ should be extended to 20 minutes and this was compiled withiin the present study. Also, because of the changes in the Nigerian monetary systems and measures to the decimal, some of the numerical problems in MQ had to be modified before using it in the present study. However, the changes were minimal. All the directions laid down for the administration of the tests by the authors were strictly adhered to.

3.3.3 The Chemistry Achievement Test (See Appendix IV) was a multiple choice test compiled for the different sets of pupils under the observed chemistry teachers and to test work done during observation period in particular. The teachers were allowed to see the tests just before they were administered. They were allowed to comment and indicate which ones were unsuitable, in their estimation, and these ones were deleted. Many items were common to all the classes because there were only slight differences in the year's syllabus, although different topics were being taught as the teacher could decide on the order of arranging and teaching these topics. However, the items covered the work-done during the period of observation and during the term, in order to have enough items for the test.

3.3.4 The Teacher's Personal Information Inventory (See Appendix V) was a questionnaire designed to gather information about the qualifications and experience of the teacher, since teacher-behaviour might be affected by his mastery of the subject i.e. his qualifications, and his experience in the art of teaching it. This questionnaire was meant to obtain some information on teacher characteristics which come under intervening variables, which could not be controlled for in this type of design but may be useful in the interpretation of results.

3.3.5 The School Information Inventory (See Appendix VI) served the purpose of establishing that a school was qualified to be selected for the study according to the criteria laid down in the sampling procedure for example, the school must have at least two science laboratories and must have been offering separate science subjects at ordinary-level in the school certificate examination.

3.3.6 The questionnaire "Chemistry as a subject" in Appendix VII was used to measure the attitude of the students to the subject, while the questionnaire "My Chemistry instructor in the high school"(Appendix VIII) was used to measure the student's perception of their teacher.

3.4 The Conceptual Model of the Study

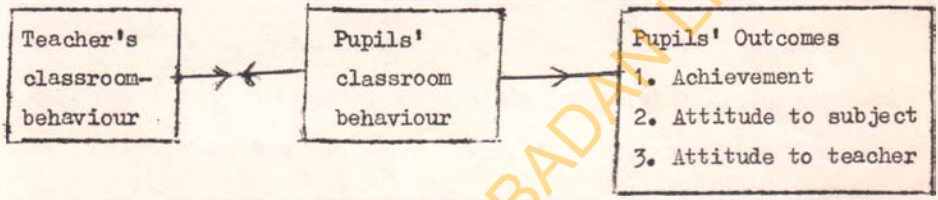
Interaction analysis provides a description of "what is" and not a description of "what ought to be". The framework of this study involves relating teacher-behaviour in the classroom to pupil cognitive and affective growth, i.e. finding the effects of teacher behaviour on pupil outcome. The study lends itself to an expost facto method, which is a descriptive approach rather than an experimental one. The conceptual model of the study is illustrated in Fig.2

The critical variables in the study are tabulated below:

INDEPENDENT VARIABLES	INTERVENING VARIABLES	DEPENDENT VARIABLES
1. Teacher Classroom behaviour	1. Intelligence 2. Aptitude in Chemistry. 3. Chemistry related activities. 4. Sex 5. School laboratory facilities etc.	1. Students' Achievement in Chemistry 2. Students' attitude to Chemistry. 3. Student's perception of the Chemistry teacher.

Fig 2

The conceptual model of the study



The teacher classroom behaviours were determined by using the observation instrument developed, and the teacher's background information was obtained from the teacher's information questionnaire.

Attempts were made to control for intervening variables by considering them in the study. For example, the intelligence of the students was taken into consideration by use of intelligence tests, and the effect of intelligence on their achievement in chemistry, if any, would be statistically investigated when establishing a relationship between the teacher behaviour and the pupil outcomes. Some of the other intervening variables were made uniform in the sampling procedure, and by considering the teachers as groups in the statistical analyses of the data.

3.5 Sampling Procedure

The study used a form of stratified sampling method. The criteria for selecting a school were as follows:-

1. The school must have at least two science laboratories, be fairly well-equipped, and must have presented pupils at ordinary-level school-certificate examinations as separate subjects, physics, chemistry and biology for three years, minimum.

2. The school must be in an urban area of Ibadan and must be at least ten years old.

3. The Principal of the school and their teachers must be willing subjects for the study, ready to submit the pupils and themselves to the conditions of the study.

Out of the (total number of) 21 schools that gave consent to help in the study, a random selection was made by picking some pieces of folded paper bearing names, from a bowl containing all the names of the schools written on pieces of paper which were folded and mixed up.

The observational technique used in this study required a team of people, but this was not possible due to lack of funds to employ co-observers, suitable to be trained for the study. Therefore, the sample had to be limited to a manageable number of ten chemistry and ten biology teachers. The schools selected were Ahmadiyya Grammar School, Eyinni High School, St. Annes' Secondary School, African Church Grammar School and Yejide Girls Grammar School, Ibadan. Only eight biology and eight chemistry teachers and their pupils completed the requirements of the comparative study for biology and chemistry teachers. Only six chemistry teachers and their pupils completed all the tests to be used in the data to study chemistry teachers in more detail.

Finally, the four schools - Ahmadiyya Grammar School, Eyinni High School, St. Anne's Secondary School and Yejide Girls' Secondary School were involved in the study. The first two schools, are co-educational whilst the last two are all girls schools. There were two biology teachers and two chemistry teachers from each school. One of the arms in form IV was selected for observation, and the criterion used was that this must be a science class, that is, one in which all the pupils were offering the three science subjects, physics, chemistry and biology. It turned out that all these pupils were also taking mathematics, as required for any science-oriented pupil. The total number of pupils involved in the study were about 300. All the pupils were in form four, and this level was chosen to ensure familiarity with separate science subjects. The fifth year students would be too busy preparing for school-certificate examinations to tolerate interruptions by the researcher. Information about the teachers and pupils are supplied in Tables 1A and 1B.

3.6 PROCEDURE

The first phase of the procedure was a period of testing. The pupils in Form IV science classes, used in the study, were given a battery of intelligence tests, ACER Forms ML, MQ and M, already

TABLE 1A

Teachers' Characteristics - Chemistry Group

Teacher No.	Sex	Age Group (years)	Qualifications	Major subjects taught	Teaching Experience (years')
1	F	21-25	W.A.E.C. N.C.E.	Chem.Physics	3
2	M	26-30	B.Sc.(Biochemistry)	Chemistry	4
3	M	21-25	B.Sc.(Biochemistry)	Chemistry	2
4	F	31-35	Diploma in Education	Chemistry Physics	8
5	M	41-45	B.Sc Dip. Ed.	Chemistry Biology	10
6	F	26-30	B.Sc Chem/Biology	Chemistry Biology	3
7	M	21-25	B.Sc - Chemistry	Chemistry	3
8	M	21-25	BSc Biochemistry	Chemistry Maths	3

TABLE 1B

Teachers' Characteristics - Biology Group

Teacher No.	Sex	Age Group (years)	Qualifications	Major subjects	Teaching Experience (years')
1	F	31-35	B.Sc. Biology Dip. Education	Biology	8
2	F	31-35	B.Sc. Botany Dip. Ed.	Biology	8
3	F	26-30	B.Sc. (Biology)	Biology	5
4	F	26-30	B. Education	Biology	4
5	F	31-35	B. Edu. (Botany)	Biology/Chem.	5
6	M	31-35	B.Ed. N.C.E.	Biology/Chem.	10
7	F	21-25	B.Sc. (Physiology)	Biology	2
8	F	36-40	B.Sc. Agric. Biology Dip. Ed	Biology	10+

described, in this order. The tests were administered to the different groups of pupils in each school by the researcher following the procedure laid down for the administration of the tests by the authors.

The pupils were also given two opinion questionnaires to fill. These ones were questionnaires titled "My High School Chemistry Instructor" and "Chemistry as a subject". They were administered by the researcher in the absence of the teachers.

In the second phase of the procedure the classroom of the teachers were observed at least twice during their teaching periods. The teaching process was recorded at three seconds intervals by recording a series of numbers representing the categories of the 18-Category system of a Modified Flanders Interaction Analysis Category - Verbal and Non-Verbal developed by the researcher. The "ground rules" established by Amidon and Flanders were followed. These rules of observation aided consistency in categorizing teacher behaviour. The rules are the following:

Rule 1: When not certain in which of two of more categories a statement belongs, choose the category that is numerically farthest from category 5.

Rule 2: If the primary tone of the teacher's behaviour has been consistently direct or inconsistently indirect do not shift into the opposite classification unless a clear indication of shift is given by the teacher.

Rule 3: The observer must not be overly concerned with his own biases or with the teacher's intent.

Rule 4: If more than one category occurs during the three-second interval then all categories used in the interval are recorded; therefore, record each change in category. If no change occurs within three seconds, repeat the category number.

Rule 5: If a silence is longer than three seconds it is recorded under category 18 (in the modified system).

The researcher received some training in the use of Flanders' system when taking a course work "Observational Techniques" under the instruction of Professor E.A. Yoloye who taught the course in the University of Ibadan, at that time.

The third phase was another period of testing. A multiple choice chemistry achievement test was given to the different groups of pupils. The items covered the topics taught during the period of observation in particular, and the rest of term that observation was done. The teachor's marks of the pupils, in the chemistry terminal examinations given by their teachers were also collected to be used in the analysis of the data.

The teachers used in the study were given the questionnaire called the "Teacher's Personal Information Inventory" to fill. This was to collect information about the teachers who were used in the study. Information about the schools used in the study was collected by filling the School's Information Inventory.

3.7 Analysis of Data

3.7.1 Computation of Data

The observational data were in form of numbers, 1, 3, 5, 6, 17, 18 etc representing the categories of the observational instrument. These figures were converted into tallies and put into a matrix according to the method used by Flanders.[1] A matrix of every lesson observed and

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1. Flanders, N.A. (1965). Teacher influence, pupil-attitudes and achievement. Cooperative research monograph No.12. Washington D.C. U.S. Government Printing Office p. 33-34.

categorised was done. There were on the whole twenty-one chemistry lessons and twenty biology lessons. If three lessons were observed and categorised for a teacher, three matrices were prepared, and percentages of time spent in each category 1 - 18 were calculated. The means of the percentages for each category was found to give an interaction pattern for each teacher. Then, for the biology and chemistry groups of teachers the means for eight sets of percentages for each of the eighteen categories were calculated. This should give the two interaction patterns for the biology and chemistry groups of teachers, in two separate sets.

A composite matrix for biology teachers was computed from twenty matrices of all their lessons by adding the number of tallies in each cell, and then finding the percentages for each cell of the eighteen by eighteen matrix. A total of 10,020 tallies made up the composite for the biology group, while in the composite matrix there were 8,300 tallies for the chemistry group. In the composite matrix the total of each column indicates the average percentage of tallies recorded for that category, and is a measure of the percentage of time teachers use a particular category. Tallies in cells 1-1, 2-2, 3-3, 4-4, 5-5, etc. indicate the number of times a category of behaviour is sustained for a period longer than three seconds, and they are called steady state cells.

All other cells indicate transitional behaviour i.e. the number of times the verbal discourse changes from one category to another; e.g. the tallies in cell 5-8 represent the number of times a category 5 is followed by category 8.

3.7.2 Tests of the hypotheses

The hypothesis number one stated that there was no significant difference between high scoring and low scoring chemistry teachers in

(a) the indirect-direct ratio (I/D)

(b) the revised indirect-direct ratio (i/d)

(c) the direct student-talk ratio (DT/ST).

Two simple statistics used for informal observation by Flander's[1] are the i/d and I/D ratios. In these ratios, i = total tallies in the categories 1 + 2 + 3 and d = total tallies in the categories 7 + 8,

1. Flanders, N.A. Interaction Analysis in the Classrooms: A manual for observers. University of Michigan. Ann Arbor 1966.

while I = 1 + 2 + 3 + 4 + 5 and D = 6 + 7 + 8. These two ratios help to visualise changes in the proportion of indirect to direct influence. The indirect-direct ratio, I/D, gives an indication of the extent to which the teacher exerts indirect and direct verbal influence. Categories 1, 2, 3 and 4 have been referred to by many authors and researchers using FIAC system as indicative of indirect teacher-influence and categories 5, 6 and 7 as direct teacher-influence. It has however been found that the utility value of I/D ratio is limited because the category 5 and 6, that is, "asking questions" and "lecturing" respectively, are used irrespective of whether the teacher is direct or indirect in his approach. A revised ratio i/d has therefore been proposed which eliminates the effects of those two categories by Amidon and Flanders[1].

The direct teacher should have i/d ratio less than one, and the indirect teacher should have i/d greater than one.

The direct student - talk ratio, DT/ST, is $\frac{6+7+8}{9+10+11}$ on the modified 18 category system developed for this study.

The I/D, i/d and DT/ST values were computed for the eight chemistry teachers, observed (See Table 2). The values obtained were used to divide the chemistry group of teachers into "high" and "low" subgroups (See Table 3A, 3B, and 3C). The means, and t-values

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1. Amidon, E.J., and Ned Flanders, Interaction analysis as a feedback. In Interaction Analysis, theory, practice and research. Amidon-Hough Ed. Addison Wesley Publishing Co. 1967 p.126-128.

were calculated for the sub-groups. This formula designed for small samples was used:

$$t = \frac{\bar{X} - \bar{Y}}{\sqrt{\left(\frac{\Sigma x^2 + \Sigma y^2}{n_x + n_y - 2}\right)\left(\frac{n_x + n_y}{n_z \cdot n_y}\right)}}$$

where $\bar{X}$, $\bar{Y}$ are the sample means, n_x and n_y the number of cases in each sample, x and y are deviations of the individual scores from the means of their respective samples; degrees of freedom, d.f. = $n_x + n_y - 2$. The resulting t-value were looked up in Fisher's Table of t[1] for tests of significance for small samples. Significant differences between the groups stated in the hypothesis were tested at 0.05 level.

The hypothesis, number two, stated that there was no significant relationship between teacher verbal-behaviour (i.e. teacher style in terms of indirect-direct, influence, etc) and pupil outcomes in chemistry.

Teacher verbal behaviours were computed in terms of indirect-direct ratio, whether high or low, revised indirect ratio, and direct student-talk ratio. These ones were the independent variables, whereas the chemistry achievement test scores, teacher's chemistry examination scores,

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1. Fisher, R.A., Statistical Methods for Research Workers, published by Oliver and Boyd, Edinburgh, 1970.

attitude to chemistry, students perception of the chemistry teacher were the dependent variables.

Multiple regression analysis was computed for each of the dependent variable and the three independent variables, I/D, i/d and DT/ST.

Intercorrelations were found between all the independent and dependent variables.

In order to investigate the effect of intervening variables e.g. intelligence, the scores of the intelligence tests were correlated with outcomes, i.e. the dependent variables namely achievement tests scores, and attitude questionnaire scores.

The hypothesis, number three, stated that there was no significant difference in the amount of time spent in each of the eighteen categories of the observation instrument used between chemistry and biology teachers. To test this hypothesis the following computation was done.

1. The average percentage of tallies for the eight chemistry teachers for each of the eighteen categories were computed, and recorded in Table 20. A similar computation for the eight biology teachers was done and recorded in Table 20.

2. Means, standard deviation and t-value were computed for each of the eighteen categories, and recorded in Table 20.

The hypothesis, number 4, stated that there was no significant difference between chemistry and biology teachers in their total interaction patterns using the 18-category observational instrument. This hypothesis was tested by using the Darwin's[1] chi-square test suggested by Dr John H. Darwin (a statistician) to Flanders[2] to compare the composite matrices of the chemistry and biology groups. (See Appendices IX and X.) Chi-square was computed and tested for significance at 0.05 level.

3.8. Reliability of the 18-category observation instrument

The modified Flanders' observation instrument with eighteen categories which was designed for this study was tested for reliability by using it to observe some chemistry and biology

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1. Darwin, J.H. Note on the comparison of several realizations of a Markoff chain. Biometrika, 1959, 46, p.412-419.

2. Flanders, N.A. Interaction Analysis in the Classroom: A manual for observers. University of Michigan Ann Arber. 1966. p.35-39.

lessons with trained co-observer, who was a graduate in chemistry, biology and education.

The percentage tallies in each category was calculated for each observed lesson, and the Pearson product-moment correlation coefficients were worked out between the data of the researcher and the co-observer. The correlation coefficients obtained for a chemistry teacher for two lessons observed at the same time by the researcher and co-observer were 0.99 and 0.98. The correlation coefficients for two lessons of a biology teacher were 0.98 and 0.99. The results show that the instrument has a high inter-rater reliability.

Moreover, the researcher got a correlation coefficient of 0.99 for two sets of data for two chemistry lessons of a chemistry teacher, and 0.98 for two biology lessons of a biology teacher, while the co-observer had co-efficients of 0.97 and 0.96 for the same chemistry lessons and biology lessons above, from her own observation-data. These results show that the teachers under observation were consistent in their teaching behaviours.

CHAPTER FOUR

THE RESULTS

4.1 The data collected

The data collected from the use of the 18-category Classroom Observation Instrument, the administration of various tests and questionnaires already described in Chapter 3 were the following:-

(a) Average percentage tallies indicating the percentage of time spent in each category of the observation instrument for each of eight chemistry and eight biology teachers. These ones were computed from the matrices of all the lessons observed for each teacher. (Appendices 11 and 12). (b) From (a) above, the average percentages of time spent by the chemistry group of teachers in each category of the observation instrument were calculated and tabulated. A similar set of data was computed for the biology group teachers. (Table 20).

(c) From (b) above, the means, standard deviations and t-values were computed from the average percentage tallies for the chemistry and biology groups. (Table 20)

(d) From (a) the indirect-direct ratio, i/d, as well as the direct student-talk ratio, DT/ST ratio, were calculated for each lesson and then the average for each teacher (Table 2).

(e) A composite 18 X 18 matrix was computed by adding all the tallies in each cell of the matrices for eight chemistry teachers and then working out their percentages.

A similar composite matrix was computed for eight biology teachers. (Appendices 9 & 10).

(f) Scores of the pupil's performance in the intelligence test-battery were listed for six classes of pupils of six chemistry teachers who completed all the tests. (Appendix 13)

(g) Scores were listed representing pupils' opinion from the two questionnaires called "My high school Chemistry instructor" and "Chemistry as a subject". These ones were for the classes and teachers in (f) above. (Appendix 13)

(h) Chemistry achievement test scores from the objective test given to the six classes of chemistry pupils were listed. (Appendix 13).

(i) The marks obtained by the pupils in the end of term chemistry test given to pupils by their teachers were also listed. (Appendix 13).

(j) A table compiling the data obtained from the questionnaire called "Teacher's personal information inventory" was made, to show the characteristics of the teachers who were used in the study. (Table 1A and Table 1B).

4.2 Differences in the teaching behaviour of chemistry teachers

The hypothesis number one stated that there was no significant difference between high scoring teachers in (a) the indirect-direct ratio, (b) the revised indirect-direct ratio and (c) the direct teacher-talk student-talk ratio.

From the average percentage of time spent in each of the categories 1 to 18 by each of the chemistry teachers (Appendix 11) the indirect-direct ratio, the revised indirect-direct ratio and the direct student-talk ratio of each chemistry teacher were calculated and tabulated in Table 2. In Table 3A, 3B and 3C these chemistry teachers were placed in the two groups based on the values of their ratios (high and low ratio-values). The means and t-values were calculated as shown in the tables. Table 3A shows that there is significant difference between the teachers with high and low revised indirect-direct ratios at $p = 0.05$ level, thus leading to the rejection of the null hypothesis. Tables 3B and 3C also show significant t-values at $p = 0.05$ level for the indirect-direct ratios and the direct student-talk ratio. The null hypothesis was rejected at $p = 0.05$ level. Therefore, there was significant difference in the teaching styles of the sub-groups of chemistry teachers as regards I/D, i/d and DT/ST ratios.

4.3 Relationship between teacher verbal behaviour and pupil outcomes in chemistry

The second hypothesis stated that there was no significant relationship between teacher verbal-behaviour and pupil outcomes in chemistry.

The second hypothesis related teacher verbal-behaviour in terms of indirect-direct influence to the learning outcomes in terms of pupils' achievement in Chemistry, attitudes towards the subject, and attitude towards their instructors.

TABLE 2

The I/D, i/d and DT/ST ratios of Chemistry teachers

Teacher Number	I/D	i/d	DT/ST
1	0.14	0.40+	58.90
2	0.60	2.21*	3.30
3	0.11	0.21+	23.19
4	0.22	1.28*	6.36
5	0.53	0.93+	2.03
6	0.16	0.92+	6.41
7	0.09	5.00*	15.81
8	0.04	0.25+	42.72

* Indirect teachers have i/d > 1

\+ Direct teachers have i/d < 1

TABLE 3A

A comparison of two groups of Chemistry teachers on i/d ratios

Teacher Number	i/d Ratio	Mean	t-value
2	2.21		
4	1.28	2.83	
7	5.00		
			2.71*
11	0.40		
3	0.21		
5	0.93	0.54	
6	0.92		
8	0.25		

TABLE 3B

A comparison of two groups of Chemistry teachers on I/D ratios

Teacher Number	I/D Ratio	Mean	t-value
2	0.60		
4	0.22	0.45	
5	0.53		
			3.78*
1	0.14		
3	0.11		
6	0.16	0.11	
7	0.085		
8	0.037		

* significant at p = 0.05 level

TABLE 3C

Comparison of the Groups of Chemistry Teachers on DT/ST Ratio

Teacher No.	DT/ST	Mean	t-value
1	58.90		
3	23.19	35.15	
7	15.81		
8	42.72		t = 3.13*
2	3.30		
4	6.36		
5	2.03	4.52	
6	6.41		

* Significant at p ≤ 0.05 level.

Since complete data were obtained for the classes of six of the chemistry teachers, only these ones could be used for the analysis.

In testing the second hypothesis, two sets of variables were identified:-

(1) The independent variables establishing teacher verbal-behaviour, namely the indirect-direct ratio (I/D), the revised indirect-direct ratio, (i/d), and the direct teacher-talk to student-talk ratio, (DT/ST).

(2) The dependent variables measuring student cognitive and affective outcomes are namely, attitude to chemistry, attitude to chemistry teachers and chemistry achievement.

Table 11 gives the means of scores of dependent variables of chemistry teachers and their pupils, wherein the indirect teachers, numbers two and four, score higher in the chemistry achievement test and the teachers chemistry test. Table 12 gives the means of the scores of independent variables of chemistry teachers and their pupils. Indirect influence teachers have i/d values greater than 1 and higher ratios of I/D, as shown for teachers no 2 and no 4. Lower values of DT/ST means more student-participation.

Table 13 gives the intercorrelation coefficients between the independent and dependent variables. It is seen that i/d, correlated significantly with chemistry achievement, but had low correlation with the other two dependent variables. I/D has negative correlation with attitude of students to chemistry, but a positive correlation with chemistry achievement although a lower

TABLE 4

Intercorrelation between all test scores for each teacher's class

Chemistry Teacher No. 1

	ML	MQ	M	Attitude Chem.	Attitude to Teacher	Chem. Ach. Test	Teacher's Test	ML +MQ +M
ML	1.00	0.61*	0.24	0.22	0.32	0.36*	0.46*	0.60*
MQ		1.00	0.57*	0.36*	0.41*	0.51*	0.67*	0.89*
M			1.00	0.30	0.19	0.098	0.14	0.87*
Attitude to Chemistry				1.00	0.71*	0.38*	0.27	0.35*
Attitude to Teacher					1.00	0.51*	0.49*	0.35*
Chemistry Ach. Test						1.00	0.75*	0.35*
Teacher's Chem. Test							1.00	0.46*
ML+MQ+M								1.00

n = 37

*value greater than +0.3246, significant p = .05

TABLE 5

Intercorrelation between all tests' scores

Chemistry Teacher No. 2

	ML	MQ	M	Attitude to Chem	Attitude to Teacher	Chem. Ach. Test	Teacher's Chemistry Test	ML +MQ +M
ML	1.00	0.39*	0.09	-0.23	-0.37	0.28	0.29	0.65*
MQ		1.00	0.25	0.05	-0.65	0.23	0.19	0.79*
M			1.00	0.24	0.26	0.32	0.16	0.67*
Attitude to Chemistry				1.00	*0.41	0.12	0.15	0.05
Attitude to Teacher					1.00	0.07	-0.03	-0.05
Chemistry Ach. Test						1.00*	-0.69*	0.39
Chemistry Teacher's Test							1.00	0.29
ML+MQ+M								1.00

n = 35

* value greater than +0.3496 are significant of p = 0.05.

TABLE 6

Intercorrelations between all test scores

Chemistry Teacher No.3

	ML	MQ	M	Atti-tude to Chem.	Att.to Teacher	Chem. Ach. Test	Teacher's Test	ML +MQ +M*
ML	1.00	-0.01	0.15	0.40	0.28	0.15	-0.05	0.38*
MQ		1.00	0.23	0.02	0.06	-0.13	-0.03	0.71*
M			1.00	0.07	-0.00	-0.04	-0.15	0.79*
Attitude to Chemistry				1.00	0.64*	-0.03	-0.17	0.17
Attitude to Teacher					1.00	0.08	-0.32	0.12
Chemistry Achievement Test						1.00	0.16	-0.05
Teacher's Chemistry Test							1.00	-0.09
ML+MQ+M								1.00

n = 30

* values greater than +0.3809 significant at p = 0.05

TABLE 7

Intercorrelations between all test scores

Chemistry Teacher No.4

	ML	MQ	M	Attitude to Chem	Attitude to Teacher	Chem. Ach.	Teacher's Test	ML +MQ +M
ML	1.00	0.17	0.10	0.48*	0.42*	0.13	0.41	0.57*
MQ		1.00	0.38	0.13	0.15	0.25	0.26	0.85
M			1.00	-0.01	0.03	0.32	0.16	0.62*
Attitude to Chemistry				1.00	0.33	*0.42	-0.53	0.29
Attitude to Teacher					1.00	0.25	0.42	0.28
Chemistry Achievement Test						1.00	0.70*	0.32
Teacher's Chemistry Test							1.00	0.40
ML+MQ+M								1.00

n = 26

* Values greater than 0.4227 are significant at p = 0.05

TABLE 8

Intercorrelation between all test scores

Chemistry Teacher No.5

	ML	MQ	M	Atti-tude to Chem.	Atti-tude to Teacher	Chem. Ach. Test	Teacher's Test	ML +MQ +M
ML	1.00	0.50*	0.20	0.08	0.28	0.01	0.30	*0.72
MQ		1.00	0.45*	-0.03	-0.01	-0.01	0.27	0.89*
M			1.00	-0.10	-0.02	-0.01	0.03	-0.02
Attitude to Chemistry				1.00	0.40*	0.42*	0.48*	-0.02
Attitude to Teacher					1.00	0.05	0.11	-0.11
Chemistry Ach.Test						1.00	0.65*	-0.01
Teacher's Chemistry Test							1.00	0.27
ML+MQ+M								1.00

n = 29

* Values greater than 0.3809 are significant at p = 0.05

TABLE 9

Intercorrelations between all that scores

Chemistry Teacher No. 6

	ML	MQ	M	Attitude to Chem	Attitude to Teacher	Chem. Ach. Test	Teacher's Test	ML +MQ +M
ML	1.00	0.47*	0.53*	-0.13	0.01	0.01	0.56*	0.78*
MQ		1.00	0.64*	0.10	0.00	-0.05	0.15	0.86*
M			1.00	0.23	0.04	-0.24	0.19	0.86*
Attitude to Chemistry				1.00	0.62*	0.03	0.24	0.00
Attitude to Teacher					1.00	0.15	0.28	0.02
Chemistry Ach. Test						1.00	0.27	-0.10
Teacher's Chemistry Test							1.00	0.31
ML+MQ+M								1.00

n = 24

* Values greater than +0.4227 are significant at p = 0.05

TABLE 10

Intercorrelations between all test scores for all the Chemistry classes combined

	ML	MQ	M	Atti-tude to Chem.	Atti-tude to Teacher	Chem. Ach Test	Teacher's Chemistry Test	ML +MQ +M
ML	1.00	0.41*	0.33*	0.09	-0.08	0.23*	0.29*	0.57*
MQ		1.00	0.49*	0.16	0.04	0.31*	0.32*	0.76*
M			1.00	0.17	0.05	0.17	0.13	0.67*
Attitude to Chemistry				1.00	*0.49	0.25*	0.16	0.13
Attitude to Teacher					1.00	0.11	0.13	-0.03
Chemistry Achievement Test						1.00	0.50*	0.29*
Teacher's Chemistry Test							1.00	0.36*
ML+MQ+M								1.00

n = 181

Values greater than +0.1946 are significant at p = 0.05

value than for i/d. DT/ST has a significant correlation with attitude of pupils to teacher but negative correlation with the other two dependent variables.

Table 14 gives the correlation coefficients between some intervening variables and the dependent variables.

Table 15A gives the means of the scores of the tests and questionnaires given to the pupils, and their standard deviations. Some of these ones constitute the dependent variables namely chemistry achievement, pupils' attitude to chemistry subject, and pupils attitude to chemistry teacher. Table 15B shows the means of the scores of the independent variables as well as dependent variables, and their standard deviations. These data in Table 15B were used in computing stepwise multiple regression analysis to determine the linear relationships between the independent and dependent variables and to find the contributions of the independent variables to outcomes.

Table 17, 18 and 19 give the results of this regression analysis. Table 17 shows that the revised indirect-direct ratio, i/d, contributes most, by 61% out of 78% contribution by the three independent variables, to chemistry achievement test results. Similarly in Table 18, i/d contributes 68.3% out of the total contribution of 79.5% to attitude to chemistry subject. It also shows that I/D and DT/ST both correlated negatively with attitude to chemistry subject. Table 19 shows that i/d contributes most to attitude of pupils to chemistry teachers with 18.8% out of 37.8%

contribution, closely followed by DT/ST with 18.4%.

On the whole, the revised indirect-direct ratio i.e. teacher's indirect influence contributed most to the cognitive and affective outcomes of pupil learning during teacher-pupil interaction. The direct teacher-talk to student talk ratio, DT/ST, contributed appreciably to attitude of the pupils to chemistry teachers. However i/d and I/D both measure indirectness of the teacher although by deleting category 6, which records lecturing, the indirectness of the teacher is better measured by the revised ratio, i/d.

4.4 Comparison of the teaching behaviour of chemistry and biology teachers

The hypothesis number three states that there is no significant difference between chemistry and biology teachers in the amount of time spent in each of the eighteen categories of the observation instrument used.

Hypothesis number three involves comparing the interaction patterns of chemistry group of teachers with biology group of teachers, whether there would be significant difference in the amount of time spent in each of the eighteen categories. Table 20 gives the interaction profiles of the chemistry and biology groups and these profiles are compared in Fig. 3.

Table 20 shows a comparison of the interaction profiles of the chemistry and biology groups of teachers. It records the average percentage-tallies for each category and the standard devitations

for each group. The values were compared category by category by means of t-tests. The t-values obtained were tested at p = 0.05 level of significance. The two-tail test showed that t-values for categories 2, 5 and 7 were significant at p = 0.05 level. For the other categories the hypothesis could not be rejected as indicated by the t-values. Thus, there was no significant difference in those categories in the amount of time spent by the chemistry and biology teachers.

The categories that were significantly different were the following:-

(a) Category 2, which records "praises and encouraging of pupils" by the teacher. The chemistry group spent 0.03% of the time on this while the biology groups spent more, 0.24%

(b) Category 5 which records "responses to pupils questions". The chemistry group spent more time here, 1.03% while the biology group spent 0.41%.

(c) Category 7 which records "Giving directions". The biology group spent 4.65% on this while the chemistry teachers spent 2.19% of their time on this.

The biology teachers spent more time in categories 2 and 7, which means that these teachers praised and encouraged the pupils more, and gave more directions to them than the chemistry teachers. The chemistry teachers, however, responded more to pupils' questions than the biology group.

Table 21 shows the percentages of time spent in non-verbal categories by the teachers and students of chemistry and biology in their classrooms. Although Table 20 shows that the individual categories 12 to 17 were not significantly different, these results show that non-verbal behaviour takes up a considerable portion of class time.

Table 22 compares the percentage of time spent in non-verbal categories by chemistry teachers during teaching periods and during practical lessons. It shows that a range of 8.79% to 16.64% of time is spent in non-verbal behaviour during the teaching periods and 27.15% to 36.16% time is spent during practical periods in the non-verbal categories. In his study, Parakh[1] found an average result of 8% of total time during lectures and 37% during laboratory peiods in biology classes. He concluded that the basic assumption underlying the Flanders' category system and other verbal interaction system that the verbal behaviour is an adequate representation of total classroom behaviour was not tenable during laboratory classes. However, Flanders did not consider non-verbal behaviour in his analysis.

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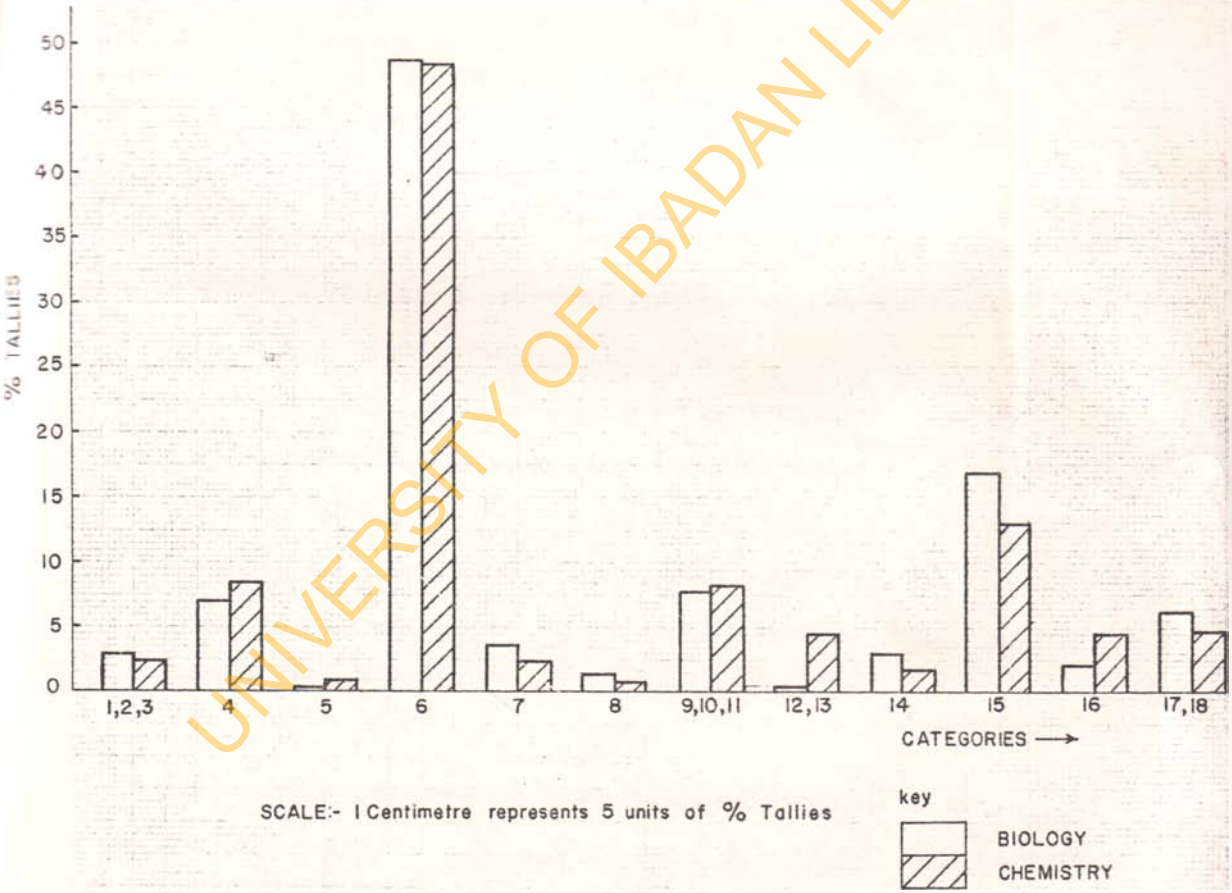
1. Parakh, J.S., A study of teacher-pupil interaction in high school biology classes. Dissertation Abstracts 26. p2561A, 1965.

FIG. 3

INTERACTION PROFILES OF BIOLOGY AND CHEMISTRY TEACHERS



SCALE:- 1 Centimetre represents 5 units of % Tallies

4.5 Comparison of interaction patterns of chemistry and biology teachers

The hypothesis number four states that there is no significant difference between chemistry and biology teachers in their total interaction patterns, using the 18-category observational instrument.

The hypothesis number four compared the total interaction pattern of the chemistry group to that of the biology group, instead of the category to category basis in the third hypothesis. This required computing a composite matrix of each group by adding up for each cell of the 18 x 18 matrix all the tallies in the matrices of all the lessons observed. The two composite matrices are in Appendix 9 and Appendix 10, and the figures are percentages of the total numbers of tallies for each group. A Darwin's chi-square test was calculated for a test of significance.

The Darwin's chi-square gave a value of 20.40 from computer analysis. From the chi-square tables, p lies between 0.10 and 0.95*, therefore, there is no reason to reject the hypothesis. The Darwin's chi-square was converted to a standard score "z" since chi-square approaches a normal distribution for higher degrees of freedom. Using the formula:

$$z = \sqrt{2X^2} - \sqrt{2n - 1}$$

where $n = s(s - 1)$, where s is the number of categories. For 18 x 18 matrices, $n = 306$, $X^2 = 20.40$, and $z = -18.33$. When $z = 2.58$

*Fisher's Table of X^2

or larger, the null hypothesis is rejected at 0.01 level of significance. Therefore the null hypothesis cannot be rejected at p = 0.01 level for a two-tailed test.

It is therefore found that there is no significant difference between the total interaction patterns of the chemistry and biology groups.

4.6 The contribution of the intervening variable intelligence to chemistry achievement and other learning outcomes

The pupils used in the study could not be controlled for intelligence from school to school and so the effect of this intervening variable on the results of the chemistry achievement scores and the other outcomes was investigated by carrying out correlational analysis and stepwise multiple regression analysis between the scores of the tests in the intelligence test battery MQ, ML, and M and the scores of the chemistry achievement test and attitude questionnaires.

Tables 4 to 9 show the results of intercorrelations between the test-scores and the questionnaire-scores obtained for the chemistry classes. (See appendix 13). Table 10 gives a combined result for all the six classes. From the Tables 4 to 9 showing results of interrelations, teachers 1, 2 and 4 have the results that intelligence measured by the tests ML, MQ and M correlates positively

and significantly at 5% level with chemistry achievement test scores. In the case of teachers, 3, 5 and 6, intelligence test scores correlated negatively with achievement and values of correlation coefficients obtained were not significant at 5% level. However the results in Table 10 showing intercorrelation coefficients of the combined scores of the six chemistry teachers showed that intelligence test scores correlated positively and significantly at 5% level with chemistry achievement. Intelligence test-scores did not correlated significantly with the other learning outcomes namely attitude to the chemistry teacher (see Tables 5 to 10) except in the case of one of the teachers (see Table 4).

Table 14 gives the correlation coefficients between some intervening variables and the dependant variables. Intelligence correlated significantly with chemistry achievement. The ages of the teachers have negative correlation with attitudes of pupils to chemistry and to the chemistry teacher, but correlated significantly at 5% level with the scores of their own tests. Experience of the teachers, which is obviously related to their ages shows similar results.

Table 16 shows the contributions of intelligence of the pupils to chemistry achievement. The results in this table were obtained from a stepwise multiple regression analysis using the means of the scores of the different tests ML, MQ and M which formed the intelligence test-battery and the achievement test-soores (see Table 15A). As shown

in Table 16 the quantitative test-MQ and the verbal test ML have positive correlation with Chemistry achievement test, and the values of the coefficients are significant at 5% level. Only MQ has appreciable positive contribution of 9.6% out of a total contribution of 10.9% to chemistry achievement. ML has a mere 1.1% contribution while intelligence measured by the sum of the scores of ML, MQ and M has a mere 0.2% contribution. In this study the classes chosen were science classes, all offering mathematics, and this was assumed to take care of the effect of this intervening variable by providing some uniformity.

TABLE 11

Means of scores of dependant variables of Chemistry teachers and their pupils

Teacher Number	Dependent Variables							
	Chemistry Achievement Test		Attitude to Chemistry		Attitude to Chemistry Teacher		Teacher's Chemistry Test	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
1	38.67	15.43	25.22	10.69	20.70	3.39	38.19	24.39
2*	49.37+	13.58	26.91	7.17	21.11	8.07	40.66	13.76
3	30.47	9.45	25.50	11.79	20.53	8.75	40.10	14.05
4*	50.31+	15.35	26.31	7.39	19.12	7.33	47.72	17.48
5	39.59	13.02	22.48	11.93	14.52	9.83	51.55	31.58
6	48.67	12.35	28.50	11.81	10.17	16.61	38.58	11.71

+* Indirect method teachers score highest on the Chemistry achievement test.

TABLE 12

Means of scores of independent variables of Chemistry teachers and their pupils

Teacher Number	Independent Variables		
	Indirect - direct ratio (I/D)	Revised indirect-direct radio (i/d)	Direct student - talk ratio (DT/ST)
1	0.14	0.40	58.90
2*	0.60	2.21	3.30
3	0.11	0.21	23.19
4*	0.22	1.28	6.36
5	0.53	0.93	2.03
6	0.16	0.94	6.41

* Indirect teachers have i/d > 1

TABLE 13

Correlation coefficients between independent and dependent variables

Independent Variables	Dependent Variables			
	Attitude to Chemistry	Attitude to Chemistry Teachers	Chemistry Achievement Test	Teacher's Chemistry Test
I/D	-0.33	0.04	0.33	0.48*
i/d	0.29	0.08	0.78*	0.17
DT/ST	-0.10	0.43*	-0.49	-0.53

*Significant of p = 0.05 level.

TABLE 14

Correlation coefficients between intervening variables and dependent variables

Intervening Variables	Dependent Variables			
	Attitude to Chemistry	Attitude to Chemistry Teacher	Chemistry Achievement Test	Teacher's Chemistry Test
Intelligence test scores	0.13	-0.03	0.29	0.36
Ages of Teachers	-0.71	-0.18	0.14	0.96*
Experience of Teachers	-0.61	-0.20	0.26	0.97*

* Significant at p = 0.05 level.

TABLE 15 (A)

Means of score of tests and questionnaires of all the Chemistry teachers

Variable	Means of Scores	Standard Deviation
ML	9.49	1.69
MQ	12.61	2.23
M	23.95	2.23
Attitude to Chemistry	25.82	2.00
Attitude to Chemistry Teacher	17.69	4.42
Chemistry Achievement Test	42.84	7.92
Teachers Test	42.80	5.51
ML + MQ + M	46.04	5.95

TABLE 15B

Means of the dependent and independent variables of all the Chemistry teachers combined

	Variable	Mean	Standard Deviation
Dependent Variables	Chemistry Achievement Test	42.82	7.92
	Attitude to Chemistry	25.83	2.00
	Attitude to Teachers	17.69	4.41
Independent Variables	I/D	0.29	0.21
	i/d	0.99	0.71
	DT/ST	16.69	22.05

TABLE 16

Contribution of intelligence of pupils to Chemistry achievement

Intervening Variables	Multiple R	R Square	RSQ Change	Simple R	% Contribution
MQ (Quantitative) Test	0.3095	0.0958	0.0958	0.3095	9.6%
ML (Language) Test	0.3294	0.1072	0.0114	0.2243	1.1%
ML+MQ+M (Combined Scores)	0.3304	0.1091	0.0029	0.2908	0.2%
M (Matrix test)	0.3311	0.1096	0.0005	0.1728	0.05%

n = 181

Values greater than 0.1946 are significant at P = 0.05

TABLE 17

Contribution of independent Variables to chemistry achievement

Independent Variables	Multiple R	R Square	RSQ Change	Simple R	Percentage Contribution
Revised Indirect - Direct Ratio(i/d)	0.7811	0.6103	0.6103	0.7812	61%
Indirect Direct Ratio (I/D)	0.8812	0.7764	0.1661	0.3295	16%
Direct Student-talk Ratio (DT/ST)	0.8871	0.7869	0.0105	-0.4968	1%

TABLE 18

Contribution of independent variables to attitude to chemistry

Independent Variables	Multiple R	R Square	RSQ Change	Simple R	Percentage Contribution
I/D	0.3294	0.1085	0.108	-0.3294	10.8%
i/d	0.8899	0.7926	0.6835	0.2863	68.3%
DT/ST	0.8921	0.7958	0.0038	-0.1026	0.4%

TABLE 19

Contribution of independent variables to attitude to teacher

Independent Variables	Multiple R	R Square	RSQ Change	Simple R	Percentage Contribution
Direct Student-talk (DT/ST)	0.4288	0.1839	0.1839	0.4288	18.4%
Revised Indirect direct ratio (i/d)	0.6094	0.3714	0.1875	0.0835	18.7%
Direct-Indirect ratio (I/D)	0.6179	0.3779	0.0065	0.0452	0.7%

TABLE 20

A comparison of the chemistry and biology groups of teachers on the percentage tallies in each of the 18 categories

Category	Sample	Percentage Tallies	Standard Deviation	t - value
1	Chemistry	0.019	0.05	1.91
	Biology	0.16	0.19	
2.	Chemistry	0.039	0.11	2.50*
	Biology	0.24	0.30	
3.	Chemistry	2.11	1.54	1.02
	Biology	2.95	1.86	
4.	Chemistry	7.09	5.42	0.59
	Biology	8.41	3.71	
5.	Chemistry	1.03	0.57	-2.64*
	Biology	0.41	0.59	
6	Chemistry	52.94	17.92	-1.46
	Biology	44.18	14.10	
7	Chemistry	2.19	1.17	2.44*
	Biology	4.65	2.59	
8	Chemistry	0.84	0.57	1.86
	Biology	2.11	2.00	
9	Chemistry	6.48	4.31	0.76
	Biology	8.13	4.14	
10	Chemistry	0.53	1.04	-1.04
	Biology	0.36	0 .64	
11	Chemistry	0.87	0.73	-1.71
	Biology	0.41	0.65	
12	Chemistry	0.38	0.11	1.27
	Biology	0.11	0.26	
13	Chemistry	2.42	4.43	-0.98
	Biology	0.69	1.73	
14	Chemistry	2.69	5.50	0.28
	Biology	3.35	5.92	
15	Chemistry	19.89	6.38	0.66
	Biology	14.28	7.01	
16	Chemistry	4.03	5.38	-0.17
	Biology	3.55	6.27	
17	Chemistry	3.81	2.24	1.73
	Biology	6.36	3.63	
18	Chemistry	0.03	0.078	-99.00
	Biology	0	0	

*Significant at p=0.05 level

TABLE 21

Percentage of time spent in non-verbal categories in Chemistry and Biology classes compared

Student's non-verbal behaviour Categories 12, 13 & 14		Teachers' non-verbal behaviour categories 15 & 16		Non-functional behaviour categories 17 & 18	
Chemistry	Biology	Chemistry	Biology	Chemistry	Biology
5.49%	4.15%	23.92%	17.80%	3.84%	6.36%

TABLE 22

Percentage of time spent by Chemistry teachers in non-verbal categories 15 and 16

Teacher Number	% Time spent during teaching periods	% Time spent during practical periods
1	16.64	-
2	11.10	-
3	16.67	28.36
4	14.66	27.15
5	14.56	36.16
6	8.79	-

CHAPTER FIVE

DISCUSSION

Introduction

The purpose of this study was to investigate the patterns of teaching behaviours of chemistry teachers in some secondary schools. The modified Flanders' Interaction Analysis Categories, an 18-category observation instrument developed by the researcher was used to observe some secondary school chemistry and biology teachers in the same schools.

The chemistry teachers were studied in greater detail for within group differences as regards indirect and direct styles of teaching. The effects of their styles on learning outcomes of the pupils were investigated. Also a comparison was made between teaching profiles of chemistry and biology from the data obtained from the use of the observation instrument.

Four hypothesis were tested in order to achieve the purpose of the study, and the results are summarised below:-

The first hypothesis stated that there was no significant difference between high scoring and low scoring teachers in

(a) the indirect-direct ratio
(b) the revised indirect-direct ratio
(c) the direct teacher-talk to student-talk ratio.

The result of the test of the hypothesis was a rejection of the null hypothesis at p = 0.05 level of significance, which meant that there was significant difference in the teaching behaviour of the chemistry teachers when grouped according to the values of those ratios in the hypothesis.

2. The second hypothesis stated that there was no significant relationship between teacher verbal-behaviour and pupil-outcomes in chemistry. From the first hypothesis three types of verbal behaviour were identified. These ones were the indirect verbal-behaviour, direct verbal-behaviour and behaviour that made for greater student participation (i.e. high i/d or I/D, low i/d or I/D and high or low DT/ST ratios).

There was a positive and significant correlation between i/d and chemistry achievement scores, therefore, the indirect influence contributed to chemistry achievement. Also indirect influence has a positive attitude to chemistry subject. The participation of the pupils contributed to attitude of the pupils to chemistry teachers but gave no contribution to chemistry achievement and attitude of pupils to chemistry.

3. The third hypothesis stated that there was no significant difference between chemistry and biology teachers in the amount of time spent in each of the eighteen categories of the observation instrument. The result of t-test between the means of percentage-time spent in each category by the chemistry and biology groups

showed that there was no significant difference in each of the eighteen categories except categories 2, 5, and 7 which involved "praising and encouraging pupils", "responses to pupils questions" and "giving directions" respectively.

4. The fourth hypothesis stated that there was no significant difference between chemistry and biology teachers in their total interaction patterns using the 18-category observation instrument. This involved subjecting the two composite matrices of the chemistry and biology groups of teachers to a Darwin's chi-square test which made a cell by cell comparison of the two composite matrices. The result was that there was no significant difference between the total interaction patterns of the chemistry and biology groups.

The discussion of the results and findings will be done under the following headings:-

1. The teaching behaviours of the chemistry teachers.
2. The comparison of the teaching behaviours of the chemistry and biology teachers.
3. The dominant items of the teacher verbal and non-verbal behaviour in chemistry classes.
4. Teacher style and pupil-achievement in chemistry.
5. Teacher-style and pupil's attitude to chemistry teachers and chemistry subject.
6. Relevance of the results to science education.

5.1 The teaching behaviours of the chemistry teachers

The results of the tests hypothesis one showed the teaching behaviours of the chemistry teachers singly and in groups. Two groups were identified. The teachers with indirect influence on the pupils scored i/d ratio > 1, while those with direct-influence had i/d < 1 and also DT/ST values having high numerical values, for more direct teacher behaviour. (see Tables 3A, 3B, 3C). Pankratz[1] in a study of verbal interaction of ten selected 12th grade physics teachers also found that they fell into two groups from their i/d ratios, and the groups were found to be significantly different at $p = 0.01$ level by means of t-tests. Also, Houston[2] using FIAC identified three teaching styles namely direct, indirect and intermediate among physics teachers.

Apart from the test of the hypothesis, differences between the chemistry teachers were examined by referring to appendix XI which gives the teaching profiles of the teachers. Only one chemistry teacher made use of category one which involved acceptance, clarification and recognition of pupils emotional state. A similar

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1. Pankratz, Roger, Verbal interaction patterns in the classroom of selected physics teachers. In Interaction Analysis: Theory, research and application. Amidon-Hough eds Addison - Wesley Pub. Co. 189 - 209, 1967.

2. Houston, J. The effects of verbal styles on physics teaching Physics Education. 1975, 10, (1) p38 - 41.

result was shown for category two which involved teacher praise and reward. On the whole the chemistry teachers did not seem to create integrative emotional climate in their classrooms.

In the case of category three which involves accepting and using pupils ideas, the "indirect" teachers 2,4, and 7 used this category more than the others with more "direct" influence. Similarly, category four which involved asking questions was used more by the indirect teachers 2, 4, and 7 than the direct method teachers. The use of category five "teacher questioning" was generally low, with a range of 0.31% to 1.93% of the total time.

The use of categories one to five should result in more direct behaviour by teachers. Nuthall[1] reported a positive correlation between teacher-praise and student achievement, and Hughes[2] found that students achieved more if teachers merely gave them a lot of acceptance such as nodding approval, or writing student's correct response to question on the blackboard. Category five which involves questioning eliciting student's response is an important teaching skill apart from contributing to indirect influence. Flanders[3] reported significant

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1. Nuthall, G.A., A review of some selected recent studies of classroom interaction and teaching behaviour. In Classroom Observation, American Research Monograph No 4 Chicago. Rand McNally 1970.

2. Hughes, D.C. An experimental investigation of the effects of pupils responding and teacher reacting on pupil-achievement. American Research Journal 10(1) :21-37. 1973.

3. Flanders, Ned ... Op cit.

positive relationsip between amount of teacher questioning and attitude to teacher and school. Nuthall also found that the tendency to ask one question at a time (which is more usual), correlated positively with student achievement.

In category six which involves lecturing, teachers 2 and 5 out of the thrree in the indirect group had the smallest percentages of time-spent, while three out of five of the direct group spent more time lecturing, with one value as high as 83.69% of the total time, resulting in a low I/D ratio.

Categories 7 and 8, "giving directions" and criticizing and justifying authority" were not heavily used generally which is commendable as these ones would have increased direct verbal influence.

In category 9 which involves pupils' response to teachers' questions, teachers 2, 4, 5, 6, 7 had more response-time to questions. On the whole, from the percentages recorded, the pupils seemed alert to teacher's questioning which is a measure of their participation. (DT/ST ratio). In category 10, the highest spontaneous participation from the pupils was scored by teacher 5, who was a "direct" method teacher (3.09%). However, on the whole, spontaneous participation was poor for the two groups, and two teachers in the direct group scored 0% for it.

In category eleven which involves pupils questioning the teacher, teacher number 6 of the direct group had the highest

score of 2.16%. Pupils did not ask questions appreciably as seen from the values recorded. This may be due to the presence of an observer, but may also be due to teachers not inviting or allowing for pupils' questions, thus reducing student participation.

The remaining categories 12 to 18 fall under the non-verbal section. Categories 12 and 14 were only relevant during practical periods as in the case of teacher 8 who had practical periods observed. It was shown that 22.23% of the time was spent on non-verbal activities out of which 16.02% was spent writing. Also teacher number 3 who had a demonstration class recorded spent 14.25% of the time in non-verbal behaviour.

Category 16 was not used by teachers who had no demonstration or practical lessons recorded. The use of the non-verbal categories complemented pupils and teachers activity during practical periods supporting Parakh's view that non-verbal behaviour could not be overlooked during practical periods in science subjects.

Category 16 involved teacher's non-verbal behaviour such as black-board work and setting out materials, and most of the teachers spent considerable time here though varied with one spending only 3.10%, whilst another spent 19.29% indicating a lot of notes-writing which should be minimized if books are available.

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1. Parakh, J.S. ..... op cit.

Category 17 2as for silence, and the range was 0.88% to 8.55%. Teacher 2 had the longest time because he spent more time on problem solving thus leading to longest wait-on-time. Category 18 which was for recording confusion was only recorded for one teacher number 8 who was in the direct group. This result seems normal since the presence of an observer was bound to prevent irrelevant behaviour from both teachers and pupils, which is a major defect of observation research in which the observer is physically present during the observation period. However a lot of information would be lost from only a tape-recorded lesson.

On the whole this detailed analysis of the behaviour of the chemistry teachers justifies the result of the hypothesis one which found significant differences at $p = 0.05$ level between the indirect and direct groups of teachers within the chemistry group.

5.2 Comparison of the teaching behaviours of the chemistry and biology teachers

The teaching profiles of biology teachers was found by calculating the mean percentages of time spent in each of the eighteen categories of the modified FIAC - 18-category observation instrument developed for this study. A similar profile was also done for the chemistry group. In the third hypothesis the teaching profiles of the chemistry and biology groups were compared category by category by means of t-tests.

The results showed no significant difference at p=0.05 level in the percentages of the time spent in the eighteen categories except in the categories 2, 5, and 7. This showed that the biology group praised and encouraged the pupils more than the chemistry group, and also gave more directions (categories 2, and 7). On the other hand the chemistry group gave more response to questions (category 5). The chemistry teachers lectured for a longer time of 52.94%, while the biology group spent 44.18% of the total time. This result in similar to that of Kubeyinje[1] who in her study recorded 72.6% for physics teachers, 65.8% for chemistry teacher and 60.6% for biology teachers indicating that chemistry teachers did more talking than biology teachers.

The biology groups of teachers, like the chemistry group did not spend much time in categories one to three as this would have increased indirect influence and hence promoted better integration in the classrooms.

Hypothesis four which stated that there was no significant difference between the total interaction patterns of the chemistry group and the

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1. Kubeyinje, T.A., A study of the teacher-pupil verbal interaction during science classes in some secondary schools in Nigeria. Unpublished M.Ed. Dissertation. University of Ibadan. 1982, p.44-48.

biology group was accepted at p= 0.05 level which means that the chemistry and biology classes are similar in the interaction between teachers and pupils.

It can be inferred from the results that classroom behaviours of chemistry and biology teachers are similar, and differences found are within group differences and not between group differences. In other words what accounts for differences in patterns are individual differences between teachers.

5.3 The dominant items of teacher verbal and non-verbal behaviour in chemistry classes

The most dominant items of verbal behaviour in the chemistry classes can be derived from the mean percentages of time spent in the verbal categories recording teacher verbal influence both direct and indirect. The most dominant verbal influence is during lecturing, which took 52.94% of the time, followed by "asking questions" which took 7.09% of the total time. Results of previous studies showed that "asking questions" was significantly associated with pupil-achievement, e.g. the work of Conners and Eisenberg,[1] and Flanders[2]. Category seven

1. Conners, C.K. and L. Eisenberg, The effect of teacher behaviour on verbal intelligence in operation headstart children. Mimeographed report. John Hopkins University School of Medicine, 1966.
2. Flanders, Ned., Analysing Teacher Behaviour. Reading Mass: Addison Wesley. 1970.

which recorded "giving directions" was next with 2.19% followed by category three "acceptance of pupil's ideas" with 2.11% of the total time.

For the non-verbal behaviour much time was taken up by cleaning of the blackboard and setting out materials which took 19.89% of classroom time, while 4.03% of the time was spent on demonstration and supervision of work.

On the whole, lecturing and blackboard work dominated the verbal and non-verbal behaviours of the chemistry teachers. This pattern does not seem to be peculiar to chemistry alone as Flanders found that the percentage of teacher-talk varied from about 50-80%. The result of this study is also similar to that of Kubeyinje,[1] who in a study of physics, biology and chemistry classes in secondary schools in Ibadan concluded among other things that teaching methods used by science teachers were restricted to mostly lectures, discussion in question and answer sessions, and note-taking, while there was little student activity during classes. She used Yoloye's[2] "class activity sheet" of classroom observation for observing science classes in the fourth forms of secondary schools in Ibadan, as was done in the present study.

Although giving information is the main thing in the teaching-process, the teacher should be guided by use of other moves to make

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1. Kubeyinje, T.A. ..... op. cit.
2. Yoloye, E.A. Evaluation for Innovation In Handbook of Curriculum Evaluation. Ed. by Erieh Levey, Unesco, Paris, Longman, New York, 1977.

integration, and good emotional climate in the classroom.

5.4 Teacher-style and pupil achievement in chemistry

The second hypothesis related the teacher behaviours to learning outcomes, namely cognitive and effective growth.

Teacher-style was determined by indirect method or integrative behaviour, and direct method or dominative behaviour, and this was established from the results of hypothesis one.

The pupils scored a mean of 42.52% in the chemistry achievement test and 42.35% in the teacher's chemistry tests, with standard deviations of 15.07 and 17.55 respectively, indicating acquisition of knowledge of chemistry during the period of observation. (see Table 15A).

The teachers who were found to be indirect also had their pupils scoring highest in the chemistry achievement test. One of the indirect teachers also scored second highest in the teacher's test.

The relationship between teacher-style and achievement in chemistry was shown in the result of the stepwise multiple regression analysis between independent variables (see Table 17) in which indirect behaviour of teachers correlated significantly at $p = 0.05$ level with chemistry achievement test scores. Indirect behaviour or indirect influence (i/d) contributed by 61% to achievement in chemistry.

Some previous similar studies support the result above. Houston[1] in his study of physics teachers using FIAC found that students exposed

1. Houston, J., op.cit

to indirect teaching method performed better than others at the higher levels of cognition. Citron and Barnes[1] who used FIAC in a study involving six biology teachers and high school students in New Jersey, found that teaching by indirect method showed more gain in cognitive achievement than by the direct method.

Campbell,[2] using FIAC, investigated the relationship between cognitive and effective process development and the revised i/d ratios of ten instructors and 251 junior High school science students, found the post-test mean achievement scores of the students under the indirect group of teachers to be significantly higher at 0.01 level than the direct group of teachers. The development of scientific attitude was also significantly higher at p = 0.05 level in the indirect group.

The superiority of indirect influence to direct influence was also supported by Wolfson[3] who concluded that chemistry students taught by teachers with high indirect-direct ratio achieved more information

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1. Citron I., and C. Barnes, The search for more effective methods of teaching high school biology to slow learners through interaction analysis. Journal of Research in Teaching 1970, 7, p 9-19.
2. Campbell, J.R., Cognitive and affective process development and its relation to teachers' interaction ratio. Journal of Research in Teaching, 1971, 8 (4) : 317-323.
3. Wolfson, M.L., op cit.

thar students taught by teachers of lower indirect-direct ratio. One can therefore conclude that teacher-style is related to pupil achievement in chemistry, from the results of the present study and previous studies.

5.5 Teacher-style and pupils' attitude to chemistry teachers and chemistry subjects

The relationship between teacher-style and affective development of pupils was considered under the second hypothesis.

Teacher-style determined by indirect-direct ratios I/D and i/d had low correlation with the attitude of pupils to chemistry teachers but DT/ST values correlated significantly at $p = 0.05$ with attitude of pupils to chemistry teachers. (see Table 13).

Considering the teacher-style and pupils' attitude to chemistry, I/D and DT/ST correlated negatively with pupils' attitude, but i/d has a positive correlation of 0.29, though not significant at 0.05 level. However i/d has a positive contribution of 68.3% to attitude of pupils to chemistry subject from multiple regression results (see Tables 18 and 19). Flanders[1] in his study of indirect-direct influence and pupil attitudes also found that the

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1. Flanders. N.A. Some relationships among teacher-influence, pupil-attitude and achievement..... op cit.

most constructive and independent attitudes were found to be associated with the indirect teacher. He obtained correlation coefficients of 0.44 for mathematics and 0.45 for social studies.

On teacher style and pupil's attitude to chemistry teachers, Table 19 recorded a correlation coefficient of 0.43 between i/d and attitude of pupils to them, indicating similar results to Flanders above for the relationship between indirectness and pupil attitudes.

Low results in this study might be due to general difficulty in measuring attitudes, due to the emotional and abstract nature of the behaviour, and because problems such as appropriateness of instrument, reading-difficulty of pupils usually caused superficiality in determining young pupils' attitudes. In spite of these problems, research findings generally revealed a significant relationship between attitude to science and science achievement. Brown[2] found that groups of pupils that had a significantly high science achievement also had a high positive attitude test-score. A similar result was obtained by Alford[2] in a study.

This study also found a positive and significant correlation between attitude to chemistry and chemistry achievement, and pupils' attitude to chemistry also correlated significantly with attitude to

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1. Brown, S.B., Science information and attitudes possessed by selected elementary school pupils. Science Education 39, 57-59, 1955.
2. Alford, D.J., Achievement and attitude. The Science Teacher, June 1972, p.17-18.

teacher (see Table 10). Therefore, teacher teacher-style that would lead to positive attitude to chemistry is desirable as this makes for higher achievement.

5.6 . Relevance of the results to science education

Science educators need to create a good emotional climate in their classrooms. They should maximize their influence over pupils, in an indirect manner by accepting pupils feelings, praising and encouraging pupils efforts, and making use of their ideas. This can be achieved by asking questions from pupils during lessons and responding warmly and patiently to questions. Ipaye[1] in his own study of science student-teachers gave similar recommendations. He was in favour of the indirect and integrative method. He also suggested that teachers in training could be better guided, and later assessed, by use of observational instrument along with other methods. In a study Chacko[2] also raised the question of the need to train teachers in the use of indirect method of teaching which will enable the teachers to make the students take more positive part in lessons. She concluded that dominative tendencies, (as well as other personality traits she studied) should be reduced during teaching.

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1. Ipaye, Tunde, Personality factor and teaching style in science. A possible guide to curriculum improvement, Journal of Science Teachers' Association of Nigeria Vol 13, No. 3, Aug. 1975.

2. Chacko, I. learning outcomes in secondary school mathematics as related to teacher and student characteristics. Ph.D. Dissertation. University of Ibadan, 1981.

In this study, the attitude of the pupils to chemistry correlated significantly with achievement and with attitude to chemistry teachers. Therefore, teachers should use a more integrative approach in order to generate a positive attitude in their pupils towards the subject. Systematic observation techniques like the one used in this study make it possible to quantify the teaching processes and their effects and outcomes.

Berlinger[1] pointed out that,

> ... Whether we are interested in effective social or natural science teaching, or effective mathematics or home economics, establishing empirical relationships between teacher behaviour and student outcomes has to be our goal. Unless replicable findings relating teacher behaviour to student achievement in natural classroom setting can be found teacher education, evaluation and accountability programs will not be believable ...

Therefore, systematic techniques should be used and encouragéd in researches on teaching in order to quantify relationship between teacher behaviour and student outcomes.

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1. Berlinger, D.C. Impediments to the study of teacher effectiveness. Paper presented at the University of Texas. Nov.2-4, 1975, for Conference on research on teacher effects.

CHAPTER SIX

SUMMARY AND CONCLUSIONS

This study investigated the types of teaching behaviours exhibited by teachers of chemistry and biology in some selected secondary schools in the urban areas of Ibadan. The schools chosen were more than ten years old, and were well-established in the teaching of science subjects. They all had at least two laboratories which were fairly well-equipped. The pupils used in the study were pupils offering the three science subjects, chemistry, biology and physics, as well as mathematics, and in the fourth forms. They had chosen to offer the sciences for their school-certificate examinations, so they must at least be quite interested in the natural sciences.

The instrument used in the study for investigating teacher- pupil interactions in their classrooms, and hence deriving teacher behaviours or styles was an 18 - category modified Flanders' Interaction Categories. Live observations were recorded of a few lessons each for eight chemistry and eight biology teachers during a period of three months. Interaction profiles of the teachers were computed in terms of percentages of time spent in the various verbal and non-verbal categories of the observational instrument. The chemistry teachers were studied in more detail to investigate the relationship between teacher-style and cognitive and affective outcomes of their pupils.

Intelligence tests that had been well-used and validated by previous researchers, in Nigeria were administered according to the

guidelines of the authors to the different groups of pupils, and these were scored. Other tests were given to the pupils to detect the learning that took place during the observation period, i.e. the multiple-choice chemistry achievement tests, as well as teachers chemistry tests. Questionnaires were given to the pupils to fill in order to determine their attitudes towards chemistry, and their chemistry teachers. The questionaire-responses were scored as recommended by the authors and inter-correlations were computed between these scores and other test-scores for each teacher, as well as for the combined group of chemistry teachers.

Analysis of the teaching interaction profiles enabled the chemistry teachers to be grouped into those with high "indirect-direct ratio" and low "indirect-direct ratio" or into "indirect influence" and "direct influence" using Flanders' terminology.

Four hypotheses were tested, and the findings are listed below:-

1. The first hypothesis which stated that there was no significant difference between the chemistry teachers, as regards indirect influence and direct influence measured by three ratios I/d, i/d and DT/ST was rejected at $p = 0.05$ level. Three of the eight chemistry teachers observed were "indirect method" teachers and five were "direct method" teachers, and the two groups were as a result of t-tests found to be significantly different in their indirect-direct verbal influence at $p = 0.05$ level.

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1. Flanders, N.A., op cit.

2. The second hypothesis which stated that there was no significant relationship between teacher verbal behaviour and pupil outcomes, was investigated using intercorrelations and stepwise multiple regression between independent variables i.e. the teachers behaviours, measured by I/D, i/d and DT/ST values and dependent variables i.e.student outcomes, measured by scores of attitude-questionaires and chemistry tests. The dependent variables were pupils' attitude to chemistry, and their teacher, and achievement in chemistry.

The results were the following:

(a) Teacher indirect influence, i/d, correlated significantly at $p = 0.05$ level with chemistry achievement test and attitude of pupils to chemistry, but not with pupils' attitude to chemistry teachers.

(b) I/D, another measure of indirectness but a less effective measure (as already discussed in chapter 3) correlated significantly with chemistry achievement test scores but not with pupils' attitude to chemistry teachers. It had a negative correlation with attitude of pupils chemistry.

(c) Teacher direct-talk to student-talk, DT/ST, had a negative correlation with chemistry achievement test and attitude of pupils to chemistry but correlated significantly with pupils attitude to chemistry teachers.

3. The hypotheses three and four which involved comparison of interaction profiles and total interaction patterns of the chemistry and biology groups of teachers respectively, were tested by analysing the data compiled from observations of chemistry and biology classes, showed the following results:-

(a) t-test values between the means of percentages of time spent in each of the categories one to eighteen by each group were calculated and the results of the two-tailed test showed that only categories 2, 5, and 7 were significantly different at $p = 0.05$ level. These were categories recording praising and encouraging the student, responding to students questions and giving directions to students. The other categories were not significantly different.

(b) A Darwin's chi-square test comparing the combined matrix of the classroom interaction patterns of the chemistry group and that of the biology showed that there was no significant difference between them.

Therefore, one can conclude that the indirect method or style of teaching contributes significantly to achievement of pupils in chemistry, and also contributes to some extent to attitude of pupils to the subject. The teacher-pupil interactions in biology and chemistry classes are on the whole similar, even though there are differences, most of these differences are not significant at $p=0.05$ level.

Recommendations for further research

Further research can be done using a larger number of chemistry teachers and the categories that are heavily used in the verbal section, namely, category six (lecturing) and category four (asking pupils questions) can be studied in greater detail. In the non-verbal section the amount of time spent in writing on the blackboard can be reduced by use of ready made charts and models, therefore an experimental study of this can be done. May be teachers need not waste a high percentage of classroom time on this boring and exerting exercise.

The effective use of observational instruments and techniques in the training and eventual grading of student-teachers in the teacher training institutions can be explored and encouraged. Other research studies however found the direct approach beneficial and more productive when applied to poor performing students. This is an area which can be explored although a form of streaming in the schools would be required and this could be an experimental study.

Implications of the study.

Findings in this study have implications for the following aspects of education:-

1. The training procedure of student science-teachers.
2. Organisation of in-service training in classroom teaching-processes for chemistry teachers.

The pre-service training of science-teachers can be enriched by recording their lessons on tapes and analysing them with classroom observational instruments, so that student-teachers can learn from the results of their own teaching profiles and those of others.

Practising teachers can be trained and retreained in-service by arranging workshops in which they can be exposed to new concepts like indirect and direct methods of teaching. They can be informed of the use of classroom observation instruments in demonstrating different methods of teaching and how teaching profiles can be obtained. The results could inspire changes in method of teaching some topics to the advantage of pupils, whose interest may be aroused to learn science subjects to the best of their abilities.

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APPENDIX 1

FLANDERS OBSERVATION INSTRUMENT

(FIAC) (From Amidon and Flanders, 1963)

Teacher talk	Indirect influence	1. Accepts feeling: accepts and clarifies the feeling tone of the students in a nonthreatening manner. Feelings may be positive or negative. Predicting and recalling feelings are included.
		2. Praises or encourages: praises or encourages student action or behavior. Jokes that release tension, not at the expense of another individual, nodding head or saying "uh huh?" or "go on" are included.
		3. Accepts or uses ideas of student: clarifying, building, or developing ideas or suggestions by a student. As teacher brings more of his own ideas into play, shift to category five.
		4. Asks questions: asking a question about content or procedure with the intent that a student answer.
	Direct influence	5. Lectures: giving facts or opinions about content or procedure; expressing his own idea; asking rhetorical questions.
		6. Gives directions: directions, commands, or orders with which a student is expected to comply.
		7. Criticizes or justifies authority: statements, intended to change student behavior from nonacceptable to acceptable pattern; bawling someone out; stating why the teacher is doing what he is doing, extreme self-reference.
Student talk		8. Student talk-response: talk by students in response to teacher. Teacher initiates the contact or solicits student statement.
		9. Student talk-initiation: talk by students, which they initiate. If "calling on" students is only to indicate who may talk next, observer must decide whether student wanted to talk. If he did, use this category.
		10. Silence or confusion: pauses, short periods of silence, and periods of confusion in which communication cannot be understood by the observer.

APPENDIX II

A MODIFIED FLANDER'S INTERACTION ANALYSIS

BY YEJIDE ABOABA

INDIRECT TEACHER VERBAL INFLUENCE	1. ACCEPTS FEELINGS 2. PRAISES AND ENCOURAGES 3. ACCEPTS OR USES IDEAS OF STUDENT 4. ASKS QUESTIONS. 5. RESPONDS TO QUESTIONS.
TEACHER DIRECT VERBAL INFLUENCE	6. LECTURING 7. GIVING DIRECTIONS 8. CRITICIZING/REJECTING/AUTHORITY/ JUSTIFYING
STUDENTS' VERBAL BEHAVIOUR	9. RESPONSE TO TEACHER'S QUESTIONS 10. INITIATION/SPONTANEOUS PARTICIPATIONS 11. QUESTIONING THE TEACHER
STUDENTS' NON-VERBAL BEHAVIOUR	12. WASHING/SETTING OUT APPARATUS 13. (a) EXAMINING MATERIALS/ (b) PERFORMING EXPERIMENTS 14. WRITING / READING
TEACHER NON-VERBAL	15. (a) CLEANING THE BLACK-BOARD (b) SETTING OUT MATERIALS 16. (a) DEMONSTRATION OF EXPERIMENT/ (b) SUPERVISION OF WORK
NON-FUNCTIONAL BEHAVIOUR	17. SILENCE 18. CONFUSION.

APPENDIX III

A.C.E.R. FORM ML

Name:.....Age.Now:.....
(SURNAME BLOCK LETTERS)

Date of Test:..... Birthday:.....

School ..... Class.....

This is a test to see how well you can think. It contains questions of different kinds. Some examples and practice questions will be given to show you how to answer the questions.

EXAMPLE A. Four of the following are alike in some way. Write the numbers of the other two in the brackets at the end of the line.

(1) tea (2) coffee (3) shoes (4) cocoa (5) pencil (6) milk (&)

Question 1. Four of the following are alike in some way. Write the numbers of the other two in the brackets.

(1) apple (2) pear (3) potato (4) banana (5) carrot (6) orange (&)

Question 2. Four of the following are alike in some way. Write the numbers of the other two in the brackets.

(1) door (2) window (3) coat (4) wall (5) roof (6) book (&)

EXAMPLE B. TOWEL is to WATER as BLOTTING PAPER is to:

(1) school (2) ink (3) writing (4) desk (5) pen ( )

Question 3. HAND is to FINGER as FOOT is to:-

(1) leg (2) arm (3) toe (4) man (5) ankle ( )

Question 4. NEWSPAPER is to SEE as WIRELESS is to:-

(1) wire (2) hear (3) dial (4) ear (5) deaf ( )

EXAMPLE C. Which two of the following statements mean most nearly the same?

(1) Too many cooks spoil the broth.

(2) Make hay while the sun shines.

(3) A stitch in time saves nine.

(4) It's a long lane that has no turning.

(5) Strike while the iron is not. ( )

Question 5. Which two of the following statements mean most nearly the same?

(1) A careless master makes a negligent servant

(2) To resist him that is set in authority is evil.

(3) Little is done when many command.

(4) When the cat is away the mice do play.

(5) Where there are seven shepherds there is no flock(&)

Question 6. Which two of the following statements together prove that "OUR DOG BIT THE POSTMAN YESTERDAY"?

(1) Our dog is the only Alsatian in the street.

(2) The postman was late yesterday.

(3) The postman is in bed because an Alsatian bit him yesterday, in our street.

(4) Dogs seem to dislike postmen.

(5) The postman had a sore leg last week (&)

You will have 15 minutes to do the test. Some questions are easier than others. Try each question as you come to it, but if you find any question is too hard, leave it out and come to it later if you have time.

Do not spend too much time on any one question. Try to get as many right as possible.

(Record your answer to NOS. 1 to 36 on the Answer sheets supplied)

1. Four of the following are alike in some way. Write the numbers of the other two on the answer sheet.

(1) table (2) chair (3) man (4) bed (5) cupboard

(6) towel (&)

2. FILTHY is to DISEASE as CLEAN is to:-

(1) dirty (2) safety (3) water (4) illness (5) health

(&)

3. Four of the following are alike in some way. Write the numbers of the other two.

(1) tube (2) artery (3) tunnel (4) string

(5) pipe (6) wire (&)

4. INCH is to SPACE as SECOND is to:-

(1) hour (2) age (3) time (4) clock (5)third (&)

5. Four of the following are alike in some way.
Write the numbers of the other two.
(1) lagoon (2) pool (3) swamp (4) lake (5) marsh
(6) pond (&)

6. PIN is to HEAD as NEEDLE is to:-
(1) prick (2) sew (3) eye (4) point (5)thred (&)

7. Four of the following are alike in some way.
Write the numbers of the other two.
(1) onlooker (2) spectator (3) critic (4) eye-witness (5) author (6) bystander (&)

8. HEAT is to ASHES as CAPENTRY is to:
(1) carpenter (2) sawdust (3) chisel (4) furniture
(5) wood (&)

9. Four of the following are alike in some way.
Write the numbers of the other two.
(1) sponge (2) water (3) mop (4) towel
(5) blotting-paper (6) dirt (&)

10. Which two of the following statements mean most nearly the same? Write the numbers)
(1) Time is a herb that cures all diseases.
(2) Anticipation is better than realization.
(3) To-day is worth two to-morrows.
(4) To speed to-day is to be set back to-morrow.
(5) There is no time like the present (&)

11. Which two statements prove that 'JOHN IS A GOOD SWIMMER"? Write the numbers.

(1) Bob goes to the baths every day.

(2) John and Bob are friends.

(3) Bob won last year's swimming championship.

(4) John beat Bob in a race last week.

(5) John has challenged Bob to a race (&)

12. TELEPHONE is to VOICE as LETTER is to:-

(1) stamp (2) post office (3) writing

(4) correspondent (5) envelope ( )

13. MANNERS are to POLITE as MORALS are to:-

(1) politics (2) politeness (3) wealthy

(4) virtuous (5) strong. ( )

14. Which two statements prove that 'MR. SMITH OWNS SOME TAMWORTHS"? (Write the numbers)

(1) Tamworths are better pigs than Berkshires.

(2) One-eighth of the pigs in that pen are Tamworths.

(3) Most of the pigs in that pen are Berkshires.

(4) All the pigs in that per belong to Mr. Smith.

(5) Most of the farmers in the district own Tamworths.

(&)

15. Four of the following are alike in some way. Write the numbers of the other two in the answers sheet

(1)spire (2) church (3) flagpole (4) steeple
(5) tower (6) hall. (&)

16. OCEAN is to LAKE as CONTINENT is to:-

(1) river (2) land (3) mountain (4) island

(5) Europe ( )

17. Which two of the following statements mean most nearly the same? (Write the numbers)

(1) Fire that's closest kept burns fiercest.

(2) Set a thief to catch a thief.

(3) A dog with a bone knows no friend.

(4) Fight fire with fire.

(5) Sow the wind, reap the whirlwind. (&)

18. "ONLY PREFECTS WEAR A BADGE". "ALL PREFECTS ARE IN FORM VI." Therefore, which one of the following statements is true? Write its number

(1) All Form VI boys may wear badges.

(2) A boy wearing a badge is in Form VI.

(3) All 1st XI boys may wear badges.

(4) V Form prefects do not wear badges.

19. Three days in the week have the same number of letters. Write the first letter of the day which begins with the letter which, of the three, comes first in the alphabet( )

20. Four of the following are alike in some way. Write the numbers of the other two.

(1) blame (2) accuse (3) indict (4) loathe

(5) censure (6) ape (&)

21. Which two of the following statements mean most nearly the same?

(1) He who follows two hares will catch neither.

(2) To blow and swallow at the same time is not easy.

(3) He holds nothing fast who graps at too much

(4) Despise the man who can blow hot and cold with the same breath.

(5) It is easy to despise what you cannot obtain.(&)

22. FEW is to MANY as OCCASIONALLY is to:-

(1) seldom (2) never (3) every (4) often (5) always( )

23. Four of the following are alike in some way. Write the number of the other two.

(1) currugated (2) involved (3) complicated (4) intricate

(5) coarse (6) complex (&)

24. Which two of the following statements together prove that "MR. REED DOES NOT LIVE IN HUME STREET"? Write the numbers)

(1) All the buildings in Hume Street are modern.

(2) All the buildings in Hume Street are flats.

(3) Mr. Reed lives in comfort.

(4) Mr. Reed does not live in a flat.

(5) Mr. Read lives five miles from town. (&)

25. If these words were rearranged correctly to form a sentence, with what letter would the middle word begin?

Is From a Molehill/a Mountain a thing Different(&)

26. GATE is to FENCE as PORT is to:-

(1) land (2) coast (3) town (4) sea (5) destination( )

27. Which two of the following statements mean most nearly the same?

(1) It's petty expenses that empty the purse.

(2) Small gains bring riches in.

(3) Even the weak are strong when united.

(4) Constant dripping wears away the stone.

(5) A chain is as strong as its weakest link. (&)

28. Four of the following are alike in some way.

Write the numbers of the other two on the answer sheet.

(1) ruler (2) heat (3) clock (4) thermometer

(5) rainguage (6) yard (&)

29. Which two of the following statements mean most nearly the same? Write down the numbers)

(1) Repentance is poor consolation

(2) More haste less speed.

(3) Quick decisions often breed regret.

(4) He'll have a bucket of tears for a cup of joy.

(5) Marry in haste, repent in leisure. &)

30. DRAMATIST is to PLAY as COMPOSER is to :-

(1) orchestra (2) piano (3) symphony (4) performance

(5) concert ( )

31. Which two of the following statements together prove that "TO-DAY IS COLDER THAN YESTERDAY"?

(1) Every Friday this month was a cold day.

(2) To-morrow is the first day of the month

(3) Last Thursday was a hot day

(4) The last day of each month this year has been the coldest day in the month.

(5) Summer is nearly over. (&)

32. Four of the following are alike in some way. Write the numbers of the other two.

(1) fugitive (2) enemy (3) evacuee (4) escapee

(5) prisoner (6) truant (&)

33. Which two of the following statements mean most nearly the same?

(1) A great fortune is a great slavery.

(2) Better beans and bacon in freedom than cakes and ale in bondage.

(3) Put a chain round the neck of a slave and the end fastens round your own.

(4) Lean liberty is better than fat slavery.

(5) Stone walls do not a prison make. (&)

34. In a certain code the English word B O A R D is written C Q D V I. What would the English word P A T be in this code?

35. Which two of the following statements mean most nearly the same?

(1) Forewarned is forearmed.

(2) The loss which is unknown is no loss at all.

(3) No man is happy that does not think so.

(4) Uneasy lies the head that wears a crown.

(5) Where ignorance is bliss, 'tis folly to be wise ( )

36. BATTLE is to DUEL as CHORUS is to :-

(1) twins (2) duet (3) selection (4) music (5) song. ( )

A.C.E.R. FORM MQ

Name:..... Age Now:.....
(SURNAME BLOCK LETTERS)

Date of Test:..... Birthday:.....

School:..... Class:.....

This is a test to see how well you can think. It contains questions of different kinds. Some examples and practice questions will be given to show you how to answer the questions.

EXAMPLE A. Find out how the following numbers go.

Write the missing numbers in the brackets.

2 5 8 • 14 17 • 23 (&)

Question 1. Find out how the following numbers go.

Write the missing numbers in the brackets.

4 3 6 5 • 7 10 • (&)

Question 2. Find out how the following numbers go.

Write the missing numbers in the brackets.

1 3 5 7 • 11 • 15 (&)

Question 3. Find out how the following numbers go.

Write the missing numbers in the brackets.

26 23 20 17 14 • 8 • (&)

EXAMPLE B. Find the number which should be in the square with the question mark and write it in the brackets.

3	5	7
6	8	10
9	11	?

( )

Question 4. In this table two numbers are missing. Find the number which should be in the square with the question mark and write it in the brackets.

2	5	9
6	.	13
11	14	?

( )

Question 5. Find the number which should be in the square with the question mark, and write it in the brackets.

1	3	5
3	.	7
5	7	?

( )

Question 6. Find the number which should be in the square with the question mark, and write it in the brackets.

17	13	9
15	11	?
9	.	1

You will have 20 minutes to do the test. Some questions are easier than others. Try each question as you come to it, but if you find any question is too hard, leave it out and come back to it later if you have time. Do not spend too much time on any one question. Try to get as many right as possible.

(Use the Answer sheet for recording answers from Nos.1 to 36 below).

1. Find out how the following numbers go. Write the missing numbers on the answer sheet.

   1 5 • 13 • 21 25 29 (&)

2. What change should I get from ₦5.00 note, if I buy two theatre tickets at 75 kobo each? ( )

3. Find the number which should be in the square with the question mark, and write it on the answer sheet.

4	1	5
7	6	.
12	?	15

( )

4. Find out how the following numbers go. Write the missing numbers on the answer sheet.

19 9 18 8 * 7 16 * (&)

5. Oliver is three times as old as his sister Pat. Their father, who is 35, is seven times as old as Pat. How old is Oliver? ( )

6. Find the number which should be in the square with the question mark, and write it on the answer sheet.

6	10	17
8	.	19
12	16	?

( )

7. Find out how the following numbers go. Write the missing numbers on the answer sheet.

512 256 128 64 # * 16 * 4 (&)

8. Which one of the following prices for oranges is the cheaptest. Write down the letter.
(1) 3 kobo each. (2) 30 kobo for 10. (3) 5 for 20 kobo
(4) 8 for 24 kobo (5) 3 for 7 kobo ( )

9. Find the number which should be in the square with the question mark, and write it on the answer sheet.

32	8	2
.	16	4
96	24	?

10. Find out how the following numbers go. Write the missing numbers.

87 78 76 67 • 56 654 • (&)

11. The total cost of ten books bound in leather is ₦20.00. Each book in an ordinary edition costs ₦1.00. How much do I pay on each book for the leather binding?

( )

12. Find the number which should be in the square with the question mark.

2	4	8
6	•	24
18	36	?

13. John and Mary are twins whose ages together are half their mother's. Their father, who is three years older than their mother, is 51. How old is John?

( )

14. Find the number which should be in the square with the question mark, and write it on the answer sheet.

1	3	9
2	•	10
5	7	?

( )

15. It took me four times as long to climb a mountain, 2,000 metres high as it took me to come down. I descended 1,000 metres in an hour. How many hours did it take me to climb up?

( )

16. Find the number which should be in the square with the question mark, and write it on the answer sheet.

1	.	9
4	12	36
?	48	144

( )

17. What are two numbers whose sum is 16, such that the first divided by the second gives three? ( )

18. Find out how the following numbers go. Write the missing numbers on the answer sheet.

0 • 3 5 6 8 • 11 (&)

19. Find the number which should be in the square with the question mark, and write it on the answer sheet.

13	9	5
7	5	?
1	.	1

( )

20. Find out how the following numbers go. Write the missing numbers on the answer sheet.

4 8 7 • 13 26 • 50 (&)

21. If nine framed pictures cost ₦27.00, and each unframed only costs one third as much, how many unframed pictures could I pay for the same money? ( )

22. Find the number which should be in the square with the question mark, and write it on the answer sheet.

.	4	6
4	.	12
8	16	?

( )

23. Find out how the following numbers go. Write the missing numbers on the answer sheet.

1 3 * * 81 243 729 (&)

24. I bought an equal number of 6 kobo magazines and 3 kobo exercise books, which cost me altogether 54 kobo. How many of each did I buy? ( )

25. Find out how the following numbers go. Write the missing numbers on the answer sheet.

41 35 30 26 * 21 * 20 (&)

26. A farmer finds that by selling his bananas at 28 kobo per kilogram he makes exactly the same profit as by selling at 21 kobo per bunch. What is the average weight of each bunch. ( )

27. A furniture dealer bought some chairs at ₦48, for twelve In selling them he received as much for two chairs as he had paid for three chairs. What was the selling price of twelve? ( )

28. Find the number which should be in the square with the question mark, and write its number on the answer sheet.

18	3	6
2	•	2
9	3	?

( )

29. I can buy 2 kilograms of cocoyams for 30 kobo. How much do I pay for 1.75 kilograms? ( )

30. In a class of 46 pupils there are 8 more boys than girls. How many boys are there? ( )

31. Find the number which should be in the square with the question mark, and write it on the answer sheet

•	1	8
18	2	?
27	•	24

( )

32. Three new books cost 45 kobo, 90 kobo and ₦1.05k respectively If I buy them second-hand I only pay two-thirds of the new price. How much do I save? ( )

33. A piece of wood 35 centimeters is to be cut into three parts, each successive part being twice as long as the previous part. What is the length of the longest part? ( )

34. A kitten is 3 days old and a puppy is 11 days old. In how many days will the puppy be twice as old as the kitten? ( )

35. A dairy serves a mixture of two parts cream and three parts milk. How many litres of cream will it take to make 15 litres of the mixture.()

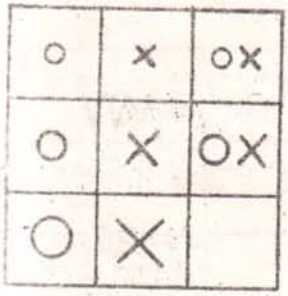
36. Find out how the following numbers go. Write the missing numbers on the answer sheet.

87 74 63 54 47 • 39 • ( )

Name.....

Age.....Years Birthday.....

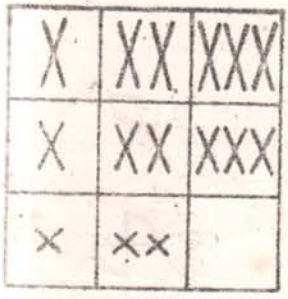
Example A.



1 XX 2 OO 3 OX

4 OX 5 OXO 6 O ( )

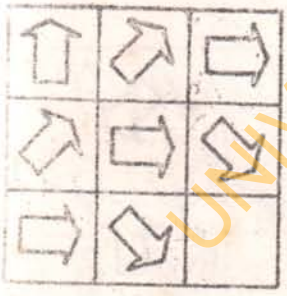
Example B.



1 X 2 XXX 3 X

4 XX 5 XXX 6 XX ( )

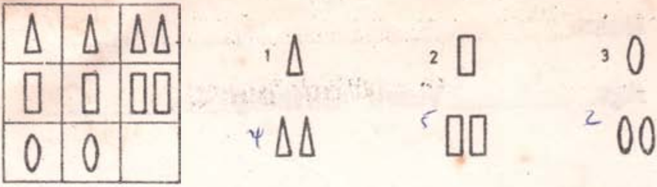
Example C.



1 2 3

4 5 6 ( )

1.



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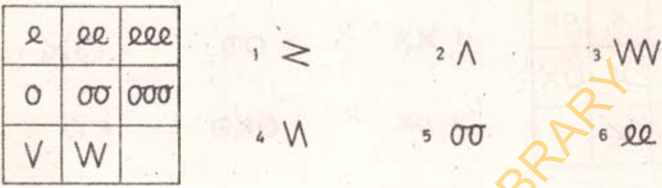

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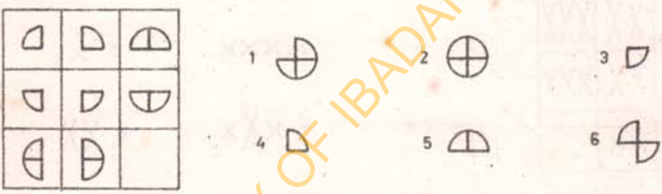

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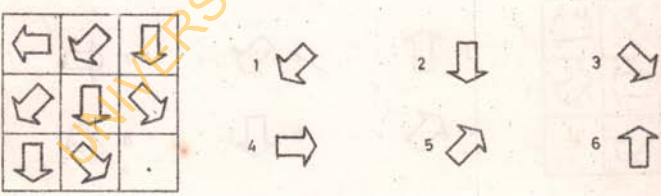

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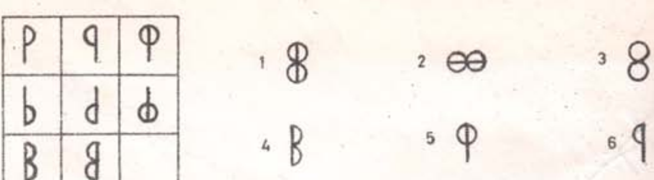

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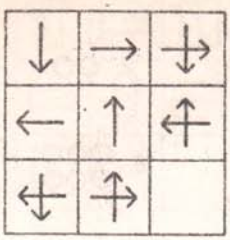
6. 

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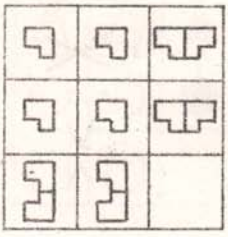
4  5  6  ( )

7. 

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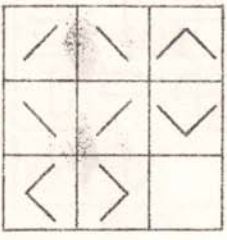
4  5  6  ( )

8. 

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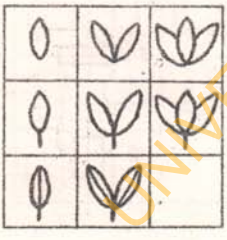
9. 

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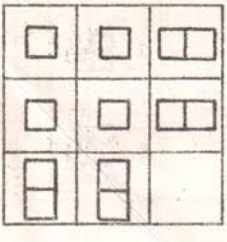
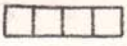
10. 

1  2  3 

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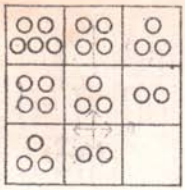
11. 

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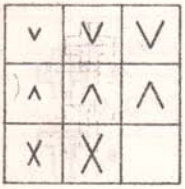
12. 

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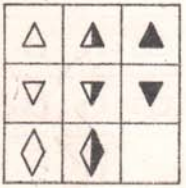
13. 

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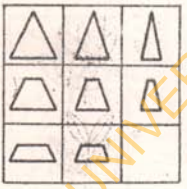
14. 

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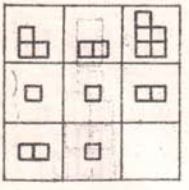
15. 

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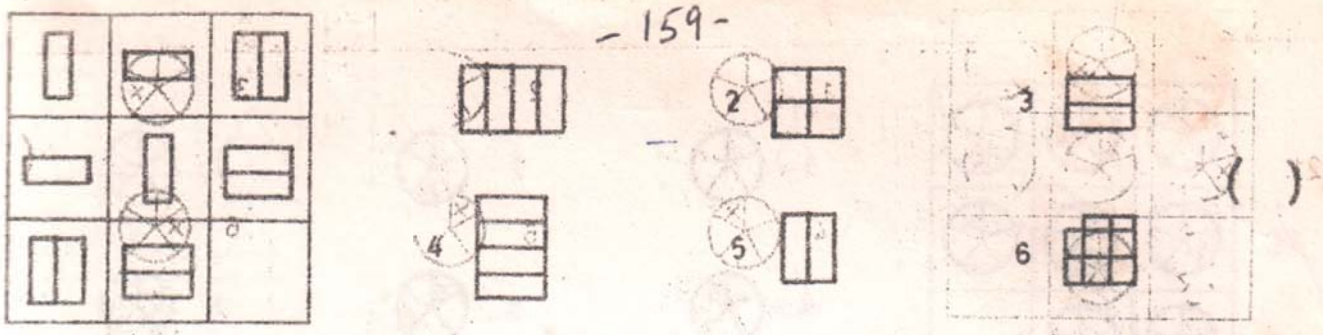

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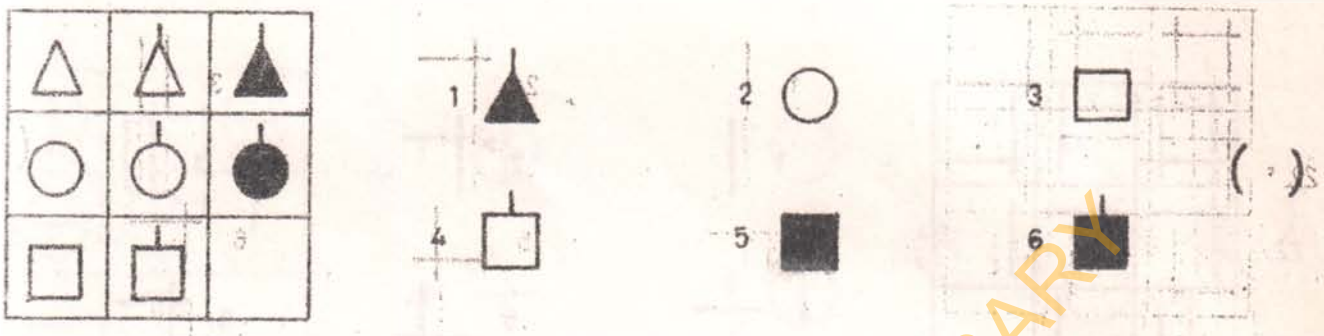

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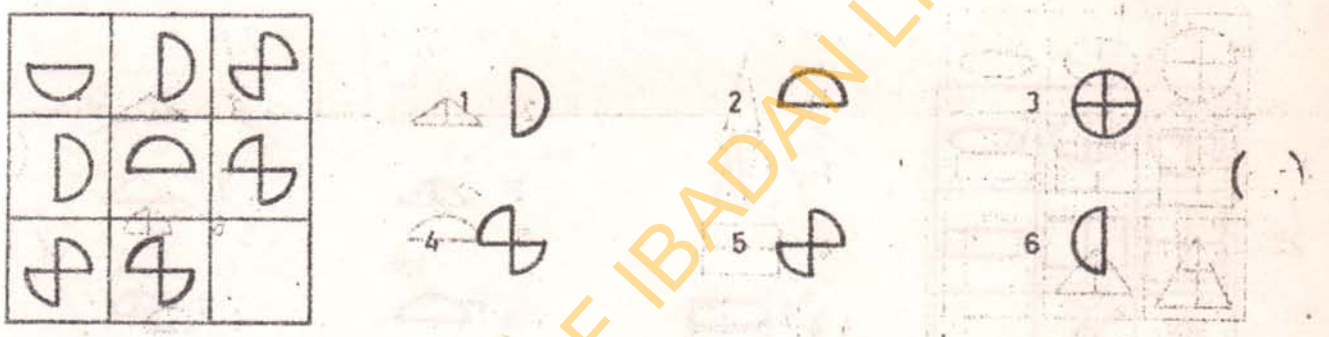

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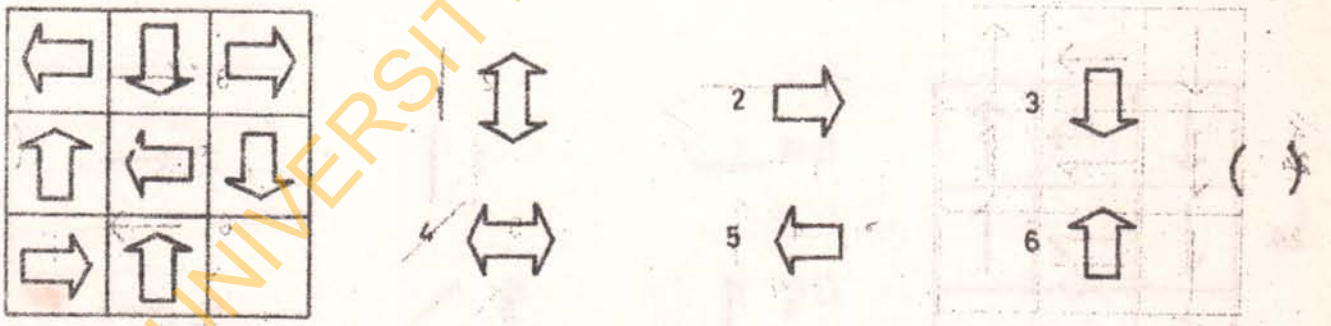

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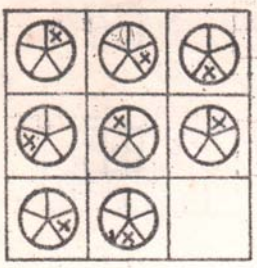
21. 

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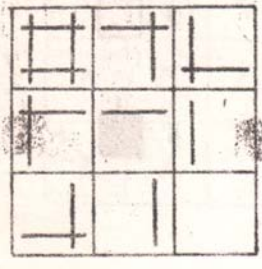
22. 

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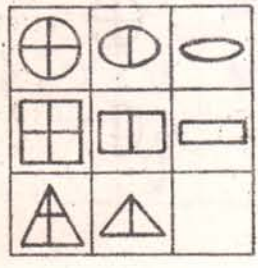
4 5  6 

23. 

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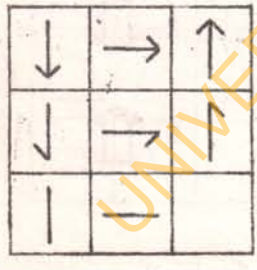
24. 

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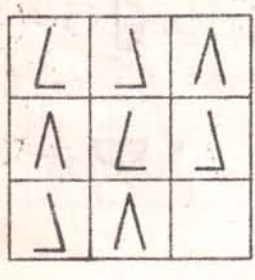
25. 

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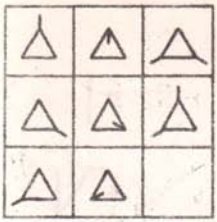
26. 

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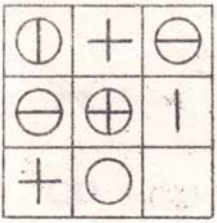
27. 

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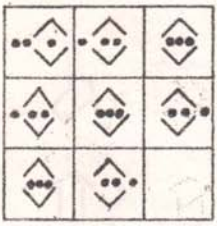
28. 

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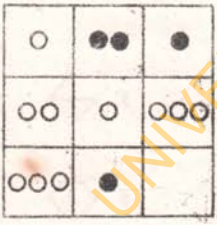
29. 

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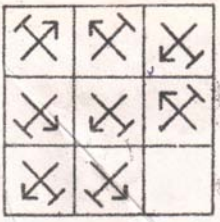
30. 

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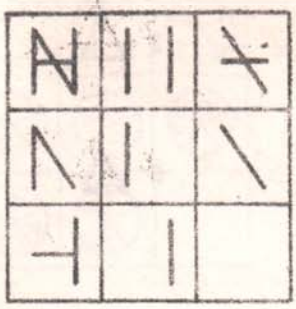
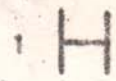
31. 

1 
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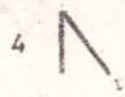
4 
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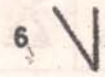
6 

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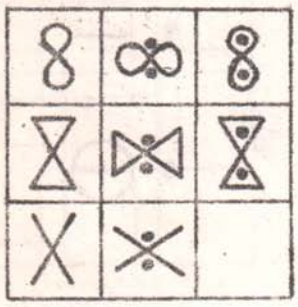
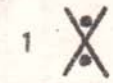
32. 

1 
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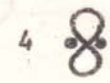
4 
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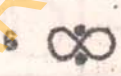
6 

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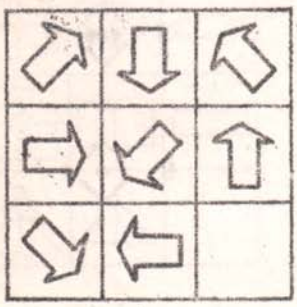
33. 

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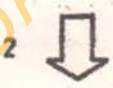
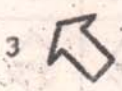
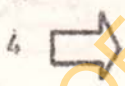
2 
3 
4 
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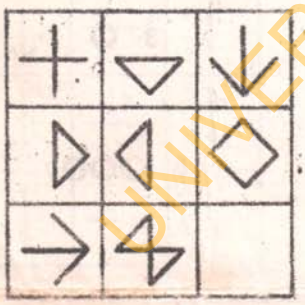
34. 

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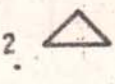
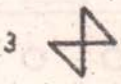
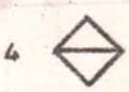
2 
3 
4 
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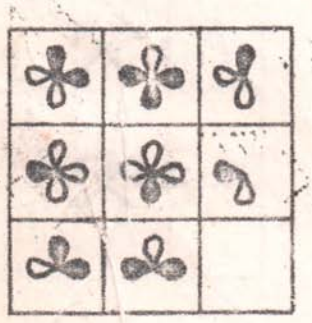
35. 

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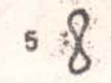
5 
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Prepared by G. D. Bradshaw, U.N.E.S.C.O. Published by The Institute of Education, University College, Ibadan, Nigeria.

APPENDIX IV

CHEMISTRY ACHIEVEMENT TEST

Put down the correct answer by writing down the appropriate letter of the alphabet on the answer sheet.

1. 4.0 g of a sample of copper (II) oxide on analysis gave 3.2 g of copper. In another sample of copper (II) oxide made by an entirely different method 2.5 g was found to contain 0.5 g of oxygen. These figures are in accordance with:
   A. Gay hussac's Law
   B. the Law of Multiple proportions
   C. the Law of Definite Proportions
   D. the Avogadro Law
   E. the Law of conservation of Mass
2. From the atomic number of an element, one can tell the
   A. atomic mass of the element
   B. number of neutrons in the nucleus
   C. number of electrons in the nucleus
   D. number of isotopes
   E. number of electrons around the nucleus
3. What determines the atomic weight of an element?
   A. the total sum of the protons and neutrons
   B. the total number of protons
   C. the total number of protons and electrons

D. the total charge on the electrons and protons

E. none of the above.

4. Atomicity of a gas is defined as

A. the number of atoms in the gas

B. the number of electrons in one atom of the gas

C. the number of atoms in one molecule of the gas

D. the number of times one atoms of the gas is as heavy as one atom of hydrogen

E. the number of atoms in 1 dm^3 of the gas.

5. The basicity of an acid is defined as

A. the concentration of the acid

B. the amount of base that will react with the acid

C. the number of hydrogen atoms in one mole of the acid

D. the number of hydroxyl ions that will react with the acid

E. the number of replaceable hydrogen atoms in one molecule of the acid

6. The charge on an electron is normally

A. Neutral B. Postitive C. Negative

D. Zero E. 1.5 units

7. During the electrolysis of acidyied water, hydrogen is liberated.

A. at the anode B. at the cathode

C. inside the electrolyte D. at the positive electrode

E. at the surface of the electrolyte

8. Hydrocarbons are compounds containing

A. Hydrogen and Oxygen

B. Hydrogen and carbonrundum

C. Hydrogen and carbon dioxide

D. Carbon and hydrogen

E. Carbon and Oxygen

9. Which of the gases have no effect on litmus?

A. carbon-dioxide

B. Nitrogen dioxide

C. Oxygen

D. Ammonia

E. Sulphur dioxide

10. A solution having a pH of 6 is

A. strongly acidic B. neutral C. weakly alkaline

D. weakly acidic E. strongly alkaline

11. The valency of sulphur in sulphur dioxide is:

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

12. Oxygen is obtained in the laboratory by the action of heat on

A. Potassium sulphate B. Potassium oxalate

C. Potassium chlorate D. Ptassium chloride

E. Potassium phosphate

13. The formula of lime-water is

A. $CaCO_3$ B. $Ca(OH)_2$ C. $Ca(HCO_3)_2$

D. $NaOH$ E. Na_2CO_3

14. Which of the following reactions does not produce carbon-dioxide?

A. the action of dilute acid on carbonate

B. burning charcoal in a coal-pot

C. the fermentation of sugar

D. the action of heat on potassium carbonate

E. the reduction of copper oxide with water-gas

15. Before mortar sets, it contains

A. calcium oxide, sand, and water.

B. calcium hydroxide, sand and water.

C. calcium carbonate, sand and water.

D. calcium chloride, sand and water.

E. calcium sulphate, sand and water.

16. 40 g of a saturated solution were found to contain 8 g of the solid solute at room temperature. What is the solubility of the solid at room temperature?

A. 40 g. B. 100 g. C. 25 g. D. 8 g. E. 48 g.

17. One atom has 19 protons and 21 neutrons. Another atom has 21 protons and 19 neutrons. These two atoms

A. belong to the same element

B. have exactly the same weight

C. have the same atomic number

D. have the same mass number

E. belong to the same isotope

18. The atomic weight of phosphorus is 31. The equivalent weight of phosphrus in the compound P_2O_5 is

A. 15.5 B. 6.2 C. 3.1 D. 31.0 E. 8.0

19. At N.T.P. 448 cc of a gas weigh 0.88 gm. What is the molecular weight of the gas?

A. 44 B. 39 C. 50 D. 176 E. 88

20. In the reaction $2H^+ + OC1^- + 2I^- \longrightarrow C1^- + I_2 + H_2O$ an iodide is being.

A. reduced B. precipitated C. Oxidised D. neutralised E. formed

21. Select the compound in which chlorine is assigned the oxidation number of, +5.

A. HC1 B. HC10 C. $HC10_2$ D. $HC10_3$ E. $HC10_4$

22. Which of the following would be possible for both strongly basic and acidic solutions.

A. solution reacts with magnesium to liberate hydrogen

B. solution turns phenolphthalein pink

C. solution is a very good conductor of electricity

D. solution turns red with litmus

E. solution is bitter

23. Cane sugar is known as

A. glucose B. sucrose C. maltose D. fructose

E. galactose

24. A weak acid is one which

A. has replaceable hydrogen atoms

B. has a lot of water in it

C. has only one replaceable hydrogen atom per mole

D. does not ionise readily in aqueous solution

E. ionises completely in aqueous solution

25. Which of these comginations are not allotropes

A. ice and steam

B. rhombic and monoclinic sulphur

C. diamond and lampblack

D. yellow and red phosphorus

E. none of the above

26. Which of the following gases has no colour when pure?

A. chlorine B. ammonia C. nitrogen dioxide

D. nitric acid vapour E. iodine vapour

27. Given the following atomic weights: Fe = 56; S = 32; O = 16; H = 1; calculate the percentage by weight of water in ferrous sulphate crystals - $FeSO_4.7H_2O$.

A. 45.3% B. 27% C. 70% D. 14.6% E. 92.1%

28. A molecule or compound which is formed by a transfer of electron is known as, a/an

A. covalent compound B. amphoteric compound

C. ionic compound D. anhydrous compound

D. monovalent compound

29. 100 cm^3 of methane (CH_4) is burnt in pure oxygen. What volume of oxygen is needed for complete combustion? (All at S.T.P.).

A. 100 cm^3 B. 200 cm^3 C. 33.3 cm^3 D. 300 cm^3 E. 50 cm^3

30 Which of the following substances is most soluble in water?

A. silver chloride B. lead sulphate

C. calcium hydroxide D. barium sulphate

E. calcium carbonate.

31. If the equivalent weight of copper is 32 in cupric oxide. What mass of oxygen will combine with 8g of copper in the formation of cupric oxide? (Atomic weight of oxygen is 16).

A. 2gm B. 4gm C. 6gm D. 16gm E. 8gm.

32. How many molecules of sodium peroxide are needed to prepare one molecule of oxygen?

A. ½ B. 1 C. 2 D. 4 E. 3

33. Which of the following gives a different type of product in its reaction with water?

A. sodium peroxide B. carbon dioxide

C. potassium oxide D. calcium oxide

E. sodium hydroxide

34. Which of the following reactions is known to be reversible?

A. calcium carbonate plus hydrochloric acid

B. synthesis of ammonia

C. action of heat on ammonium nitrate

D. synthesis of water

E. all of these

35. A litre of gas at 790 mm. and 37°C has its volume halved and its pressure changed to 750 mm. What is its temperature?

A. 19.5°C B. 17.6°C C. 147°C D. -126°C E. none of the above

36. Which of the following has the highest percentage of hydrogen? atomic weights, H = 1; S = 32, C = 12, N = 14, O = 16, P = 31.

A. sulphuric acid B. Phosphoric acid

C. acetic acid D. hydrochloric acid

E. nitric acid.

37. Faraday's first law of electrolysis states that the weight of a substance liberated at an electrode is proportional to

A. number of amperes

B. time of passing of the current

C. number of electrodes

D. quantity of electricity passed

E. the electrochemical equivalent

38. If a piece of iron is dipped into some concentrated nitric acid

A. it dissolves to form ferrous nitrate

B. it dissolves to form ferric nitrate

C. it is completely oxidised to ferrous oxide

D. it is completely oxidised to ferric oxide

E. no vissible reaction takes place.

39. Which of the following is not an oxidising agent?

A. hydrogen peroxide

B. potassium permanganate

C. ozone

D. carbon monoxide

E. manganese dioxide

40. By reducing 9.7 gm of a copper oxide a residue of 7.81 gm was left. What is the empirical oxide for copper oxide.

Atomic weights, O = 16, Cu = 63

A. Cu_2O

B. CuO

C. CuO_2

D. CuO_3

E. Cu_2O_3

41. When sulphur dioxide is passed into an acid solution of potassium dichromate

A. the solution turns yellow

B. the solution turns yellow and a yellow precipitate is formed.

C. the solution turns green

D. the solution turns green and a yellow precipitate is formed.

E. the solution turns colourless

42. Avogadro's number is

A. the number of litres occupied by a gram-molecular weight of a gas at S.t.p.

B. the number of atoms in a gram-molecule

C. the number of molecules in a gram-molecule

D. the number of electrons around the atomic nucleus

E. the actual mass of a single atom.

43. The empirical formula of a hydrocarbon containing 81.82% carbon

A. CH_4 B. $(CH)_n$ (C) $(CH_3)n$ (D) C_3H_6

E. None of these

(Atomic weights C = 12; H = 1)

44. A M/2 solution of sulphuric acid, (H_2SO_4) Atomic weights S = 32, H = 1, O = 16 will contain.

A. 98 gm of sulphuric acid per litre

B. 45 gm of sulphuric acid per litre

C. 9.8 gm of sulphuric acid per litre

D. 49 gms of sulphuric acid per litre

E. 22.5 gms of sulphuric acid per litre.

45. 27.5cc of a solution of caustic soda neutralised 25 cc of a 0.1M hydrochloric and. The concentration of the caustic soda is.

A. 5 gm/lire B. 6 gm/litre

C. 3.46 gm/litre D. 3.64 gm/litre

E. 3.00 gm/litre

(Atomic Weights Na = 23; H = 1; O = 16;)

46. Boyle's Law can be explained by the kinetic theory as follows:

A. If the volume of the gas is reduced, the molecules travel faster and thus the pressure is increased.

B. If the volume of the gas is reduced the molecules are in a smaller volume, so they hit the side of the container more often, increasing the pressure.

C. If the volume of the gas is reduced the molecules can only move in a small space, hitting each other more often thus decreasing the pressure.

D. If the volume of the gas is reduced, the pressure is increased due to increase in the attraction of the molecules.

E. All of these.

47. Which of the following statements is false

A. If liquid aire is heated the oxygen boils off first

B. Air which has been dissolved in water contains a higher percentage of oxygen than ordinary air.

C. Manganese dioxide is used as a catalyst in the preparation of oxygen from potassium chlarate.

D. Both oxygen and nitrogen are colourless; edourless, tasteless and neutral to litmus.

E. Magnesium will burn in both oxygen and nitrogen.

48. With the following information:-

$N_2 + 3H_2 \xrightarrow{\text{catalyst}} 2NH_3 + \text{heat}$,

Temperature, 2000°C. Pressure, 350 atmospheres yield = 15%

Which of the following statements is true?

A. The yield could be increased by reducing the pressure

B. The yield could be increased by increasing the pressure

C. The yield could be increased by increasing the temperature

D. The yield could be increased by reducing the amount to catalyst

E. All of these

49. Which of the following ion pairs would be expected to form a precipitate in a dilute solution.

A. Ca^{++}, PO_4^{-3} B. NH_4^+, $SO_4^=$ C. Ca^{++}, NO_3^-

D. Na^+, $S^=$ E. Ca^{++}, Cl^-

50. How many grams of sodium carbonate must be put with 500cc of water to make a decimolar (0.1m) solution? Atomic weights: Na = 23, O = 16, C = 12.

A. 1.06 B. 5.3 C. 10.6 D. 106 E. 103

51. Which statement is correct?

A. 1gm of water has 1 ml. volume and weighs 1 cm^3

B. 1 mlof water has 1 gm volume and weighs 1 cm^3

C. 1 cm^3 of water has 1 ml. volume and weighs 1 gm

D. 1 gm of water has 1 cm^3 volume and weighs 1 ml

E. none of these

52. The general classes into which all matter may be divided are

A. substances, solids, compounds;

B. elements, atoms, mixtures;

C. mixtures, compounds, elements;

D. elements, compounds, substances;

E. none of these.

53. Which of the following elements is known not to be diatomic?

A. oxygen B. sulphur C. chlorine

D. nitrogen E. none of these

54. The molecular formula does not tell us

A. the elements present

B. the ratio of the elements

C. number of atoms present

D. the arrangement of the atoms in the molecule

E. none of these.

55. Which of the following is not positively charged?

A. sulphur nucleus B. hydrogen ion

C. sodium atom D. proton E. none of these

56. Subtracting the atomic number of an atom from its atomic weight gives.

A. nil

B. the number of electrons

C. the number of protons

D. the number of neutrons

E. none of these.

57. The periodic table is constructed on the idea that the chemical properties of the elements are periodic functions of their

A. numbers of neutrons

B. atomic numbers

C. atomic weights

D. Alphaberical order

E. none of these

58. The valency of a given element is most closely related to its

A. atomic weight B. atomic size

C. number of shells of electrons

D. outer shell of electrons

E. none of these.

59. How many carbonate radicals are present in one molecule of ferric carbonate?

A. 1 B. 2 C. 3 D. 4 E. None of these.

60. How many bicarbonate radicals are present in one molecule of cupric bicarbonate?

A. 1 B. 2 C. 3 D. 4 E. none of these.

61. The general equation A + BC -----> AB + C illustrates

A. composition B. decomposition

C. replacement D. double decomposition

E. both composition and decomposition

62. Two molecules of sulphuric acid can be written:

A. $2H_2SO_3$ B. $2H_2SO_4$ C. $2HSO_4$

D. H_2SO_4 E. none of these

63. The number of hydrogen atoms present in $4Na_2CO_3 10H_2O$ is:

A. 160 B. 4 C. 10 D. 2 E. 80

64. The temperature which corresponds to $283^{\circ}K$ is

A. $10^{\circ}C$ B. $12^{\circ}C$ C. $20^{\circ}C$ D. $30^{\circ}C$ E. $11^{\circ}C$

65. One litre is:

A. 100c.c B. 22.4c.c. C. 2.24c.c.

D. 1000c.c. E. 22400c.c.

66. Which of the following substances can react with an ai acid?

A. carbonate B. Metal C. oxide D. hydroxide

E. all of these.

67. Which of the following could not be made by direct union of the elements?

A. zinc sulphide B. sodium chloride

C. ferrous chloride calcium sulphide E. none of these

68. When carbon is oxidized to carbon dioxide, its valency changes from

A. +2 to +4 B. +0 to +2 C. 0 to +4

D. +0 to -4 E. none of these

69. Acidic oxides react with water directly to form

A. alkalis B. hydroxides C. peroxides

D. oxygen E. acids

70. Which of the following is not an acidic oxide?

A. carbon dioxide B. sulphur dioxide

C. nitrogen pentoxide D. ferric oxide

E. sulphur trioxide

71. Observation that every compound has a fixed composition by weight resulted in the law of

A. conservation of mass B. definite proportions

C. multiple proportions D. faseous volumes E. none of these

72. Reduce to N.T.P: 1500c.c at 800mm and 220^{o}K

A. 875 cc B. 700 cc C. 2190 cc D. 1500 cc

E. none of these

73. The man who correctly explained the law of Combining Volumes of Gases was

A. Dalton B. Avogadro C. Gay-Lussac

D. Proust E. None of these

74. If six litres of a gas at N.T.P. weighs 7.5 gms, what is its molecular weight.

A. 75 B. 38 C. 168 D. 134 E. none of these

75. The initial volume of a gas at $0^{\circ}C$ and 76mm is 273cc. At $14^{\circ}C$ and 574 mm the volume will be

A. 280c.c. B. 480c.c. C. 380c.c. D. 308c.c.

E. None of these

76. A compound which in solution or in fused state will conduct electric current and is decomposed by it is:

A. electrolysis B. non-electrolyte C. electrode

D. voltameter E. electrolyte

77. The instrument which can supply electric current is:

A. voltameter B. cathode C. anode

D. battery E. ammeter

78. Faraday's first law of electrolysis states that the weight of a substance liberated at an electrode during electrolysis is proportional to:

A. number of amperes B. time of passing the current

C. number of electrodes D. quantity of electricity passed

E. electrochemical equivalents of the elements concerned

79. Which of the following is an electrolyte

A. alcohol in water B. sugar in water

C. Acetic acid D. Distilled water

E. Milk in water

80. The term most closely associated with the idea of "electrolytes" is

A. atom B. ion C. molecule

D. Covalent bonding E. mixture

81. Tap water is usually classed as

A. a conductor B. a good electrolyte

C. a weak electrolyte D. a non-electrolyte

E. a strong electrolyte

82. The positive electrolyte in electrolysis is called;

A. anode B. cathode C. metallic electrode

D. non-metallic electrode E. none of these

83. In the electrolysis of concentrated hychochloric acid, the element discharged at the positive pole is

A. water, B. hydrogen gas C. chlorine gas D. hydrogen chloride gas E. none of these

84. In the electrolysis of copper sulphate solution using copper electrode the reaction is that

A. copper atoms are released at the anode

B. copper atoms are deposited at the anode

C. oxygen atoms are released at the anode

D. oxygen atoms are deposited at the anode

E. none of these.

APPENDIX V

TEACHER'S QUESTIONNAIRE - PERSONAL INFORMATION

If the question requires you to provide an answer, please write your answer on the line provided. If you are asked to choose one or more of several alternatives, place a check ( ) in the box(es) against the alternatives of your choice.

1. NAME: .....(Capital letters)
   SURNAME First Name
2. Female ( ) Male ( )
3. Married ( ) Single ( )
4. Nationality .....
5. Age: 16 - 20 ( )
   21 - 25 ( )
   26 - 30 ( )
   31 - 35 ( )
   36 - 40 ( )
   41 - 45 ( )
   46 - 50 ( )
   51 - 60 ( )

6. Number of years of teaching generally:-

0 - 2 ( )

3 - 5 ( )

6 - 8 ( )

9 - 10 ( )

10 + ( )

7. No of teaching years of specific subject: Chemistry, Physics/Biology/ Mathematics. .....

8. Have you a Science degree? Yes ( ) No ( )

Which?

Master of science ( ) ..... in .....

Bachelor of Science ( ) ..... in .....

Doctorate degree ( ) ..... in .....

9. Have you a teacher training diploma/degree?

Diploma in Education ( )

Postgraduate diploma in Education ( )

Bachelor's degree in Education ( )

Master's degree in Education ( )

Doctorate degree in Education ( )

10. Other Certificates received

(i) .....

(ii) .....

(iii) .....

11. Subject(s) taught chiefly at secondary school level

(a) Physics ( )

(b) Chemistry ( )

(c) Biology ( )

(d) Mathematics ( )

(e) Others not listed .....

12. Co-curricular Activities:-

(a) .....

(b) .....

(c) .....

(d) .....

APPENDIX VI

SCHOOL'S INFORMATION INVENTORY

Name of School: .....

Address .....

Year Founded .....

No of streams .....

Total population of school .....

No of teachers on the whole .....

No of science teachers .....

Types of laboratories
1. ..... No .....
2. ..... No .....
3. ..... No .....
4. ..... No .....
5. ..... No .....
6. ..... No .....

Whether
Co-educational Yes ..... No .....

Subjects Offered At O - Level
1. ..... 7. .....
2. ..... 8. .....
3. ..... 9. .....
4. ..... 10. .....
5. ..... 11. .....
6. ..... 12. .....

Assessment of standard of the Laboratories of:

	Good	Average	Poor
Chemistry			
Physics			
Biology			
Sizes of Laboratory			
Equipment for Laboratory			
Frequency of Use of the Laboratories			

No of lessons for chemistry in Form IV .....

No of lessons for chemistry in form V .....

No of laboratory attendants .....

Is chemistry-teaching well-established in the school? Yes/No

APPENDIX VII

OPINION QUESTIONNAIRE

NAME _____ SEX _____

COURSE _____ AGE _____

DATE _____

Directions: We just want to find out how you felt about certain things. There are no 'right' or 'wrong' answers.

Below are pairs of words that describe the heading at the top of the list. Each pair is on a scale. Example

Never dull ======= ===== ==== ==== ==== Always dull

Please shade the space that best reflects how you feel the word pair describes the heading at the top of the list.

MATHEMATICS

If you feel that Mathematics is for you very 'mysterious' shade as shown below -

Mysterious ==== ==== ==== ==== Understandable

It is very 'understandable'

If you have No opinion

Mysterious ==== ==== ==== ==== Understandable

CHEMISTRY AS A SUBJECT

1.	important	====	====	====	====	====	unimportant
2.	not applicable	====	====	====	====	====	applicable
3.	beneficial for society	====	====	====	====	====	harmful for society
4.	Practical	====	====	====	====	====	theoretical
5.	never intellectually exciting	====	====	====	====	====	sometimes intellectually exciting
6.	oriented towards principle	====	====	====	====	====	oriented towards facts
7.	Complex	====	====	====	====	====	Simple
8.	valuable	====	====	====	====	====	worthless nee
9.	not needed by society	====	====	====	====	====	needed by society
10.	challenging	====	====	====	====	====	not challenging
11.	good	====	====	====	====	====	bad
12.	never fun	====	====	====	====	====	sometimes fun
13.	rewarding	====	====	====	====	====	unrewarding
14.	difficult	====	====	====	====	====	easy
15.	interesting	====	====	====	====	====	not interesting
16.	opportunity for initiative	====	====	====	====	====	no opportunity for initiative
17.	discouraging	====	====	====	====	====	encouraging
18.	Exciting	====	====	====	====	====	Boring
19.	Organized	====	====	====	====	====	Unorganized
20.	Uninvolved	====	====	====	====	====	Involved
21.	Demanding	====	====	====	====	====	Undemanding
22.	Unnecessary	====	====	====	====	====	Necessary

APPENDIX VIII

OPINION QUESTIONNAIRE

NAME _____ SEX _____

CLASS NO. _____ AGE _____

DATE _____

Directions: We just want to find out how you felt about certain things. There are no 'right' or 'wrong' answers.

Below are pairs of words that describe the heading at the top of the list. Each pair is on a scale. Example.

Never dull ==== ==== ==== ==== Always dull

Please shade the space that best reflects how you feel, the word pair describes the heading at the top of the list.

MATHEMATICS

If you feel that Mathematics is for you very 'mysterious' shade as shown below -

Mysterious ==== ==== Understandable

It is very 'understandable'

Mysterious ==== ==== Understandable

If you have No opinion

Mysterious ==== ==== Understandable

CHEMISTRY INSTRUCTOR IN THE HIGH SCHOOL

1.	passive	====	====	active
2.	never intellectually exciting	====	====	sometimes intellectually exciting
3.	oriented toward principles	====	====	oriented toward facts
4.	organized	====	====	unorganised
5.	valuable	====	====	unorganised
6.	efficient	====	====	inefficient
7.	challenging	====	====	not challenging
8.	good	====	====	bad
9.	weak academically	====	====	strong academically
10.	never fun	====	====	sometimes fun
11.	helpful	====	====	not helpful
12.	authoritarian	====	====	democratic
13.	interesting friendly	====	====	not interesting friendly
14.	discouraging	====	====	encouraging
15.	exciting	====	====	boring
16.	pace inadequate for the students	====	====	boring
17.	clarifies	====	====	complicates

APPENDIX IX

COMPOSITE MATRIX OF EIGHT CHEMISTRY TEACHERS

Category	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	0	0	0	0.012	0	0	0.012	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0.024	0.002	0	0	0	0	0	0	0	0	0	0	0.012	0	0	0
3	0	0	0.13	0.51	0	0.86	0.16	0.48	0.072	0.012	0.056	0	0	0	0.38	0.036	0.093	0
4	0.012	0	0.024	0.83	0.048	0.37	0.16	0.036	5.34	0	0.036	0	0.012	0.036	0.048	0.024	0.64	0
5	0	0	0.012	0.084	0.14	0.72	0.06	0.012	0	0.024	0.060	0	0.012	0	0.024	0.024	0.064	0
6	0	0	0	2.28	0	38.98	0.29	0.048	0.06	0.29	0.27	0.024	0.072	0	4.25	0.70	1.49	0.012
7	0	0	0.012	0.012	0.012	0.30	0.90	0.024	0.25	0	0.048	0.036	0.048	0.048	0.14	0.024	0.50	0.012
8	0	0	0	0.16	0	0.25	0.048	0.072	0.18	0.024	0.024	0	0.036	0.012	0	0.09	0.048	0
9	0.012	0.036	2.11	1.59	0	1.31	0.12	0.46	0.66	0.084	0.06	0	0.012	0.012	0.14	0.12	0.12	0
10	0	0.012	0.048	0.048	0.18	0.14	0.024	0.072	0	0.012	0.012	0	0	0	0.036	0.048	0.006	0
11	0	0	0	0.012	0.64	0.02	0	0.012	0	0.012	0.24	0	0	0	0.012	0	0	0
12	0	0	0	0	0.06	0	0	0	0	0	0	0.55	0.012	0	0	0.012	0.012	0
13	0	0	0	0.036	0.012	0.048	0.084	0.072	0	0	0.012	0	3.59	0.084	0	0.036	0	0
14	0	0	0.012	0.048	0	0.012	0.096	0.048	0	0	0	0	0.06	1.51	0	0	0.062	0.024
15	0	0	0.012	0.81	0	3.96	0.096	0	0.048	0.072	0.06	0	0.024	0.084	7.32	0.12	0.27	0
16	0	0	0	0.35	0	0.35	0.06	0.012	0	0.084	0.072	0	0.084	0	0.048	3.36	0.20	0
17	0	0	0	0.72	0.06	1.42	0.34	0.012	0.24	0.024	0.048	0.04	0.012	0.04	0.47	0.048	0.92	0.012
18	0	0	0	0	0	0	0.024	0.00	0	0	0	0	0	0	0.012	0	0.028	0.064
T	0.024	0.048	2.38	7.61	1.16	48.76	2.47	0.94	6.85	0.64	0.94	0.65	3.97	1.87	13.89	4.62	4.41	0.13

N = 8,300 tallies

The values are percentage tallies.

COMPOSITE MATRIX OF EIGHT [illegible]

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0	0	0.02	0.01	0	0.02	0.02	0	0.05	0	0	0	0	0	0	0	0	0
0	0	0.06	0.01	0	0.09	0.02	0	0	0	0	0	0	0	0.01	0	0	0
0.01	0.03	0.07	0.37	0	1.25	0.13	0.03	0.13	0.01	0.01	0.01	0	0	0.26	0	0.01	0
0.02	0	0.01	0.78	0.02	0.40	0.42	0.20	4.76	0.01	0.01	0	0	0	0.08	0.06	0.79	0
0	0	0	0.04	0.03	0.18	0	0.04	0	0.03	0.01	0	0.02	0	0	0	0.03	0
0.01	0	0.03	2.97	0	38.43	0.74	0.07	0.02	0.11	0.66	0	0.02	0.06	4.40	0.05	1.92	0
0	0	0.01	0.33	0	0.58	0.78	0.06	0.97	0.02	0.08	0	0.05	0.02	0.14	0.08	0.45	0
0.01	0	0.03	0.33	0	0.49	0.21	0.10	0.09	0.01	0	0	0	0.02	0.04	0.03	0.13	0
0.07	0.15	2.02	1.14	0	1.43	0.39	0.67	0.49	0.02	0.05	0	0	0	0.31	0.02	0.11	0
0	0.01	0.02	0.04	0.07	0.05	0.01	0.06	0	0.01	0	0	0	0	0.10	0	0.01	0
0	0	0.01	0.02	0.23	0	0	0.01	0	0.04	0.01	0.01	0	0	0	0	0.02	0
0	0	0	0.01	0	0	0.01	0	0	0	0	0.08	0	0	0	0	0	0
0	0	0	0.01	0	0.01	0.06	0.01	0	0	0	0	0.26	0	0	0	0.03	0
0	0	0	0.06	0	0	0.07	0.03	0.01	0	0	0	0	2.50	0.05	0.05	0.05	0
0	0	0.02	0.59	0	3.61	0.23	0.05	0.02	0.09	0.04	0	0	0.07	10.98	0.07	0.82	0
0	0	0	0.08	0	0.05	0.03	0.06	0	0	0	0	0.01	0.10	0.01	1.81	0.07	0
0	0	0	0.78	0.01	2.31	0.53	0.10	0.33	0.03	0.08	0	0.02	0.05	0.21	0.03	1.77	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.12	0.19	2.32	7.56	0.36	48.90	3.69	1.49	6.87	0.36	0.35	0.10	0.38	2.82	16.59	2.2	6.25	0

N = 10,020 tallies

The values are percentage tallies.

APPENDIX XI

Average Percentage Tallies in each of 18-categories for Chemistry Teachers

Categories Teacher No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	0.15	0	1.00	4.20	0.87	64.67	3.21	0.22	3.69	0.36	0.22	0	0	0	16.47	0	4.67	0
2	0	0	5.32	18.37	0.37	38.55	2.44	1.35	12.81	0.19	0.25	0	0	2.91	8.97	0	8.55	0
3	0	0	0.86	3.38	1.53	47.47	3.75	1.30	2.59	0.16	1.05	0	12.16	2.09	16.19	4.51	2.96	0
4	0	0	2.53	7.11	1.14	52.80	1.36	0.78	7.63	0.13	1.48	0	0	0	18.40	3.53	3.16	0
5	0	0.31	2.55	11.01	1.93	26.83	1.63	1.70	11.33	3.09	1.13	0	1.29	0.47	19.29	13.94	3.49	0
6	0	0	2.45	6.86	1.40	65.71	1.80	0.88	8.69	0	2.16	0	0	0	5.74	0	4.29	0
7	0	0	1.77	4.57	0.68	83.69	0.19	0.17	4.38	0.34	0.69	0	0	0	3.10	0	0.88	0
8	0	0	0.39	1.21	0.31	43.81	3.17	0.34	0.73	0	0	0.31	5.90	16.02	6.93	10.27	2.49	0.22
Total of 1 - 8	0.15	0.31	16.87	56.71	8.23	423.53	17.55	6.74	51.85	4.27	6.96	0.31	19.35	21.49	95.09	32.25	30.49	0.22
Mean of Sample	0.02	0.04	2.11	7.09	1.03	52.94	2.19	0.84	6.48	0.53	0.87	0.038	2.42	2.69	11.89	4.03	3.81	0.03
Standard Deviation	0.053	0.11	1.54	5.42	0.575	17.92	1.174	0.57	4.31	1.04	0.73	0.11	4.43	5.50	6.38	5.38	7.24	0.078

APPENDIX XII

Average percentage tallies in each of 18-categories for Biology teachers

Categories / Teacher No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	0	0	0.75	2.95	0	60.53	2.85	0.39	1.86	0.12	0.07	0	0.07	0	25.57	0.13	4.70	0
2	0.08	0	2.55	8.39	0.09	52.25	3.67	1.53	7.16	0	0.09	0	0	0.16	17.97	0	6.11	0
3	0	0.38	2.48	7.16	0.69	56.35	3.32	0.48	7.01	0.34	0.52	0.12	0.49	0.70	8.15	0.12	11.67	0
4	0.21	0	5.06	14.55	1.74	41.61	4.48	6.33	14.55	0	1.89	0	0	0	6.12	0	3.42	0
5	0.28	0.86	5.77	17.21	0.49	19.20	9.71	3.60	8.52	1.84	0.65	0	0	16.00	14.26	8.14	3.52	0
6	0.19	0	0.76	7.41	0	31.56	6.46	2.28	6.08	0	0	0	4.94	1.14	8.55	17.49	13.12	0
7.	0	0.29	2.16	7.05	0.24	53.56	1.27	0.98	6.34	0.59	0.07	0	0	0	21.96	0.85	4.64	0
8	0.55	0.35	4.08	13.21	0	34.80	5.41	1.26	13.56	0	0	0.75	0	8.77	11.16	1.68	3.82	0
Total (Sample) 1 - 8	1.31	1.88	23.61	67.93	3.25	349.86	37.17	16.85	65.08	2.89	3.29	0.87	5.50	26.77	114.24	28.41	51.00	0
Mean of Sample	0.16	0.24	2.95	8.49	0.41	44.18	4.65	2.11	8.13	0.36	0.41	0.11	0.69	3.35	14.28	3.55	6.38	0
Standard Deviation	0.19	0.30	1.86	3.71	0.59	14.10	2.59	2.00	4.14	0.64	0.65	0.26	1.73	5.92	7.01	6.27	3.83	0

Appendix XIII (a) Scores of tests and questionnaires given to Chemistry Class

Test No / Student No	1	2	3	4	5	6	7	8
01	8	4	7	22	18	42	59	19
02	4	7	23	18	22	5	19	34
03	4	6	19	44	26	28	23	29
04	9	12	28	26	20	21	36	49
05	7	4	16	24	16	44	31	27
06	10	19	28	40	26	54	88	57
07	5	2	7	12	16	21	20	14
08	13	19	29	30	30	36	22	61
09	4	14	18	36	10	40	40	36
10	8	6	9	11	21	56	55	23
11	3	0	11	24	30	36	17	14
12	3	12	19	27	18	15	6	34
13	4	1	26	26	18	32	14	31
14	6	9	27	20	12	30	33	42
15	10	21	28	30	30	52	82	59
16	5	7	23	22	23	32	50	35
17	11	13	20	26	19	32	46	44
18	7	7	6	40	30	40	34	20
19	9	12	29	26	20	36	27	50
20	9	7	19	24	17	44	43	32
21	6	8	28	14	6	24	14	42
22	14	18	11	28	34	56	77	43
23	7	11	29	32	26	42	15	47
24	7	9	29	36	28	32	18	45
25	4	8	26	20	22	24	31	38
26	3	5	15	30	26	48	43	23
27	3	9	24	32	26	72	43	36
28	5	3	6	20	14	24	19	14
29	9	8	23	8	7	27	24	40
30	6	5	5	28	26	44	44	16
31	8	10	17	32	20	48	28	35
32	8	25	30	33	29	60	83	63
33	4	7	9	-5	0	36	27	20
34	5	7	14	-1	1	18	7	26
35	11	13	25	40	22	44	18	49
36	9	24	29	28	34	72	98	62
37	9	21	27	30	25	64	79	57

Code of Test numbers

1. ML
2. MQ
3. M
4. Attitude to Chemistry
5. Attitude to Chemistry teacher.
6. Chemistry achievement test.
7. Chemistry Teacher's test.
8. ML + MQ + M.

Appendix XIII (b) Scores of tests and questionnaires given to Chemistry Class

Teacher Number Two

Test No	1	2	3	4	5	6	7	8
Student No								
01	14	22	25	33	27	88	74	61
02	3	10	23	36	30	68	47	36
03	9	16	26	24	26	32	23	51
04	9	12	25	36	30	36	38	46
05	8	16	28	23	25	32	23	52
06	16	23	27	27	23	40	52	66
07	7	10	27	25	25	60	47	44
08	13	13	18	24	11	48	25	44
09	7	16	14	11	10	36	41	37
10	7	6	29	32	24	48	43	42
11	6	14	26	33	27	64	41	46
12	10	11	25	32	14	40	25	46
13	11	28	29	32	28	56	36	68
14	14	7	22	6	14	52	21	43
15	8	8	26	32	27	56	58	42
16	9	16	28	25	15	60	35	53
17	8	17	28	15	18	56	48	53
18	13	13	28	32	28	60	64	54
19	7	23	31	32	30	44	26	61
20	10	8	28	34	30	44	39	46
21	14	13	20	16	30	40	24	47
22	11	14	22	27	20	48	50	47
23	9	18	30	30	29	40	26	57
24	6	15	29	26	30	64	59	50
25	4	9	18	25	21	20	28	31
26	7	9	26	28	16	36	37	42
27	27	21	29	20	4	68	66	77
28	8	14	25	19	20	56	53	47
29	7	13	24	32	24	36	20	44

Appendix XIII C - Scores of tests and questionnaires given to Chemistry Class Teacher Number Three

Test No / Student No	1	2	3	4	5	6	7	8
01	7	17	24	33	24	28	23	48
02	6	13	27	22	20	8	17	46
03	7	12	31	27	20	48	64	50
04	7	4	21	38	24	28	62	32
05	13	4	25	44	28	36	40	42
06	7	4	28	27	30	32	28	39
07	9	8	20	40	28	28	57	37
08	10	14	22	23	17	40	41	46
09	7	10	24	16	23	48	27	41
10	0	7	14	4	8	16	45	21
11	7	0	20	-5	5	36	50	27
12	12	4	24	44	30	20	38	40
13	6	11	25	13	21	40	41	42
14	7	16	13	24	22	44	63	36
15	11	17	24	12	13	18	57	52
16	6	15	28	23	-3	24	71	49
17	8	14	29	24	26	36	40	51
18	7	6	10	38	30	36	35	23
19	10	12	22	32	22	28	42	44
20	11	14	30	27	30	32	29	55
21	6	16	28	28	25	20	24	50
22	7	4	18	32	26	28	28	29
23	9	16	20	32	24	20	34	45
24	8	15	26	28	27	24	34	49
25	10	9	21	40	19	32	21	40
26	11	8	14	5	15	32	48	33
27	9	5	25	22	3	40	23	39
28	11	12	22	32	28	36	40	45
29	7	7	26	24	23	32	40	40
30	9	6	28	16	8	24	41	43

Appendix 13 (d) Scores of tests and questions given to Chemistry Class

Teacher Number Four

Test No	1	2	3	4	5	6	7	8
Students No								
01	9	10	21	30	18	36	33	40
02	12	6	27	26	22	54	48	45
03	9	19	28	30	-6	54	33	56
04	12	6	28	34	23	51	50	46
05	14	16	24	33	19	72	58	54
06	7	19	30	17	21	54	30	56
07	9	13	25	34	24	39	32	47
08	11	16	30	30	24	39	44	57
09	8	9	19	22	12	21	35	36
10	15	16	27	34	20	60	74	58
11	8	20	26	18	20	48	56	54
12	11	16	27	28	21	60	49	54
13	8	20	22	30	24	51	61	50
14	11	15	29	18	16	24	30	55
15	13	21	29	22	20	54	52	63
16	14	18	24	29	21	57	58	56
17	12	11	26	16	20	42	62	49
18	15	15	27	20	20	45	32	57
19	15	22	28	44	34	84	81	65
20	21	12	21	29	30	36	42	54
21	11	4	25	26	10	48	37	40
22	6	5	24	26	20	81	73	35
23	16	15	29	32	18	66	85	60
24	11	3	24	27	21	45	39	38
25	4	12	26	10	16	57	24	42
26	7	8	23	19	9	30	23	38

Appendix XIII (e) Teacher number Scores of tests to questionnaires given to Chemistry Class Teacher No Five

Test No / Students No	1	2	3	4	5	6	7	8
01	10	17	25	32	16	44	44	52
02	12	14	26	24	18	4	28	52
03	7	10	24	37	19	32	55	41
04	7	7	24	32	23	48	44	38
05	3	17	29	20	17	48	58	49
06	12	8	25	23	3	40	47	46
07	8	14	23	29	23	60	67	45
08	7	19	30	21	19	44	60	66
09	15	14	24	30	24	48	75	53
10	11	18	21	24	26	32	49	50
11	6	10	19	6	24	28	30	35
12	7	7	27	26	20	48	56	41
13	2	3	15	28	16	32	55	20
14	10	14	28	9	19	56	47	52
15	10	12	24	34	22	52	57	46
16	8	11	27	0	18	28	52	46
17	11	17	25	36	0	56	57	53
18	12	14	18	2	-6	36	45	44
19	13	19	26	26	16	32	62	58
20	15	14	27	27	0	40	52	56
21	11	6	21	30	-1	64	77	38
22	14	17	29	2	-1	24	52	60
23	8	11	25	23	21	28	47	44
24	13	22	27	9	4	28	51	62
25	5	9	25	18	11	36	37	39
26	9	7	25	32	24	32	38	41
27	14	16	24	38	24	52	75	54
28	6	3	24	-2	0	28	22	33
29	10	10	22	31	22	48	56	42

Appendix XIII (f) - Scores of tests and questionnaires given to Chemistry Class

Teacher Number Six

Test No	1	2	3	4	5	6	7	8
Students No								
01	11	16	28	36	26	28	33	55
02	8	7	24	32	22	52	38	39
03	14	22	29	32	-7	28	41	65
04	9	17	26	32	21	44	23	52
05	8	6	19	20	7	56	28	33
06	14	13	26	-2	36	52	53	
07	12	13	19	23	12	68	29	44
08	14	12	24	36	22	64	53	50
09	10	23	23	40	31	48	40	56
10	16	17	30	6	-26	40	31	63
11	9	21	33	40	26	60	35	63
12	12	15	28	11	3	48	28	55
13	10	19	28	27	-24	40	21	57
14	22	20	29	32	13	68	62	71
15	10	17	25	36	16	40	21	52
16	12	18	27	37	28	48	66	57
17	13	17	28	-6	-5	40	42	58
18	7	15	29	42	16	60	44	51
19	19	23	32	26	24	60	47	75
20	4	15	19	24	-18	68	38	38
21	9	11	23	24	10	56	44	43
22	5	7	22	30	13	40	34	34
23	11	11	26	24	6	40	35	48
24	13	13	26	44	30	36	41	52