

THE UNIVERSITY OF HULL

Teacher Performance Characteristics and Pupil
Outcomes Within Science Classrooms in Kuwaiti
High Schools

being a thesis submitted for the degree of
Doctor of Philosophy

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By

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Purpose of the Study

No one can deny the wealth of information, that has been gained in the last seventy years or so, in relation to what happens in classrooms, and about relationships between teachers' behaviours and other variables related to the quality of teaching.

The main purpose of this study was to:

- 1) see how science has been introduced in some Kuwaiti high schools;
- 2) examine the effects the adopted methods of teaching may have had on Kuwaiti pupils' intellectual outcomes;
- 3) examine the effects the sex of pupils /teachers may have had on the intellectual attainments of the observed fourth grade high school pupils;
- 4) assess how pupils perceived their science teachers' behaviours and to compare these perceptions with those of science supervisors, in Kuwait, of these same teachers;
- 5) examine the effects the sex of pupils/teachers may have had on the perception of pupils to the characteristics of their science teachers and
- 6) locate variables related to both the behaviours of the observed science teachers, in their classrooms, and the teacher-pupil classroom interaction variables that affected the achievement of science pupils.

Thus this present research is the first comprehensive observational study undertaken of science teaching in Kuwaiti high schools.

AMENA, ■ Ibraheem Hussain Ali El-metthen.

Ph.D. Education.

To

Father	Ebraheem Al-methen
Mother	Nora Al-humaidan
Sister	Loulwa
Sister	Istiklal
Sister	Elham
Brother	Walaed
Brother	Nabeel
Brother	Sameer
Brother	Salah
Brother	Issam
Brother	Mohammed
Brother	Hissam

For Their Financial and Moral Support During
The Period of my Study

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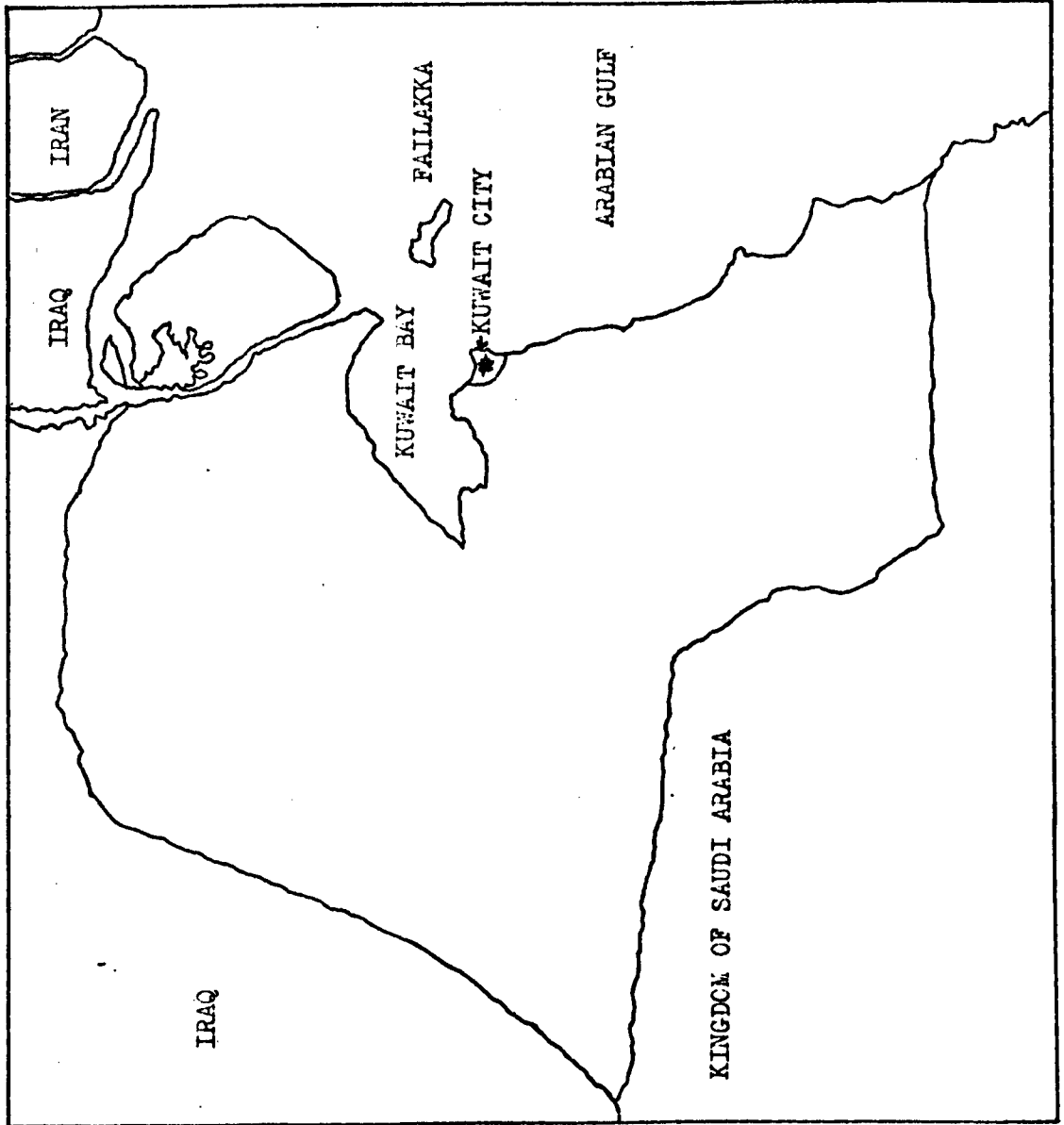
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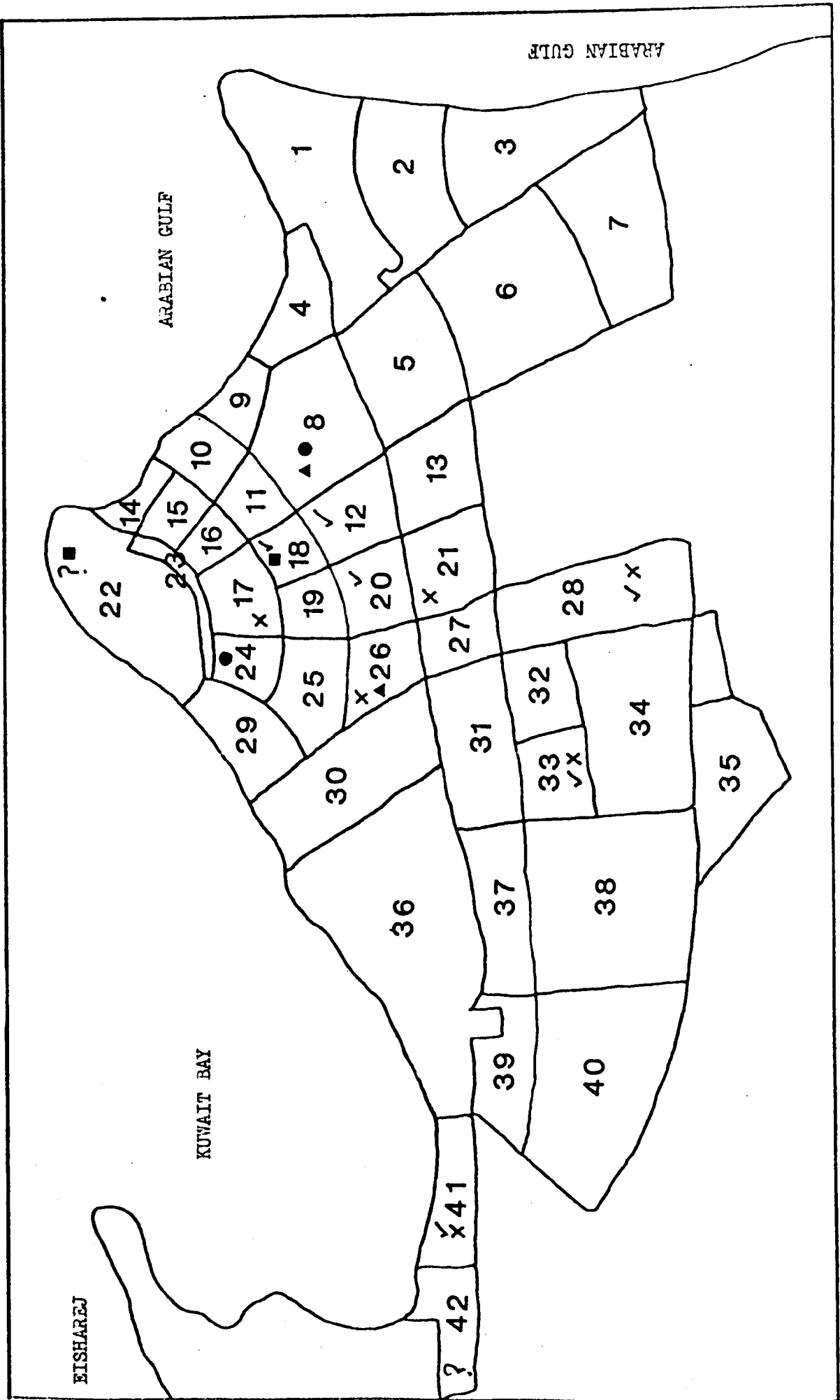
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The Map Of Kuwait





Where x and ✓ = Male and Female Kuwaiti High Schools
who participated in the main study

x = Male High Schools(6)

✓ = Female High Schools(6)

Where ● and ▲ = Male and Female Kuwaiti Institutes
who participated in the pilot study

▲ = Male commercial and teacher institutes(2)

● = Female commercial and teacher institutes(2)

Where ? and ■ = Male and Female Kuwaiti High Schools
who participated in the pilot study

? = Male High Schools(2)

■ = Female High Schools(2)

Purpose of the Study

No one can deny the wealth of information, that has been gained in the last seventy years or so, in relation to what happens in classrooms, and about relationships between teachers' behaviours and other variables related to the quality of teaching.

The main purpose of this study was to:

- 1) see how science has been introduced in some Kuwaiti high schools;
- 2) examine the effects the adopted methods of teaching may have had on Kuwaiti pupils' intellectual outcomes;
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- 5) examine the effects the sex of pupils/teachers may have had on the perception of pupils to the characteristics of their science teachers and
- 6) locate variables related to both the behaviours of the observed science teachers, in their classrooms, and the teacher-pupil classroom interaction variables that affected the achievement of science pupils.

Thus this present research is the first comprehensive observational study undertaken of science teaching in Kuwaiti high schools.

INTRODUCTION

Factors Underlying the Purpose of the Present Study

Several factors lay behind the origin of this study, some of which are related to educational research as a whole, while others are especially restricted to the teaching of science in Kuwait.

A. Factors related to educational research in general

Despite the accumulation of research findings on teaching quality, it was found to be particularly difficult to provide a single model for effective teaching with a coherent structure which would either facilitate theory development or guide practice in the teaching-learning situation. Four of the following main reasons may be suggested for this position:

- 1) Many of the instruments used in research (which will be mentioned in some of the following chapters) were of "specific condition" studies (Rosenshine, 1970; Medley and Mitzel, 1963, Pederson and Jacobs, 1976).^{1,2,3.} Such studies were either too limited to be of general interest and application, or of specific interest to the research being carried out, such as some experimental studies which had been carried out under special "test" situations, for example, to investigate the effect of new curricula (Renner, et al., 1977; Anderson, et al.,

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1. Rosenshine, B. 1970(a) "Evaluation of classroom Instruction". Review of Educational Research, Vol.40, No.2, pp.279-300.
 2. Medley, D.M., and Mitzel, H.E., 1963 "Measuring Classroom Behaviour By Systematic Observation". In: Handbook of Research on Teaching, N.L.Gage (ed.), Rand McNally and Company, Chicago, pp.247-328.
 3. Pederson, A.A., and Jacobs, J.E. 1976. "The Effect of Grade Level on Achievement In Biology", Journal of Research In Science Teaching, Vol.13, No.3, pp.237-241.

1969)^{1,2} or to study the effect of new experimental teaching methods (Dunkin and Biddle, 1974; and Renner, et al., 1977)^{3,4}.

2) In spite of the consistent results gained by some studies, in recent years, which operationally have tried to define some teaching variables and examine their relationships to both pupils' outcomes and teaching excellence, many educators, however, are still dissatisfied with the fruitless outcomes published by many other studies (Gage, 1963; Medley and Mitzel, 1963; Wallen and Travers, 1963; and Getzel and Jackson, 1963)^{5,6,7, & 8}. This arises, because, such studies show either instability or little correlation between various observed variables (Erlich and Shavelson, 1978; Rosenshine, 1970; Heath and Nielson, 1974;

1. Renner, J.W., Abraham, R.M., and Stafford, D.G. 1977 "A Summary of Research in Science Education, 1976". ERIC Information Analysis Center for Science, Mathematics and Environmental Education, Columbus, Ohio, National Association for Research in Science Teaching, National Inst. of Ed. (DHEW), Washington, D.C.
2. Anderson, G.J., Walberg, H.J., and Welsh, W.W. 1969. "Curriculum Effects on the Social Climate of Learning: A New Representation of Discriminant Functions", American Educational Research Journal, Vol.6, No.3, pp.315-328.
3. Dunkin, M.J., and Biddle, B.J., 1974, "The Study of Teaching", Holt, Rinehart and Winston, Inc.
4. Renner, W.J., Abraham, R.M., and Stafford, G.D. 1977, op.cit.
5. Gage, N.L., 1963. "Paradigms For Research on Teaching. In: Handbook of Research on Teaching, Gage, N.L., (ed.). Rand McNally and Company, Chicago, pp.94-141.
6. Medley, D.M., and Mitzel, H.E., 1963, op.cit.
7. Wallen, N.E., and Travers, R.M.W. 1963. "Analysis and Investigation of Teaching Methods". In Handbook of Research on Teaching, N.L. Gage (ed.), Rand McNally and Company, Chicago, pp.448-505.
8. Getzel, J.W. and Jackson, P.W. 1963. "The Teacher, Personality and Characteristics". In Handbook of Research on Teaching, N.L. Gage (ed.), Rand McNally and Company, Chicago, pp.506-582.

Evans, 1962, Vecchio and Costin, 1977; and Brophy and Evertson, 1974).^{1,2,3,4,5 & 6}

3) Another reason, limiting the generalization of most results of classroom studies, is connected with differences in the duration of some studies, the grade levels chosen; the subject matter chosen, pupils' aptitude differences, sex differences, together with differences in place and culture (Barr, 1950; and Veldman and Peck, 1969).^{7,8}

4) The variety of variables (Shadbolt, 1978)⁹ being investigated also hindered the generalization of most previous studies. In addition, there was a lack of agreement on both a standard definition of teacher efficiency (Barr, 1950; and Vecchio and Costin 1977)^{10,11} as well as on the validity

1. Erlich, O. and Shavelson, R.J. 1978 "The Search for Correlations Between Measures of Teacher Behaviour and Student Achievement": Measurement Problem, Conceptualization Problem, or Both?, Journal of Educational Measurement, Vol.15, No.2, pp.77-89.
2. Rosenshine, B. 1970(b). "The Stability of Teacher Effects Upon Students Achievement". Review of Educational Research, 40,pp.647-662.
3. Heath, R.W. and Nielson, M.A. 1974 "Research Basis for Performance-Based Teacher Education". Review of Educational Research, 44,pp.463-484.
4. Evans, K.M. 1962. "Sociometry and Education". Routledge and Kegan Paul.
5. Vecchio, R. and Costin, F. 1977. "Predicting Teacher Effectiveness from Graduate Admissions Predictors". American Educational Research Journal, Vol.14, No.2, pp.169-176.
6. Brophy, E.J. and Evertson, C.M. 1974. "Process-Product Correlations in the Texas Teacher Effectiveness Study. Final Report" The Research and Development Center for Teacher Education, The University of Texas at Austin, Report No.74-4.
7. Barr, A.S. 1950 "Teaching Competencies". Encyclopedia of Educational Research, pp.1446-1454.
8. Veldman, D.J. and Peck, R.F., 1967, "The Pupil Observation Survey: Teacher Characteristics From the Students' View Point" Texas University, Austin, Research and Development Center for Teacher Education, Report No. RMM-2, pp.1-25.
9. Shadbolt, R.D. 1978 "Interactive Relationships Between Measured Personality and Teaching Strategy Variables". British Journal of Educational Psychology, 48, pp.227-231.
10. Barr, A.S., 1950, op.cit.
11. Vecchio, R. and Costin, F. 1977, op.cit.

of criteria chosen for evaluating effective teaching (Kirk, 1969; and Tatsuka and Tideman, 1963).^{1,2}

5) Furthermore, there was often a lack of agreement on the terms for describing classroom dimensions. These different terms could be applied to the description of either a teacher's style of teaching or of his/her controlling behaviour in the classroom (see chapter 1 pp.20-21).

B. Factors Related to Science Education in Kuwait

Science education has developed rapidly in Kuwait over the past thirty years. Its importance in the curriculum reflects its vital role in the development of this country. In liaison with the Ministry of Education, researchers have focussed upon trying to modify the science curriculum to make it more appropriate to the needs of the teaching of science in Kuwaiti schools. Thus many curriculum techniques have been developed and introduced into schools.

The provision of educational television through closed circuit, has been one noticeable innovation (beginning in 1973) introduced, as a first step, in helping teachers to impart science to their pupils in a more efficient manner. The failure and the success of these attempts, however, at improving both the quality of the science curriculum and the teaching of science, have been mainly judged on pupils' intellectual outcomes, and on pupil/teacher supervisor's opinions. In spite of the fact that teachers and pupils constituted the more important elements involved in the educational process, they were seldom consulted. Often their reactions during the initial experimental stage (when observations were taking place) and later at the end of the experimental stage were totally ignored.

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1. Kirk, G. 1969. "Measuring Teacher Competence." Scottish Educational Studies. 1, 3, pp.26-31.
 2. Tatsuka, M.M. and Tideman, D.V. 1963 "Statistics as an Aspect of Scientific Method in Research on Teaching". In: Handbook of Research on Teaching, N.L.Gage (ed.). Rand McNally and Company, Chicago, pp.142-170.

Moreover, pupils in Kuwait were never approached on their perceptions of the methods and techniques being used in the teaching of science.

It is apparent that the usual approach has serious shortcomings, because important elements in the educational process are being left out.

In conclusion, there was considerable dissatisfaction with the results reached by some researchers as a consequence of conflicting results, design weaknesses inherent in many studies, and some difficulty in reaching standard definitions of both effective teaching and related variables.

Thus accurate knowledge about teaching efficiency is rather limited, and there is a real need for more research on classroom interactions. Furthermore, the involvement of pupils, in the data-gathering process (Medley & Mitzel, 1963; and Hughes, et al., 1959)^{1,2} of classroom interactions, will no doubt be of great help especially to those educators who are spending an enormous amount of time and effort in improving education in different parts of the world.

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1. Medley, D.M. and Mitzel, H.E., 1963 op.cit.
 2. Hughes, M.M., Devaney, E.F., Fletcher, J.R., Miller, L.G., Rowan, N.T. and Welling, L. 1959. "Development of the Means for the Assessment of the Quality of Teaching in Elementary Schools." A Research Report. Utah University, Salt Lake City, Report Number CRP-353 ED 002 844.

CHAPTER I

Educational Research and Effective Teaching

Synopsis

This chapter is concerned with three main areas, all of which are related to effective teaching in one way or another.

The first part of the chapter is concerned with:-

- 1) Various definitions of effective teaching as seen by educators.

The second part of the chapter is concerned with:-

- 1) Factors affecting effective teaching as isolated by teachers.

Some of these factors are related to teachers while others are related to pupils or to the environment of the classroom, e.g.

- a. teacher's knowledge of the subject matter,
- b. communication skills,
- c. motivation,
- d. educational environment, and
- e. independence.

The third part of the chapter is concerned with:-

- 1) Studies that have been carried out by investigators in their attempts to uncover the many variables related to effective teaching. Some of these studies were concerned with, e.g.,

A. Teachers' behaviours and pupils' outcomes;

- a. teachers' controlling behaviours (i.e., teaching methods)
- b. teachers' beliefs,
- c. teachers' attitudes.

B. Pupils' variables;

- a. sex of pupils,
- b. attitudes of pupils,
- c. intelligence of pupils,

- d. levels of pupils' attention,
- e. motivation of pupils', and
- f. efforts of pupils.

These educators tried to relate teachers' behaviours and attitudes as well as pupils' variables to effective teaching.

2) Studies by which researchers attempted to establish an appropriate way by which effective teaching can be measured, e.g.,

- a. pupils' achievement.

1.10 INTRODUCTION

The primary goal of educational research is seen by Anderson, Walberg, and Welch (1969)¹ as an attempt "to establish the conditions for effective learning in school classes".²

Much of educational research focused on classroom interaction and teaching efficiency in one way or another. Many educators, who were interested in studying effective teaching, have spent much time and effort in trying to study what really happens in any classroom, and in finding out how "effective" teaching could be "defined" and "accomplished".

Part One

1.20 Various Definitions of Effective Teaching as seen by Educators.

What is teaching efficiency?

A study of past reports has shown a varied approach to the subject of teaching efficiency. As far as Barr (1950)³ is concerned, teaching efficiency has not yet been adequately defined, because, the crucial factors which are essential for effective teaching, have not yet been uncovered. Matters have been further complicated by Stafford and Graves (1978),⁴ whose report indicated that "the definitions of effective teaching vary with the nature of the educational program".⁵ Gage (1963),⁶ on the other

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1. Anderson, J.G., Walberg, J.H., and Welch, W.W., 1969 op.cit.
 2. Anderson, J.G., Walberg, J.H., and Welch, W.W., 1969, ibid.(p.315).
 3. Barr, A.S. 1950, op.cit.
 4. Stafford, L. and Graves, C. 1978. "Some Problems In Evaluating Teacher Effectiveness". Nursing Outlook, Vol.26, No.8, pp.494-497.
 5. Stafford, L. and Grave, C. 1978, ibid. (p.497).
 6. Gage, N.L. 1963, op.cit.

hand, claimed that the efficiency of teachers could be seen by the "realization of some values which take the form of some educational objectives".¹ These values were listed as pupils' achievement, attitude, behaviour, and so forth.

Part Two

1.21 Components of effective teaching

Medley and Mitzel (1963)² claim that:

"Most classroom visitors go to the classroom not to find out what effective teacher behaviour is, but to see whether the teacher is behaving effectively, i.e., the way they believe he should behave".³

This brings us to the question of what constitutes "good" or "effective" teaching.

Despite the complications alluded to earlier in deriving an agreed definition of teaching efficiency, several educators, during the past decade, have emphasized certain aspects of the educational process, considering these particularly important in forming a sound basis for "good" teaching. Those most frequently mentioned were a teacher's knowledge of his/her subject matter, communication skills, repetition, motivation, appropriate educational environment and pupils' independence.

1.22 Teacher's Knowledge of his/her Subject Matter:

A teacher's knowledge and understanding of the subject matter he is teaching are fundamentally important attributes of the successful teacher

1. Gage, N.L. 1963 *ibid.*, (p.116)

2. Medley, D.M. and Mitzel, H.E. 1963, *op.cit.*

3. Medley, D.M. and Mitzel, H.E. 1963, *ibid.* (p.257).

(Getzel and Jackson, 1963; and Goates and Thoresen, 1976).^{1,2} On the other hand, however, it is necessary to emphasise that it is pointless to have a teacher who is an expert in his subject, but who is unable to impart successfully his knowledge to his pupils or to inspire them with an interest to learn from him (Dewey, 1933; and Vecchio and Costin, 1977).^{3,4}

Indeed we may have a teacher, whose knowledge of the subject is just about satisfactory, but who has all the true qualities of a good teacher, e.g., the ability to listen, to encourage enquiry, to awaken and satisfy pupils' curiosity, to enhance their social sensitivity and awareness, or who is, in short, "around and about the classroom, guiding, probing and encouraging".⁵

Indeed, some teachers tend to believe that they have performed all the preparations required of them before they enter the classroom if they have acquired a good knowledge of the subject matter intended to be taught to their pupils. This makes them pay little attention to other factors vital for their success as teachers, for instance, the psychology of learning (especially as related to the specific subject they are teaching), their pupils' attitudes, abilities and attainments, their needs and experiences, interests, drives,⁶ and all those complex factors that make

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1. Getzel, J. W. and Jackson, P.W. 1963, op.cit.
 2. Goates, J. T. and Thoresen, E.C. 1976 "Teachers Anxiety: A Review with Recommendations". Review of Educational Research, Vol.46, No.2, pp.159-184.
 3. Dewey, J. 1933 "How we think". A Restatement of Relation of Reflective Thinking to the Educative Process, D.C.Heath and Company.
 4. Vecchio, R. and Costin, F. 1977, op.cit.
 5. Shaefer, G.J., 1971 "Teaching the Teachers" New Dimension for Instructional Roles, In: R.C. Pucinski and S.P.Hirsch (eds.). The Courage to change: New Directions for Career Education, Englewood Cliffs, N.J.: Prentice Hall (p.136).
 6. Taba, H. 1932 "The Dynamics of Education", A Methodology of Progressive Educational Thought, London, Kegan Paul, Trench, Turbner and Company Ltd.

the teaching situation an enjoyable, stimulating, and creative enterprise. After all, the teaching-learning process is a human exchange in which both teachers and pupils take part. In other words, such teachers overlook the fact that truly successful teaching is a complex process of communication based upon creative interactions between teachers and pupils.¹

If one was to criticise a particular aspect of their personal behaviour in the classroom or some other aspect of their performance, which is not strictly related to their expertise and knowledge of the subject matter, these teachers may be reluctant to accept such criticism, or, at best, they may dismiss it as not really important. Their reluctance to appreciate this type of criticism rests partly upon the fact that although it is generally agreed that a teacher's knowledge and competence in his field of teaching is essential, there is less agreement upon the many conditions, skills, and qualities that a "good" and "effective" teacher should possess.

1.23 Communication skills

Churchill and Samuel (1976)² are among those educators who stress the importance of the personal style of a teacher and particularly his communication skills. According to these two writers, essential personal qualities and methods of a "good" teacher include his/her dynamism, delivery, time spent with pupils, positive pupil reinforcement, and positive attitudes towards pupils. Anderson, (1971)³ in addition emphasises the

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1. Amidon, E. and Hunter, E. 1967 "In Improving Teaching" The Analysis of Classroom Verbal Interaction, Holt, Rinehart and Winston, Inc.
 2. Churchill, R.L. and Samuel, B.L., 1976. "Communication and Teaching Effectiveness in Industrial Education". American Educational Research Journal, Vol.13, No.3, pp.181-197.
 3. Anderson, G.J. 1971 "The Assessment of Learning Environment", A Manual for the Learning Environment Inventory and the My Class Inventory, Halifax, Atlantic Institute of Education.

importance of verbal communication skills as a vital condition in effective teaching by stating that:

"Some repetition of verbal content increases communication effectiveness, whereas the inclusion of new verbal material at each step increases its efficiency." 1 (p.7)

1.24 Motivation

Bruce and Howard (1977)² write that "motivation breeds academic success and success enhances motivation".³ In other words, they consider motivation and academic success to be circular in their relationship to each other. Moreover, some other educators claim that the poor academic performance of many pupils may be largely due to poor motivation on the part of pupils, and the failure of teachers to make the learning experience sufficiently interesting. It is known though, that curiosity is considered to be part of children's lives, "but sometimes teachers, without meaning to, stifle the interests of their pupils because of the way in which they teach."⁴ Breuning (1978)⁵ adds to the importance of motivation in effective teaching by confirming that "regardless of teaching technique, there must be sufficient incentive to motivate the students to learn the course material."⁶

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1. Ibid., p.(7).
 2. Bruce, A.C. and Howard, M.B. 1977. "Indian Education in the City, Correlates of Academic Performance". Journal of Educational Research, Vol.70, No.3, pp.135-141.
 3. Ibid., p.140.
 4. Amidon, E. and Hunter, E. 1967 op.cit., (p.18).
 5. Breuning, E. Stephen, 1978. "Precision Teaching in The High School Classroom: A Necessary step Towards Maximizing Teacher Effectiveness and Student Performance". American Educational Research Journal, Vol.15, No.1, pp.125-140.
 6. Breuning, E.S. 1978 ibid. p.137.

1.25 Educational Environment

Other educators concerned with effective teaching, assert that teaching will not attain a high level of efficiency in the absence of an appropriate environment in the classroom. An appropriate environment is a complex situation involving many factors, such as, the absence of tension in the classroom, where pupils feel relaxed enough to be able to communicate with their teacher and vice-versa; sufficient preparation of the studied subjects on the part of the teacher; teacher's impartiality towards all pupils, and so forth. Fraser (1975)¹ found that this appropriate environment had "a potent influence on learning".² Furthermore, Power and Tisher (1975)³ allege that, in the right environment, genuine understanding and sensitivities may be developed regardless of the curriculum used.

1.26 Independence

By "independence" it is particularly understood that pupils are encouraged to be responsive in class and to show their full intellectual potential without having to rely completely on their teachers. The development and the encouragement of independence have been recognized by educators as some of the most important aims and conditions of effective teaching. Flanders (1967, 1970)^{4,5} for instance believed that the most important

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1. Fraser, J. Barry, 1975 "The Impact of ASEP on Pupil learning and Classroom Performance", Research in Science Education, Vol.5, pp.1-12.
 2. Ibid. (p.2).
 3. Power, N.C. and Tisher, R.P. 1975. "Experimental Studies of Teacher Structuring Behaviour in ASEP Classroom". Research in Science Education Vol.5, pp.13-21.
 4. Flanders, N.A. 1967. "Some Relationships Among Teacher Influence, Pupil Attitudes, and Achievement". In Amidon-Hough (eds.), Interaction Analysis: Theory, Research and Application, pp.217-242.
 5. Flanders, N.A. 1970. "Analyzing Teacher Behaviour". Addison-Welsely Publishing Company, Inc. Philipines.

responsibility of a "good" teacher was to change the response patterns of his pupils from development to independent ones. Taba (1932)¹ considered that this can be achieved when teachers stop providing "ready answers to ready questions."² (see also: Glaser, 1966; Burner, 1966; McKeachie, 1954 and 1963).^{3,4,5,6}

1.27 Conclusion

Most of the early studies of teacher effectiveness evoked universal qualities of effective teachers. For example, it was assumed that an effective teacher is intelligent, well organized, active, warm, has good knowledge and understanding of his subject, and is a good disciplinarian. The teacher, who possessed these characteristics to a lesser extent, would be less effective. Although there may be general agreement with these qualities for the effective teacher; such qualities may not need to be held with the same intensity for all types of subject matter, grades, pupils' sex, or level of ability. Consequently, it is possible that some qualities may be very important and may have predominant influences on the

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1. Taba, Hilda, 1932 op.cit.
 2. Ibid., p.237.
 3. Glaser, R. 1966 "Variables In Discovery Learning". In L.S.Shulman and E.R.Keislar (eds.). Learning by Discovery, A Critical Appraisal, Chicago, Rand McNally.
 4. Burner, J.S. 1966 "Some Elements of Discovery" in L.S.Shulman and E.R. Keislar (eds.). Learning by Discovery, A Critical Appraisal, Chicago; Rand McNally.
 5. McKeachie, W.J. 1954. "Student Centred Versus Instructor Centred Instruction". Journal of Educational Psychology, 45, pp.143-150.
 6. McKeachie, W.J. 1963. "Research on teaching at The College and University Level". In: Handbook of Research on Teaching, Gage, N.L. (ed.). Chicago, Rand McNally and Company, pp.1118-1172.

effectiveness of teaching, whereas others may not, because, one has to realize that each teaching situation and each classroom are often unique. Often it is only when the teacher in charge projects his own personality into his teaching that pupils can find warmth with which to respond.

Therefore, teaching is often considered as a difficult art (Willard, 1932; Gallagher, 1970; Dunkin and Biddle, 1974; Medley and Mitzel, 1963; and Flanders, 1967 and 1964).^{1,2,3,4,5,6}

It needs a skilled teacher to carry out the responsibility of practising this art (Hight, 1950; and Stern, 1963).^{7,8} In other words, effective teaching is more likely to occur if the teacher has an adequate mastery of the subject matter he is teaching and of the various kinds of techniques he will be using to achieve the required educational goals of his profession (Gallagher, 1970; Shavelson, et al., 1977; and Broudy,

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1. Willard, Waller, 1932. "The Sociology of Teaching". John Wiley and Sons, Inc. New York.
 2. Gallagher, J.J. 1970. "A Topic Classification System for Classroom Interaction" In Classroom observation. J.J. Gallagher, G.A. Nuthall, and B. Rosenshine, American Educational Research Association Monograph Series on Curriculum Evaluation, Monograph No.6, Chicago, Rand McNally.
 3. Dunkin, M.J. and Biddle, B.J. 1974, op.cit.
 4. Medley, D.M. and Mitzel, H.E. 1963, op.cit.
 5. Flanders, N.A. 1967, op.cit.
 6. Flanders, Ned.A. 1964. "Some Relationships Among Teacher Influence, Pupil Attitudes, and Achievement". In Contemporary Research on Teacher Effectiveness. Biddle, J. Bruce and Ellena, J. William (eds.), Holt Rinehart and Winston.
 7. Hight, G. 1950 "The Art of Teaching", New York, Knopf.
 8. Stern, G.G. 1963, "Measuring Non-Cognitive Variables in Research on Teaching" in: Handbook of Research on Teaching. N.L. Gage (ed.), Rand McNally and Company, Chicago, pp. 398-447

1963).^{1,2,3} He should, for instance, be able to decide what methods to use and when to use them. As Dewey (1933)⁴ puts it, "it is an old saying that unity in variety makes every work of genuine art. Certainly the art of teaching bears out the saying."⁵

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1. Gallager, J.J. 1970 op.cit.
 2. Shavelson, R.J., Cadwell, J. and Izu, T. 1977. "Teachers' Sensitivity to The Reliability of Information in Making Pedagogical Decisions". American Educational Research Journal, Vol.14, No.2, pp.83-97.
 3. Harry, S.Broudly, 1963. "Historic Exemplars of Teaching Methods". In: Handbook of Research on Teaching. Gage, N.L. (ed.), Chicago, Rand McNally, pp.1-43.
 4. Dewey, J. 1933, op.cit.
 5. Ibid., (p.53).

Part Three

1.30 Studies Related to Effective Teaching

Effective Teaching and Changes in Pupils' Behaviours

Anyone who wants to understand how effective teaching may be accomplished, must understand not only teaching and the whole educational process, but also the outcomes of the process which appear in the changes that take place in the learner (Barr, 1950; Hughes, 1963, Thorndike and Hagen, 1969; Medley and Mitzel, 1963; Remmers, et al.1966).^{1,2,3,4,5}

Bloom (1963)⁶ believes that if the criteria of effectiveness are not related to changes in pupils' behaviour, the researchers have used only proximate criteria and have avoided the main ones. Moreover, Saadeh (1970)⁷ adds that:

"No definition of the teaching act can assume that the test of its effectiveness does not lie in its accomplishment of the goals of education in terms of some pupils' outcomes." 8

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1. Barr, A.S. 1950 op.cit.
 2. Hughes, M.M. 1963 "Utah Study of the Assessment of Teaching." In: Theory of Research in Teaching, Bellack, A.A. (ed.). Bureau of Publications, Teacher College, Columbia University, New York.
 3. Thorndike, R.L. and Hagen, E. 1969. "Measurement And Evaluation in Psychology and Education". John Wiley and Sons, Inc.
 4. Medley, D.M. and Mitzel, H.E. 1963. op.cit.
 5. Remmers, H.H., Gage, N.L.; and Rummel, F.J. 1966 "A Practical Introduction to Measurement and Education". A Harper International Student Print, Harper & Row, John Weatherhill Inc.
 6. Bloom, B.S. 1963. "Testing Cognitive, Ability and Achievement" In Handbook of Research on Teaching, N.L. Gage (ed.), Rand McNally and Company, Chicago, pp.379-397
 7. Saadeh, I.Q. 1970. "Teacher Effectiveness on Classroom Efficiency: A New Direction in the Evaluation of Teaching". The Journal of Teacher Education; 21, 1, pp.73-91.
 8. Saadeh, I.Q. 1970, ibid. (p.74).

1.31 Effective teaching and pupils' achievement.

As soon as measures of the changes, that take place in the learner, are accepted as important criteria for measuring teaching effectiveness, there is the problem as pointed out by Denny (1968)¹ as to the sort of outcomes one should look for. Evans (1962)² suggests that the most obvious and easiest change to measure is the change in pupils' knowledge (see also: Power and Sadler, 1976; Stones and Morris, 1972; Flanders, 1970; and Eggleston, et al. 1976).^{3,4,5,6} Evans, however, considers that changes in pupils' behaviours and attitudes are not easily measurable, because changes in such variables, over a period of time, cannot always be assigned with certainty to the influence of a particular teacher or indeed to any cause. Achievement or gain by pupils has, therefore, appeared to be an obvious choice when measuring teacher competence as the teaching process has been considered to be primarily concerned with effective change in pupils.

Moreover, a large number of investigators has sought to identify different elements, relating to both teachers and pupils, which are thought

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1. Denny, D.A. 1968. "Identification of Teacher-Classroom variables Facilitating Pupil Creative Growth". American Educational Research Journal, Vol.5, pp.365-383.
 2. Evans, K.M. 1962, op.cit.
 3. Power, C. and Sadler, R. 1976. "Non-Linear Relationships Between Measures of Classroom Environments and Outcomes". Research in Science Education, Vol.6, pp.77-88.
 4. Stones, E. and Morris, S. 1972. "Teaching Practice". Methuen, London,
 5. Flanders, N.A. 1970 op.cit.
 6. Eggleston, J.F.; Galton, M.J.; and Jones, M.E. 1976 "Processes and Products of Science Teaching". School Council Research Studies, Macmillan Education.

to be essential to teaching success, by measuring the correlations between measures of these factors and measures of pupils' outcomes (mainly pupils' achievement). Some of these variables, commonly used, are teachers' controlling behaviours and attitudes, and pupils' attitudes, intelligence, level of attention and motivation. These were considered by many educators as some of the most important elements by which pupil achievement may be predicted.

1.32 Teachers' behaviours and pupils' outcomes

1.33 Teachers' Controlling Behaviours

Different terms were applied to the dimensions of teacher controlling behaviour or style of teaching (see Dunkin and Biddle, 1974; Lewis, 1974; and Medley and Mitzel, 1963),^{1,2,3} most of which deal with warmth, directiveness and management of the teacher in the classroom. Teacher controlling behaviour has been operationally defined in various studies as:

1. Authoritarian-Democratic (Lewen, et al. 1939)⁴;

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1. Dunkin, J.M. and Biddle, B.J. 1974, op.cit.
 2. Lewis, Roman, 1974 "Teachers' Direction and Support of Student Behaviour", Research in Science Education, Vol.4, pp.141-150.
 3. Medley, D.M. and Mitzel, H.E. 1963, op.cit.
 4. Lewen, K., Lippitt, R.; and White, R. 1939 "Patterns of Aggressive Behaviour in Experimentally Created Social Climates". Journal of Social Psychology, No.10, pp.271-299.

2. Permissive-Control (Solomon, et al. 1964)¹;
3. Teacher centred-Student centred (Rogers, 1951)²;
4. Didactic-Heuristic (Eggleston et al., 1976)³;
5. Dominative-Integrative (Anderson and Brewer, 1945)⁴;
6. Directiveness-Permissiveness (Christensen, 1960)⁵;
7. Direct-Indirect (Flanders, 1960; 1967; & 1970);^{6,7,8} and
8. Instructor Centred-Student Centred (McKeachie, 1954).⁹

In reviewing some studies undertaken in recent years on teaching methods and their relationships with effective teaching, there appears to be different points of view about the efficiency of certain styles of teaching on some pupils' outcomes. Some investigators believed that certain styles of teaching - teacher controlling behaviours - may have advantages on pupils' outcomes than some other styles. On the other

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1. Solomon, D.; Bezdek, W.E.; and Rosenberg, L. 1964 "Dimensions of Teacher Behaviour" *Journal Experimental Education*, 33, 1, pp.23-40.
 2. Rogers, C.R. 1951. "Client Centred Therapy" Houghton Mifflin, Boston.
 3. Eggleston, J.F., Galton, M.J., and Jones, M.E. 1976 op.cit.
 4. Anderson, H.H. and Brewer, H.M. 1945. "Studies of Teachers' Classroom Personalities. Dominative and Socially Integrative Behaviour of Kindergarten Teachers". *Applied Psychology Monograph*, No.6.
 5. Christensen, C.M. 1960 "Relationships Between Pupil Achievement, Pupil Affect-Need, Teacher Warmth and Teacher Permissiveness". *Journal of Educational Psychology*, 51, pp.169-174.
 6. Flanders, N.A. 1960 "Teacher Influence on Pupil Attitudes and Achievement". *Cooperative Research Programme - Project No.397*, University of Minnesota, Minneapolis.
 7. Flanders, N.A. 1967 op.cit.
 8. Flanders, N.A. 1970 op.cit.
 9. McKeachie, W.J. 1954 op.cit.

hand, other educators claimed that according to various studies they had conducted, it was found that there were no differences between different styles of teaching, and that they have the same impact on pupils' outcomes.

a. Studies related to the different impact on pupil achievement by various teaching methods

Obler and his associates (1977),¹ for example, stated that, as a result of a six-year experimental programme covering pupils' academic, personal and adjustment difficulties in college, it was found that the experimental group which was taught by a new team approach called the "Teacher-Mentor-Counsellor" (TMC),² showed a better academic achievement and personal growth than the experimental group which was taught by a traditional educational programme called a "revolving door" system.³ DiVesta (1953)⁴ conducted another study to determine the relative efficiency of some instructional techniques, and found that certain instructional methods such as - lectures, seminars and illustrative presentation - were more favourably accepted by pupils than the discussion method which was found to be relatively less effective or less productive when used with large groups. In a survey of baccalaureate nursing students

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1. Obler, M.; Francis, K.; and Wishengrad, R. 1977. "Combining of Traditional Counselling, Instruction, and Monitoring Functions with Academically Deficient College Freshmen". Journal of Educational Research, Vol.70, pp.142-147.
 2. Teacher-Mentor, Counsellor (TMC): In which all faculty offer all services to the same body of pupils.
 3. A Revolving Door System:- Is a system where pupils go in and out with a little change in their abilities.
 4. DiVesta, J. Francis, 1953. "Evaluation of Several Teaching Methods by Adult Students". Journal of Educational Research, Vol.46, pp.659-671.

in two universities in the United States, Stafford and Graves (1978)¹ found that "demonstration" quality was one of the factors that influenced the success of a graduate nursing programme. Moreover, Will, C.V. (1976)², in a study of eight-year-old children, showed the superiority of "longer-worded" instructions over the "shorter-worded" ones. In a study carried out by Flanders (1967)³, achievement of pupils was found to be higher in most "indirect" classes in both mathematics and social studies than in the "direct" classes. Flanders also added that teachers who were able to shift from "indirect" to "direct" with the passage of time, were able to create situations in which pupils learned more.

Moreover, the findings of Wright's (1977)⁴ study did not signify that "deductive" and "inductive" methods were equally appropriate for all sixth-grade students. Brophy et al's (1975)⁵ findings as well, agreed with the previous results after conducting an experiment aimed at increasing the probability of obtaining stable and meaningful relationships between teacher behaviour and pupils' learning. However, depending on the

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1. Stafford, L. and Graves, C.C. Jr., 1978. op.cit.
 2. Will, C.V. 1976. "The Wording of Spoken Instructions to Children and its Effect on their Performance of Tasks". Educational Studies, Vol.2, No.3, pp.193-199.
 3. Flanders, N.A. 1967. op.cit.
 4. Wright, P. David, 1977. "Interactions Between Instructional Methods and Styles of Concept Learning". Journal of Educational Research, Vol.70, pp.150-156.
 5. Brophy, E.J.; Coulter, L.C.; Crawford, J.W.; Evertson, C.M.; and King, E.C. 1975. "Classroom Observation Scales: Stability Across Time and Context and Relationships with Student Learning Gains." Journal of Educational Psychology, Vol.67, No.6, pp.873-881.

economic status (SES)¹ of the pupil, teacher effect was found to have a differential relationship with pupils' achievement. In other words, when teachers, in low SES schools, were compared with those in high SES schools, the teaching behaviours of the teachers were found to affect the two groups of pupils differently, although these teachers proved, in previous years, to have shown good stability in their behaviour over the years. The results of the study did not turn out as was expected with teaching behaviours affecting pupils uniformly but there were significant differences when teachers worked with pupils coming from different society levels (lower-lower class to upper-middle class). These differences in pupils were reflected in their behaviours in the classroom and, thus, in their teachers' behaviour. These, in turn, affected the expected outcomes.

b. Studies showing no differences in the impact on pupil achievement of using various teaching methods

Bills (1952)² designed a study to determine if there were any differences between the two sets of achievement of 900 pupils when they were taught general psychology by two different methods. The results of the study showed that there were no measureable differences in knowledge of the course content between pupils taught by a "lecture-discussion" method and a "student-centred" method. Granville (1952)³ confirmed Bills' results after conducting a similar study with sixty-four Freshmen pupils.

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1. "The Socioeconomic status (SES) of the classroom ranged from lower-lower class to upper-middle class."
 2. Bills, Robert, E. 1952. "An Investigation of Student Centered Teaching". Journal of Educational Research, Vol.46, pp.313-319.
 3. Granville, B.Johnson, 1952. "A Comparison of Two Techniques for Improvement of Reading Skills at the College Level". Journal of Educational Research, Vol.46, pp.193-205.

Thirty-two of these pupils were taught by a new technique, namely, "group psychotherapy", while the other thirty-two pupils were taught reading skills directly. The results of the experiment showed that the new technique had no clear advantages over the other method and that both methods introduced to pupils, improved reading ability to approximately the same extent. Moreover, Veldman and Peck (1963)¹ doubted the suggestion that "democratic" methods constituted a necessary part of affecting teaching behaviour. These writers also added that, the idea of "autocratic" behaviour being related to poor teaching, needs more definitive testing in the future.

1.34 Teachers' Beliefs

The belief a teacher has towards the success and failure of his/her pupils is considered by many educators to be an important element affecting the achievement of these pupils. Palardy (1969)², for example, concluded that first-grade boys whose teachers believe that they could achieve as good results as those of girls in the same grade level, achieved better results than those pupils, whose teachers believed that they would be far less successful than girls.

1.35 Teachers' Attitudes

Research on teaching in recent years, has used operationally-defined variables of teacher personality, such as teacher attitudes, and examined their relationships to pupil outcomes. It is known that in the teaching-learning process the teacher is the one who introduces and manages classroom activities; every move a teacher takes is conditioned by his attitude (Hughes, et al. 1959).³ These in turn affect the degree of pupil participation, as well as the mental processes they may develop in their work.

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1. Veldman, D.J. and Peck, R.F. 1963. "Student Teacher Characteristics from the Pupils' View Point". Journal of Educational Psychology, Vol.54, No.5, pp.346-355.
 2. Palardy, J.Michael, 1969, "What Teachers Believe - What Children Achieve". Elementary School Journal, April, pp.370-374.
 3. Hughes, M.M.; Devaney, E.F.; Fletcher, J.R.; Miller, L.G.; Rowan, T.N.; and Welling, L. 1959. op.cit.

Barker-Lunn (1972)¹ and Berk, et al. (1970)² shared the same view, that whatever attitude a teacher has will affect his pupils' attitudes, which in turn will affect pupils' achievement either positively or negatively. This may result, as Barker-Lunn suggested, from the teacher's treatment of a pupil in a classroom influencing his interpersonal relationships with his classmates. Thus, the whole class may treat this particular pupil in the same way as their teacher does, i.e., if their teacher accepts this pupil they will accept him, and if their teacher rejects him they may most likely follow their teacher's behaviour as well. This, therefore, may suggest that the negative feelings towards school, learning, teachers and classmates of less-able pupils may be caused by their teachers' attitudes. Moreover, Peng and Ashburn (1978)³ attempted to investigate the relationships of negative and positive teacher effect⁴ with pupils' outcomes (as realized by pupils themselves). It was assumed that such relationships would arise from teachers' behaviours having differential effects on pupils. The results of this study, however, indicated that positive teacher effect, according to pupils' reports, was not related positively to pupil achievement.

1.40 Factors related to pupils and their effects on pupils' outcomes

Many factors relating to pupils have been examined, as being thought to be associated with pupil academic success in one way or another, such as pupils' sex, attitudes, intelligence, aptitude, motivation, levels of attention, and efforts.

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1. Barker-Lunn, J.C., 1972. "The Influence of Sex, Achievement Level and Social Class on Junior School Children's Attitudes". The British Journal of Educational Psychology, Vol.42, pp.70-74.
 2. Berk, E.L.; Rose, H.M.; and Stewart, D. 1970. "Attitudes of English and American Children Towards Their School Experience", Journal of Educational Psychology, Vol.61, No.1, pp.34-40.
 3. Peng, S.S. and Ashburn, E.A. 1978. "Teacher Affection In Relation to Pupil Achievement". Journal of Teacher Education, Vol.29, No.4, pp.76-79.
 4. Positive teacher behaviour is the intensity of supportive or reinforcing behaviours that a teacher adopts when he is friendly and warm with his pupils. This behaviour was expected to encourage pupils to develop higher self-esteem which in turn, would lead to pupils achieving higher outcomes.

1.41 Pupils' Sex

The sex of a pupil is regarded by many educators as being one of the most important factors affecting the achievement of boys and girls in different grade levels. Hilton and Berglund (1974)¹, and Leinhardt, Sewald, and Engel (1979),² for example, believe that boys are better achievers in mathematics than girls. Backman (1972)³ regards boys as better achievers in mathematics and verbal knowledge than girls. Klausmeier and Wiersma (1964)⁴ also consider boys as more successful in convergent thinking skills than girls. Gates (1961)⁵, and Leinhardt, Sewald, and Engel (1979)⁶, on the other hand, believe that girls are better achievers than boys in reading. Moreover, Klausmeier and Wiersma (1964)⁷ also consider girls as better achievers than boys in divergent-thinking skills.

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1. Hilton, Thomas L., and Berglund, Gosta, W., 1974. "Sex Differences in Mathematics Achievement - A Longitudinal Study", *Journal of Educational Research*, Vol.67, No.5, pp.231-237.
 2. Leinhardt, G.; Sewald, A.M.; and Engel, M., 1979, "Learning What's Taught: Sex Differences in Instruction". *Journal of Educational Psychology*, Vol.71, No.4. pp 432-439.
 3. Backman, M.E., 1972, "Patterns of Mental Abilities: Ethnic, Socio-economic, and Sex Differences". *American Educational Research Journal*, No.9, pp.1-12.
 4. Klausmeier, H.J. and Wiersma, W. 1964, "Relationship Of Sex, Grade level, and Locale to Performance of High IQ Student of Divergent Thinking Tests". *Journal Educational Psychology*, Vol.55, No.2, pp.114-119.
 5. Gates, A.I., 1961, "Sex Differences in Reading Ability", *Elementary School Journal*, 61, pp.431-434.
 6. Leinhardt, G.; Sewald, A.M.; and Engel, M., 1979, op.cit.
 7. Klausmeier, H.J. and Wiersma, W. 1964, op.cit.

1.42 Pupils' attitudes

Pupils' attitudes (see Renner, et al., 1977; Wandt, 1963; and Hughes, et al., 1959)^{1,2,3} towards teachers, classmates, school, and the like, were examined by many educators. Barker-Lunn (1972)⁴ considered that brighter pupils tend to have more positive attitudes, and that there is a tendency for more favourable attitudes to be found among middle-class pupils in contrast to working-class pupils. Barker Lunn also argued that the achievement of girls in the 3rd and 4th grades of the junior school is better than that of boys because girls develop better attitudes towards their schools and classes than do boys in the same grade level. Moreover, Volker and Simonson (1974)⁵ claimed that a person's attitude towards a particular experience plays an important role in determining his success. Furthermore, pupils' attitude is considered by Chansky and Bregman (1957)⁶ as one of the best single predictors for the achievement of pupils. This is because the researchers believe that pupils' attitude is often related to their motivation.

1.43 Pupils' Intelligence

Pupil intelligence is found to be one of the factors affecting pupils' growth and achievement (Barr, 1950).⁷ Intelligence and achievement are found to be positively related. That is to say, high achieving pupils are the most intelligent ones, and vice-versa.

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1. Renner, W.J.; Abraham, R.M.; and Stafford, G.D., 1977, op.cit.
 2. Wandt, Edwin, 1953. "The Measurement of Teacher's Attitudes Toward Group contacted in the Schools." *Journal of Educational Research*, Vol.46, pp.113-122.
 3. Hughes, M.M.; Devaney, E.F.; Fletcher, J.F.; Miller, L.G.; Rowan, T.N.; and Welling, L. 1959. op.cit.
 4. Barker-Lunn, J.C. 1972, op.cit.
 5. Volker, R. and Simonson, R.M., 1974. "Individualizing a Work-shop on Individualized Instruction". *Audiovisual Instruction*, Vol.19, No.5, pp.19-22.
 6. Chansky, N.M., and Bregman, M., 1957. "Improvement of Reading In College". *Journal of Educational Research*, Vol.51, pp.313-317.
 7. Barr, A.S. 1950, op.cit.

1.44 Aptitude of a Pupil

Aptitude of pupils is also considered to have a significant effect on the gain of pupils. Dispenzieri, Kalt, and Newton (1967)¹ believed that the aptitude of college pupils is positively related to their achievement. Moreover, the verbal and mathematical aptitudes of fourth-grade pupils are found by Khan and Roberts (1969)² to correlate positively with their intellectual achievement.

1.45 Levels of a Pupil's Attention

The level of a pupil's attention, in the classroom, is also believed to be an important factor that affects pupils' academic achievement. Brophy and his colleagues (1975)³, however, did not agree with this observation, and they claimed that, according to their study, learning gains do not correlate strongly with level of attention.

1.46 Motivation

Finally, motivation is found by Bruce and Howard (1977)⁴ to be highly correlated with academic performance. They suggested that motivation and academic performance follow each other, i.e., "motivation breeds academic success and success enhances motivation."⁵

1.47 Pupils' Efforts

Frieze and Snyder (1980)⁶ suggested that pupils' efforts could be

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1. Dispenzieri, A., Kalt, N.C., and Newton, D., 1967. "A Comparison of Student at Three levels of Ability and Three levels of Achievement using the Omnibus Personality Inventory". The Journal of Educational Research Vol.61, No.3, pp.137-141.
 2. Khan, S.B., and Roberts, Dennis M., 1969, "Relationships Among Study Habits and Attitudes, Aptitude and Grade 8 Achievement", Educational and Psychological Measurement, 29, pp.951-955.
 3. Brophy, E.J., Counter, L.C., Crawford, J.W., Everston, C.M. and King, E.C., 1975, op.cit.
 4. Bruce, A.C. and Howard, M.B. 1977, op.cit.
 5. Ibid. (p.140).
 6. Frieze, I.H., and Snyder, H.H. 1980, "Children's Beliefs About the Causes of Success and Failure in School Setting", Journal of Educational Psychology, Vol.72, No.2, pp.186-196.

considered as one of the important factors which might affect their achievement. Thereby, the more work a pupil carried out to improve his level of competence the better results he/she may accomplish.

1.5 Summary

- 1) Firstly, the various definitions, applied by many educators, towards teaching efficiency were considered. Some of these educators, such as Barr (1950)¹, claimed that unless factors essential for effective teaching are clearly discovered, teaching efficiency cannot be adequately defined. Stafford and Grave (1978),² on the other hand, held the opinion that the definition of teaching efficiency was connected with the nature of the educational programme. Gage (1963),³ suggested that the recognition of teaching efficiency was based upon the realization of some elements related to pupils' behaviours.
- 2) Secondly, the factors that many educators located as being essential for teaching efficiency, were teacher's knowledge of the subject matter (Getzel and Jackson, 1963; and Goates and Thorensen, 1976),^{4,5} communication skills the teacher performed in the classroom (Robert and Becker, 1976; Anderson, 1971; and Bruce and Howard, 1977)^{6,7,8} inspiring both motivation

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1. Barr, A.S. 1950, op.cit.
 2. Stafford, L. and Graves, C.1978, op.cit.
 3. Gage, N.L. 1963, op.cit.
 4. Getzel, J.W. and Jackson, P.W., 1963, op.cit.
 5. Goates, J.T. and Thorenson, E.C., 1976, op.cit.
 6. Robert, L.C. and Becker, L.S. 1976, op.cit.
 7. Anderson, G.J. 1971, op.cit.
 8. Bruce, A.C. and Howard, M.B. 1977, op.cit.

(Bruce and Howard, 1977; and Breuning, 1978)^{1,2} and an independent spirit in the pupils (Flanders, 1967 and 1970; Taba, 1932; Breuner, 1966; McKeachi, 1954 and 1963)^{3,4,5,6,7,8} and the provision of an appropriate environment within the classroom (Fraser, 1975; and Power and Tisher, 1975)^{9,10}.

3) Thirdly, both the methods of teaching; beliefs; and the attitudes of teachers were considered by many educators, as three of the most important elements by which the effectiveness of teachers on their pupils' outcomes may be evaluated. The effectiveness of teachers' behaviours was examined, by many researchers, in relation to several pupil outcomes but mainly on pupil achievement. Other factors, such as pupils' attitudes, motivation, sex, efforts, aptitude, intelligence and level of attention in the classroom, were also investigated by some educators, as to their effectiveness on pupil achievement; no conclusive agreement was reached as to their definite effects. In other words, investigators, such as Obler, et al. (1977)¹¹

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1. Bruce, A.C. and Howard, M.B. 1977, *ibid*.
 2. Breuning, S.E. 1978, *op.cit*.
 3. Flanders, N. 1967, *op.cit*.
 4. Flanders, N. 1970, *op.cit*.
 5. Taba, H. 1932, *op.cit*.
 6. Breuner, J.S. 1966, *op.cit*.
 7. McKeachi, W.J. 1954, *op.cit*.
 8. McKeachi, W.J. 1963, *op.cit*.
 9. Fraser, J.B. 1975, *op.cit*.
 10. Power, N.C. and Tisher, R.P., 1975, *op.cit*.
 11. Obler, M.; Francis, K.; and Wishengrad, R. 1977, *op.cit*.

DiVesta (1953)¹; Will, (1976)²; Flanders (1967)³; Wright (1977)⁴ and Brophy, et al. (1975)⁵ found that some teaching methods did affect differently the achievement of pupils, who were taught by these methods, while some other educators, such as Wright (1977)⁶; Bills (1952)⁷; Granville (1952)⁸; and Veldman and Peck (1963)⁹, claimed that according to various studies they had conducted, it was found that there were no significant differences between different styles of teaching, and that they had a similar effect on pupils' outcomes.

Moreover, from the review of the literature consulted in this chapter, it is noted that some educators, such as Stafford and Graves (1978)¹⁰; Flanders (1967)¹¹; Hughes, et al. (1959)¹²; Barker-Lunn (1972)¹³; Berk, et al. (1970)¹⁴; and Peng and Ashburn (1978)¹⁵, identified the controlling behaviours and attitudes of teachers, and measured the effects of these variables on pupil achievement. However, some other educators,

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1. DiVesta, J. Francis, 1953, op.cit.
 2. Will, V.C. 1976, op.cit.
 3. Flanders, N.A. 1967, op.cit.
 4. Wright, P. David 1977, op.cit.
 5. Brophy E.J., Counter, L.C., Crawford, J.W., Evertson, C.M., and King, E.C. 1975, op.cit.
 6. Wright, P. David, 1977, op.cit.
 7. Bills, E.Robert, 1952, op.cit.
 8. Granville, B.Johnson, 1952, op.cit.
 9. Veldman, J.D. and Peck, R.F. 1963, op.cit.
 10. Stafford, L. and Graves, C.C.Jr., 1978, op.cit.
 11. Flanders, N.A. 1967, op.cit.
 12. Hughes, M.M., Devaney, E.F., Fletcher, J.F., Miller, L.G., Rowan, T.N., and Welling, L. 1959, op.cit.
 13. Barker-Lunn, J.C. 1972, op.cit.
 14. Berk, E.L., Rose, H.M., and Stewart, D. 1970, op.cit.
 15. Peng, S.S. and Ashburn, E.A. 1978, op.cit.

such as Wallen and Travers (1963)¹, Gage (1963)², and Dunkin and Biddle (1974)³ claimed that research, in this field of education, has failed to provide conclusive evidence that a teacher's effectiveness can be identified in terms of the influence of his/her personality characteristics, or even the methods or styles of teaching which may be employed, upon the outcomes produced by his/her pupils. These writers in their reviews of research on teaching have noted the need for new tools to categorize the behaviour of both teachers and pupils in classroom interactions.

Therefore, the need for more research, in the field of classroom interaction is essential, so that more definite conclusions may be reached as to what constitutes effective teaching.

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1. Wallen, N.E. and Travers, R.M.W. 1963, op.cit.
 2. Gage, N.L. 1963, op.cit.
 3. Dunkin, M.J. and Biddle, B.J., 1974, op.cit.

CHAPTER IIStudies Related To The Teaching of ScienceSynopsis

This chapter is restricted to classroom studies involving only science subjects. The studies reviewed here were carried out to investigate and evaluate the teaching of science in different parts of the world.

They are mainly concerned with:

- 1) Curriculum Evaluation;
- 2) Affective Studies; and
- 3) Instrument Development.

2.0 Studies Related To The Teaching of Science

2.1 Curriculum Evaluation

The trend of the last number of years of studying the curriculum and its effect on teaching efficiency has clearly increased. Many investigators looked at a variety of topics, from measuring the effect of the curricula on attitudes to those concerned with concept attainment. Most of these studies ran the gamut from elementary through high schools, and took into account all science subjects, including physics, chemistry, biology and combined science.

The studies of the curricula, reviewed in this chapter, were mainly divided into three areas; the assessment of a specific curriculum, a comparison of a new curriculum with a traditional one, and research into the implementation of new curricula. A large number of these studies investigated the Nuffield combined science curriculum (see: Leece and Mathews, 1976; and Mathews and Leece, 1976)^{1,2} which is now commonly used in many English schools, for the teaching of biology, chemistry and physics. Some of these studies were conducted either to find out how both pupils and teachers perceived the curriculum materials, or to examine the effect of these materials on pupils' outcomes. Swain and Fairbrother (1976)³, for example, used two types of schools; the drop-outs^(a) and

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1. Leece, J.R. and Mathews, J.C. 1976 "Nuffield Advanced Chemistry Research Project. Casting the Net Wider: Questionnaires and other Sources of Information". School Science Review, Vol.58, No.203, pp.342-347.
 2. Mathews, J.C. and Leece, J.R. 1976. "Nuffield Advanced Chemistry Research Project: reporting and using examination outcomes". School Science Review, Vol.58, No.204, pp.546-553.
 3. Swain, J.R.L.; and Fairbrother, R.W. 1976. "Aspects of the Non-Adoption of The Nuffield Physical Science Course". School Science Review, Vol.58, No.203, pp.315-355.
- a) The drop-outs are those schools which adopted the Nuffield Physics Project, and those after trying it dropped it.

and the non-adopters^(b) in their study. A questionnaire was developed and applied to the "drop-out" teachers requesting them to state their opinions of the Nuffield physics course. The "non-adopter" teachers were also requested to react to the same questionnaire by giving their opinions about the course. The main conclusion found in this study was that this course needed to be reduced in overall content. Charles (1976)¹ adopted quite a different objective in his study, when he investigated the possibility of applying the Nuffield Combined Science to pupils with different ranges of abilities. Charles conducted his study on pupils aged 11-13, taught by 18 teachers in an Exmouth school. Four methods were used to evaluate the course, namely, staff discussion; a staff questionnaire; a pupil questionnaire; and coded response tests. According to the results of the study, the curriculum was only suitable for 75% of the pupils thus indicating that it was inappropriate for about one quarter of them. It was also found that teachers enjoyed teaching the course.

Ukens and Merrifield (1976)² directed their investigation on those mental abilities needed as prerequisites for learning the content of a Conceptually-Orientated Programme in Elementary Science. The authors believed in the importance of ascertaining the level of understanding of pupils' mental abilities, as an important step towards the selection of curriculum materials, by both curriculum developers as well as classroom teachers. The Guildford's Structure of Intellect (SI) and the COPES

- b) The non-adopters are those schools which adopted the Nuffield Advanced Biology, but not the Nuffield Physics.
- 1. Charles, D.J. 1976. "Nuffield Combined Science - An Evaluation" School Science Review, Vol.58, No.202, pp.129-134.
- 2. Ukens, L.L. and Merrifield, P.R. 1976. "The structure of Intellect Model Applied to a Copes learning Sequence". Journal of Research in Science Teaching, Vol.13, No.3, pp.221-225.

pre-post tests were applied to 158 sixth-grade pupils. It was concluded that certain mental operations were found to be necessary as pre-requisites to an understanding of the COPES mechanical energy sequence, and that these pre-requisites included convergent and divergent thinking operations. If pupils lack these operations, then their attainment of the chosen curriculum would be difficult if not impossible.

Another approach adopted in a series of curriculum evaluations was the use of a comparison method. Most of these studies compared new curriculum materials with traditional ones. Symington and Fensham (1976)¹ tried to compare the achievement and creativity of elementary-school pupils (grade 1-6) by using two different curricula. A Science-Process Approach (SAPA) was compared with a traditional programme. The SRA achievement test and the Torrance Test of Creative Thinking (TTCT), Verbal form A, were used to measure both achievement and creativity of pupils in elementary schools. The results of the study indicated that, while there were no differences between the achievement of both groups, a higher verbal fluency and a higher verbal flexibility were indicated in the experimental group. The authors claimed that these two components were recognized as necessary for divergent thinking and problem solving.

Lazarowitz and Lee (1976)² related the use of new curricula (such as, Biological Science Curriculum Study (BSCS), Physical Science Study Committee (PSSC), Harvard Physics Project (HPP), Chemical Bond Approach (CBA), and Earth Science Curriculum Project (ESCP)) to teachers'

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1. Symington, D.J. and Fensham, P.J. 1976. "Elementary School Teachers' Closed-Mindedness, Attitudes Toward Science, and Congruence with a New Curriculum". *Journal of Research in Science Teaching*, Vol.13, No.3, pp.441-447.
 2. Lazarowitz, R. and Lee, A.E. 1976. "Measuring Inquiry Attitudes of Secondary Science Teachers". *Journal of Research in Science Teaching*, Vol.13, No.5, pp.455-460.

attitudes towards inquiry strategies, and compared them with attitudes of teachers who used the traditional curriculum. Two instruments were used to collect data; the Inquiry Science Teaching Strategies Instrument (ISTS) to measure the attitudes of secondary-science teachers towards inquiry strategies and the Personal Data Form (PDF) to collect some information about teachers, concerning their use of new programmes, and subject matter taught, as well as their experience in the use of these programmes. Lazarowitz concluded, from the analysis of the collected data, that more favourable attitudes towards inquiry strategies were found between science teachers who used new programmes in their teaching activities than non-users. It was also found that years of experience, in the use of these programmes, were related to more favourable attitudes toward inquiry strategies.

Finally, Johnstone and Mughol (1976)¹ tried to pick out those concepts of physics, taught in secondary schools, which caused some trouble to pupils, and to study the factors giving rise to such problems in the study of physics. A total of "996" university, post-O-grade; and pre-O-grade pupils were enrolled in this project. These pupils were asked to respond to 23 concepts associated with topics in physics. According to the results, the authors found that some concepts caused problems with pupils when they were at their elementary level, and these same problems seemed to be carried over into their undergraduate careers.

1. Johnstone, A.H. and Mughol, A.R. 1976. "Concepts of physics at secondary level". *Physics Education*, Vol.11, No.7, pp.466-469.

2.2 Research Studies Related to Variables Associated with Pupils'

Achievement

A large number of science educators in the last number of years studied effective parameters, such as attitudes, beliefs, self-concepts, values, and interests. They attempted to find out the degree of influence these parameters had on science education. Many of these studies were directed towards attitudes concerning science as a discipline, a school subject, scientists, or science teaching methods. However, most of these studies tried to relate attitudes to grades, aptitudes, personality factors, abilities and the like. Accordingly, many investigators have developed their own instruments to measure these affective parameters.

Pupils' attitudes towards science is one of the major areas of studies in science teaching. Novick and Duvdvani (1976)¹ investigated tenth-grade Israeli pupils' attitudes towards science, and related them to schools' and pupils' variables. The Science Attitude Inventory (SAI) was used after being translated into Hebrew. Some factors such as sex and type of curriculum used, were found to have no effect on pupils' attitudes. However, school type as well as the cultural background were found to be significantly related to pupils' attitudes. Pupils' achievements were also found to be related to both attitudes and sex of pupils.

Several studies have been released by the National Assessment of Educational Progress (see: National Assessment of Educational Progress,

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1. Novick S., and Duvdvani, D. 1976. "The Relationship Between School and Student Variables and the Attitudes Toward Science of Tenth-Grade Students in Israel." *Journal of Research in Science Teaching*, Vol.13, No.3, pp.259-265.

1975, a & b; and 1976).^{1,2,3} These studies attempted to interpret different aspects of information collected during the period 1969-1973 concerning science assessments. The "NAEP" studies concentrated on investigating pupils' knowledge and attitudes towards science. Pupils in four age levels (9-year olds, 13-year olds, 17-year olds and adults aged 26-35) were studied. The "NAEP" studies indicated an overall decline in science achievement for all groups between 1969 and 1973. However, although most of the pupils taking part in these projects expressed some interest in science, a decline in the pupils' positive attitudes towards science was reflected in the pupils' responses to the attitude items. Moreover, it was also recognized from the results of the NAEP studies that sex of pupils, age, race, and cultural differences were related to pupils' achievements in science.

The impact of science on society was the major problem that Sadava (1976)⁴ studied. Sadava focussed his study on the attitudes of the non-science major undergraduate pupils towards science. A science course (Principles of Natural Science) was designed for the participating pupils. An opinion survey was also administered to the pupils (non-science majors) before and after taking the "PNS" course which was designed for them. The results of the study showed that the non-major pupils possessed negative

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1. National Assessment of Education Progress. 1975(a). "Selected Results from the National Assessment of Science: Attitude Questions". Education Commission of the States, Denver, Colorado, N.A.E.P. ED 127 200.
 2. National Assessment of Education Progress, 1975(b). "Selected Results from the National Assessment of Science: Energy questions." Education Commission of the States, Denver, Colorado, N.A.E.P. ED 127 203.
 3. National Assessment of Educational Progress, 1976. "Highlights and Trends from National Assessment: Changes in Science Achievement, 1969-1973". Sauls, J.M. Education Commission of the States, Denver, Colorado, N.A.E.P. ED 127 202.
 4. Sadava, D. 1976. "Attitude Toward Science of Non-Science Major Undergraduates: Comparison with the general Public and Effect of a Science Course". Journal of Research in Science Teaching, Vol.13, No.1, pp.79-84.

attitudes towards science, and that pupils' opinions after being exposed to the PNS were more negative than they were when the course started.

Ward (1976)¹ was interested in investigating the proposition, that there was no conclusive evidence for a general relationship between cognitive achievement and class size. Science pupils, from twelve high schools in three regions in the United States, were studied for their attitudes towards science by using a Science Attitude Inventory (SAI) and for their achievement in science by using an achievement test. Ward found that there was no evidence of a direct relationship between class size and pupils' attitudes toward science. The results, however, showed that a strong relationship existed between class size and achievement, and between achievement and attitude.

Symington and Fensham (1976)² were interested in studying how various teachers' personality factors influenced the adoption of certain programmes. The authors investigated teachers attitudes towards science with respect to dogmatism. Symington and Fensham wanted to find out whether or not teachers with high dogmatism would resist any new curriculum introduced to them. Seventy-two (4th-5th grades) science teachers in Australia were investigated to determine how dogmatism and attitudes of teachers towards science in congruence with new curriculum would affect the adoption of new Science Programmes. The Schwinian's Science Support Scale was used to test teachers' attitudes towards science. An inverse relationship was found between teachers' attitudes

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1. Ward, H. William, Jr. 1976. "A Test of the Association of Class size to Students' Attitudes Toward Science." *Journal of Research in Science Teaching*, Vol.13, No.2, pp.137-143.
 2. Symington, D. J. and Fensham, P.J. 1976, op.cit.

towards a new science curriculum and dogmatism, i.e., teachers who felt compatible with the newly-introduced curriculum together with those with positive attitudes towards science were measured low on dogmatism.

Other affective studies attempted to study the effects of some teachers' behaviour on pupils' attitudes and outcomes. Santiesteban (1976)¹ for example, selected 144 third and fourth-grade pupils, and 48 elementary teachers, to examine the effect of teacher questioning performance on pupils' achievement and attitudes towards science. Pupils' attitudes were measured by a previously developed pupils' attitude measure. The results of this study seemed to support the conclusion that teachers' behaviour and the way they questioned pupils about the subject matter being discussed did affect pupils' attitudes and outcomes.

An examination of the questioning style among widely used books was also undertaken. Lowery and Leonard (1978)² studied some high school text books (such as those from Modern Biology, e.g., BSCS Green Version; BSCS Blue Version,; and BSCS Yellow Version) and related them to the Science learning (inquiry) process. The authors adopted the textbook Questioning Strategies Assessment Instrument (TQSAI) to differentiate between questioning styles used in these books.

In Australia, Gardner (1976)³ conducted a study on 1014 pupils using the PSSC Curriculum to investigate the effect of some pupils' and

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1. Santiesteban, A.J. 1976. "Teacher Questioning Performance and Student Affective Outcomes". *Journal of Research in Science Teaching*, Vol.13, No.6, pp.553-557.
 2. Lowery, L.F. and Leonard, W.H. 1978. "A comparison of Questioning Styles Among Four Widely Used High School Biology Textbooks". *Journal of Research In Science Teaching*, Vol.15, No.1, pp.1-10.
 3. Gardner, P.L. 1976. "Attitudes Toward Physics: Personal and Environmental Influences". *Journal of Research in Science Teaching*, Vol.13, No.2, pp.111-125.

teachers' personality characteristics on pupils' attitudes towards the Study of Physics. Four different instruments were used, namely The Physics Attitude Index (PAI); Personal Preference Index (PPI); The Physics Classroom Index (PCI); and an achievement test, to assess pupils' perception towards physics learning; to measure personality characteristics; to express pupils' needs as they occur in the classroom and to measure pupils' outcomes consecutively. The results of this study indicated that the more serious pupils were found to maintain a more favourable attitude towards the study of physics subjects, when they were taught by a serious teacher. On the other hand, the attitudes of the less serious pupils towards physics, when taught by these teachers, were found to decline. These results, however, indicate that the same teaching behaviour can have a markedly different impact on pupils' attitudes, depending on the personality of the pupils being taught.

Furthermore, when two different teaching methods are introduced to pupils, will these methods be accepted equally by pupils, or will they favour one of the methods rather than the other? In addition, will these methods show different impacts on pupils' attitudes, behaviours, and outcomes?

Many investigators sought answers to these question. Hermann and Hincksman (1978)¹, for example, introduced two different methods to 299 ninth-grade pupils. The inductive and deductive approaches were used to teach chemistry. Teachers were provided with both inductive and deductive learning task programmed-instruction booklets. Pupils' anxiety was measured by a modified scale (from Sarason's Anxiety Scale for Children). Pupils' achievements were measured by both an immediate retention and a

1. Hermann, G.D. and Hincksman, N.G. 1978. "Inductive Versus Deductive Approach in Teaching A Lesson In Chemistry". *Journal of Research In Science Teaching*, Vol.15, No.1, pp.37-42.

delay retention test. The results of this study, suggested tentatively, that the deductive method might be superior if immediate retention was desired, especially with different learning tasks. But if a delay retention was desired, the two teaching methods would give the same results. It was also found that sex, anxiety, and pupils' I.Qs all have no significant correlations with the above-mentioned teaching methods.

Tjosvold and his colleagues (1977)¹ carried out a similar study, when they involved three teachers and eighty pupils from fourth and fifth-grade levels. The inquiry and didactic methods were used in teaching a new course on liquid evaporation (which was adopted from Science For the Seventies). Pupils were asked to respond to a questionnaire, at the end of each lesson, which investigated the degree of their acceptance of the teaching method used, their teachers' attitudes towards the other pupils and their own subjective learning. The results of the study indicated that pupils' acceptance of a teaching method depended on their competition and cooperation with each other. Pupils who worked in a cooperative way did not mind the method of the teaching. On the other hand, pupils who wished to compete with each other, preferred the didactic teaching method. Moreover, it was also found that the degree of pupils' acceptance of their teachers depended on their acceptance of the adopted methods of teaching. Finally, the results of the achievement test did not indicate any differences, when the two teaching methods were compared.

Differences among pupils' abilities (Thiel and George, 1976)², motivations (Winsberg and Ste-Marie, 1976)³ and self perceptions (Shymansky,

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1. Tjosvold, D.; Marino, P.M.; and Johnson, D.W. 1977. "The Effects of Cooperation and Competition on Student Reactions to Inquiry and Didactic Science Teaching". *Journal of Research in Science Teaching*, Vol.14, No.4, pp.281-288.
 2. Thiel, R.P. and George, K.D. 1976. "Some Factors Affecting the Use of The Science Process Skill of Prediction by Elementary School Children", *Journal of Research in Science Teaching*, Vol.13, No.2, pp.155-166.
 3. Winsberg, S. and Louis Ste-Marie, 1976. "The Correlation of Motivation and academic Achievement in Physics". *Journal of Research in Science Teaching*, Vol.13, No.4, pp.325-329.

Penick; Matthews and Good, 1977)¹ were other areas of interest to some educators. Pederson and Jacobs (1976)² investigated the ability of ninth and tenth-grade pupils in studying the same subject matter. A sample of 684 ninth-grade and 721 tenth-grade pupils was mixed in their classes, and then introduced to a biology course. Eighteen teachers were involved in the teaching of the selected biological content. A multiple-choice final examination was administered to the participating pupils to measure their achievement outcomes. By analyzing the results of the achievement tests, it was found that there were no significant differences between the two groups, i.e., the ninth-grade pupils possessed the same capacity and background as the tenth-grade pupils to succeed in biology.

The differences among pupils' motivations to study science have always been a matter of concern to science educators. In the Study of Winsberg and Ste-Marie (1976)³ three types of motivation were considered, motivation as a security need; an esteem need; or a growth need (see, Winsberg and Ste-Marie, 1976 p.326). This study was carried out to investigate the relationship between these three kinds of motivation together with pupils' academic achievement. Second-year college pupils were selected to participate in this study. Pupils were asked to react to the Mernit College Motivation Inventory (MCMI) and to a physics academic achievement test. A negative correlation was found between motivation to satisfy security needs and academic achievement in physics.

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1. Shymansky, J.A.; Penich, J.E.; Matthews, C.C.; and Good, R.G. 1977. "A Study of Student Classroom Behaviour and Self-Perception as it Relates to Problem Solving". *Journal of Research in Science Teaching*, Vol.14, No.3, pp.191-198.
 2. Pederson, A.A. and Jacobs, J.E., 1976, op.cit.
 3. Winsberg, S. and Louis Ste-Marie, 1976, op.cit.

Academic achievement, however, had little correlation with both motivation to satisfy esteem needs, and with motivation to satisfy growth needs.

Many other investigators tried to examine teachers' behaviour especially their instructional methods and how these were related to pupils' abilities. Yeany (1976)¹, for example, conducted a study on 64 elementary student teachers, engaged in teaching science to grades 3 through 6, to assess the relationships between the pupil's average ability, the number of pupils in a class, and teaching strategies employed by these student teachers. Two instruments were used to collect information concerning both teachers and pupils. The Teaching Strategies Observation Differential (TSOD) was used by trained observers, to code teacher-pupil behaviour at one-minute intervals, and the Elementary Science Activities Check List (ESAC) was adopted to collect information about teaching strategies as perceived by pupils. The results of the study indicated the absence of significant relationships between the adopted teaching strategies used by student teachers and either pupils' abilities or class size. These results, however, gave the impression that elementary-student teachers did not seem to adjust their methods of teaching to be appropriate to pupils of different ranges of abilities.

Suchman (1977)² was one of many educators, who was interested in investigating factors which could make learning as exciting to pupils as it should be, and how such excitement could be accomplished. Suchman recognized, from his visits to schools, the absence of inquiry by pupils,

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1. Yeany, R. Jr. 1976. "A study of the Correlation Between Elementary Student Teachers' Selection of Science Teaching Strategies and Average Class Ability and Size". Journal of Research In Science Teaching, Vol.13, No.3, pp.249-252.
 2. Suchman, J.R. 1977. "Heuristic Learning and Science Education. Journal of Research in Science Teaching, Vol.14, No.3, pp.263-272.

and that teachers were handling all the activities in the classroom most of the time, and they were treating pupils as consumers rather than knowledge producers. Heuristic learning was thought by Suchman, as a way of introducing knowledge to pupils in a more exciting and efficient way, where pupils could think and operate, and where they could become more active and observant. Suchman thought that teachers should promote pupils to engage in heuristic learning as part of effective teaching.

A teacher's experience, competency, and attitude towards science and the teaching of science, were considered by Piper and Butts (1976)¹, to be major factors influencing the teaching of science in elementary schools. The authors decided to introduce a televised science inservice programme, to help 76 teachers in teaching a new course (Science - A Process Approach). Each teacher was provided with a guide book to help her to state the performance objectives to be accomplished after each lesson, the enabling activities, and an evaluation of the stated objectives. Semantic differential pre- and post-tests were given to teachers, as well as a science competency post-measure. Records of activities were also "turned in" by each teacher covering science activities taught the previous week. The results of the study indicated that, the televised inservice programme proved (on the post-measure) to be beneficial to teachers in assessing them in acquiring the most important skills for teaching the new course. Moreover, the results of the study also indicated that teachers' attitudes were improved positively towards science and the teaching of science.

2.3 Instrument Development

Much of evaluative research is involved in the development of suitable instruments in order to collect information necessary for a proposed

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1. Piper, M.K. and Butts, D.P. 1976. "The Development and Evaluation of a Televised Science Inservice Programme". Journal of Research in Science Teaching, Vol.13, No.2, pp.177-183.

research. Some of these instruments are of general interest, while others are for specific purposes.

One of these new evaluation instruments was that developed by Lazarowitz and Lee (1976)¹ which was called the Inquiry Science Teaching Strategies Instrument (ISTSI). This instrument was developed to measure secondary-science teachers' ability to exhibit appropriate behaviours in using inquiry teaching.² The ISIS consisted of forty Likert-type items, which were either positively or negatively related to an inquiry approach. The developed instrument (as the authors claimed) was checked for validity by expert judges; it was also shown to have a value of 0.48 - 0.85 for the Alpha-Coefficient of reliability.

Fraser (1978)³ was interested in developing a suitable instrument for measuring the understanding of science among upper elementary and junior high-school pupils. His developed instrument was based on the Cooley and Kolpfer's Instrument [test on Understanding Science (TOUS) forms EW and JW]. Fraser's instrument consisted of three distinct subscales, namely a "Philosophical" subscale, an "Historical" Social Subscale, and a "Normality of Scientists" subscale. Reliabilities between 0.55 and 0.61 were found for the three subscales (each of which contained 10 items) when a KR-20 reliability coefficient was calculated. In the cross validation study the reliabilities of the subscales ranged from 0.51 to 0.62.

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1. Lazarowitz, R. and Lee, A.E. 1976, op.cit.
 2. The inquiry approach as seen by the writers requires teachers to "create teaching situations in which students are stimulated to formulate problems and hypotheses". p.455.
 3. Fraser, B.J. 1978. "Developing subscales for a Measure of Students Understanding of Science". Journal of Research in Science Teaching, Vol.15, No.1, pp.79-84.

Munby, (1975)¹ developed a category scheme based on three methods of teaching (see, 2a, b & c) for analyzing verbal classroom interactions in chemistry and physics, with specific attention to the provision made for pupils to acquire knowledge of the science content which was under consideration during a given lesson.

Another observational instrument was developed by Parakh (1967)³ for observing and analyzing different biology high-school classes. This instrument was composed of 45 categories, namely, 16 major categories, 2 minor categories and 1 residual category. In the selected sample 10 biology teachers were observed eight times each (4 lectures and 4 laboratory classes) for four successive weeks. A direct observation as well as recorded audio-tapes were used for observing and coding classroom interaction during the development of the instrument. The instrument

1. Munby, Hugh A. 1975. "Analyzing Science Teaching: A Case Study Based on Three Philosophical Models of Teaching". The explanatory Modes Project, Background Paper, No.5, Ontario Institute for Studies in Education, Ontario, Canada, ED 130 836 SE 021 325.
- 2a. The Impression Model: where teachers are given information which have to be accepted by pupils as truth without argument. Pupils are not allowed in this case to ask questions about this information and teachers do not ask questions other than those which have to be answered by recalling facts and principles.
- 2b. The Insight Model: where teachers use some verbal cues to inspire pupils, and pupils in this case have to find the answers themselves, through their perceptions of observable phenomena. However, pupils' responses are restricted by cues provided to them as well as by the phenomena they have to observe.
- 2c. The Rule Model: in which pupils are acquiring knowledge which requires evidence and proof. Teachers are responsible in this case for providing evidence and proof from different sources, so that pupils are provided with some grounds for judging the phenomena.
3. Parakh, S. Jal, 1967, "A Study of Teacher-Pupil Interaction In High School Biology Classes", Part II, Description and Analysis, Journal of Research in Science Teaching, Vol.5, pp.183-192.

contained "verbal" and "non-verbal" categories. The coding procedure, was of 5-second duration or less (depending on the shifting from one behaviour to another) for a certain behaviour.

Anderson and Herrera (1976)¹ recognized that there was no appropriate instrument for the evaluation of science in the Spanish language, although there were large Spanish-speaking populations living in the United States of America. These writers, therefore, attempted to translate an existing attitude scale into Spanish. According to these authors, however, the problem in transferring any scale or instrument from one language to another, was not just a translational problem, but also involved the evaluation of culture-bound items. The Allen Inventory of Attitudes Towards Science and Scientific Career was translated by Anderson and Herrera into a Spanish version, which included 38 items out of the original 95 item Likert-type scale. The new instrument, which was called the Escala De Actitude De Allison (EDAA), was administered to college-age pupils after obtaining a reliability coefficient alpha of 0.80 in one case, and 0.89 in another.

Anderson and Scott (1978)² developed a Classroom Process Scale (CPS), for the assessment of teaching effectiveness. The system was based on three assumptions, which involved, the nature of the classroom process, the observation of the classroom processes, and the uses of the observational information. The authors believed that there were three types of content found in any classroom interaction, namely, the informational, conceptual,

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1. Anderson, E.J. and Herrera, D.B. 1976. "Development of a Science Attitude Scale for Spanish-Speaking Populations". Journal of Research in Science Teaching, Vol.13, No.1, pp.45-48.
 2. Anderson, L.W. and Scott, C.C. 1978. "The Classroom Process Scale (CPS): An Approach to The Measurement of Teaching Effectiveness". Paper Presented at the Annual Meeting of The American Educational Research Association, Toronto , Canada. ED 155 132.

and the procedural objectives. Accordingly, they developed a system which was directed at finding out what teaching method would be appropriate for teaching each content. The CPS system was developed to code two independent variables, namely, type of content presented and type of teaching method (see Anderson and Scott, 1978, pp.9-10) with pupil involvement in learning as the dependent variable. The coding procedure in the CPS was carried out either by two observers (one observing pupils' behaviours, and the other one observing the teachers' behaviours) or by a single observer trained in coding both the pupils' as well as the teachers' behaviours. In the CPS, pupils were coded every 5 seconds, and teachers were coded every thirty seconds.

2.4 Summary

Studies related specifically to science education, which were carried out in three areas, namely, curriculum evaluation, research studies related to pupil achievement, and instrument development were reviewed in this chapter.

1) Studies related to curriculum evaluation

The Nuffield Science Curriculum was developed and introduced into schools in an attempt to improve the teaching of science. However, the introduction of such a new curriculum may not necessarily give the desired outcomes either because of some shortcomings in its construction, such as the amount of syllabus that it covers (Swain and Fairbrother, 1976)¹ or of its overall suitability for pupils with a range of abilities (Charles, 1976)². This may imply that any new curriculum should necessarily be

1. Swain, J.R.L. and Fairbrother, R.W. 1976, op.cit.

2. Charles, D.J. 1976, op.cit.

tried and examined several times before it is finally adopted in schools (Ukens and Merrifield, 1976).¹

2) Research Studies related to pupil outcomes

Science educators attempted to uncover the different variables that may have had an impact on pupils' outcomes measured in terms of pupils' achievement and attitudes. Variables that were related to teachers, pupils and to classrooms were correlated with pupils achievement and attitudes towards science.

From the literature reviewed in this chapter it was apparent that some variables, namely, pupils' attitudes, ability, cultural background, race, and intellectual background were found to correlate significantly with pupils' achievement (National Assessment of Educational Progress, 1975(a), 1975(b), and 1976; Novick and Duvdvani, 1976; and Ward, 1976).^{2,3,4,5,6} Pupils' age and motivations were, however, found to have different correlations with pupils' achievement (National Assessment of Educational Progress, 1975(a), 1975(b); 1976; Pederson and Jacobs, 1976; and Winsberg and Ste-Marie, 1976).^{7,8,9,10,11} Moreover, sex of pupils was found to correlate

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1. Ukens, L.L. and Merrifield, P.R. 1976, op.cit.
 2. National Assessment of Educational Progress, 1975(a), op.cit.
 3. National Assessment of Educational Progress, 1975(b), op.cit.
 4. National Assessment of Educational Progress, 1976, op.cit.
 5. Novick, S. and Duvdvani, 1976, op.cit.
 6. Ward, J.W.Jr., 1976, op.cit.
 7. National Assessment of Educational Progress, 1975(a), op.cit.
 8. National Assessment of Educational Progress, 1975(b), op.cit.
 9. National Assessment of Educational Progress, 1976, op.cit.
 10. Pederson, A.A. and Jacobs, J.E. 1976, op.cit.
 11. Winsberg, S. and Ste-Marie, L. 1976, op.cit.

significantly with pupils' achievement but not with pupils' attitudes (National Assessment of Educational Progress, 1975(a), 1975(b), 1976; and Novick and Duvdvani, 1976).^{1,2,3,4} Furthermore, class size was also found to correlate significantly with pupils' achievement but not with pupils' attitudes (Ward, 1976).⁵

Teacher's behaviour, in the classroom, such as his/her teaching method was found by many educators to have an impact on pupils' attitudes (Santesteban, 1976; Herman and Hincksman, 1978; and Suchman, 1977).^{6,7,8} This impact, however, may depend on the type of pupil being enrolled with the teacher. In other words, the effect that a certain teaching method may have on pupils' outcomes depends on these pupils' characteristics or on their behaviours in the classroom (Tjosvold, Marino, and Johnson, 1977; and Gardner, 1976).^{9,10} Therefore, a good teacher is the one who modifies his/her teaching method on the basis of pupils' characteristics, in order to achieve better results. Unfortunately not many teachers do so (Yeany, 1976).¹¹

Teachers' attitudes towards science may be related to the type of curriculum they adopt at schools or to their ability in mastering, to a

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1. National Assessment of Educational Progress 1975(a), op.cit.
 2. National Assessment of Educational Progress 1975(b), op.cit.
 3. National Assessment of Educational Progress 1976, op.cit.
 4. Novick, S. and Duvdvani, 1976, op.cit.
 5. Ward, H.W. Jr. 1976, op.cit.
 6. Santiesteban, A.J. 1976, op.cit.
 7. Herman, G.D. and Hincksman, N.G. 1978, op.cit.
 8. Suchman, J.R. 1977, op.cit.
 9. Tjosvold, D.; Marino, P.M.; and Johnson, D.W. 1977, op.cit.
 10. Gardner, P.L. 1976, op.cit.
 11. Yeany, R. Jr. 1976, op.cit.

great extent, the skills required for teaching any specific course.

Therefore, one may suggest that the most qualified and the most satisfied teachers are the ones who may have a better attitude towards the curriculum and the subject matter they are teaching (Lazarowitz and Lee, 1976; Symington and Fensham, 1976; and Piper and Butts, 1976).^{1,2,3}

2) Instrument development

Many instruments were developed by science investigators to collect data necessary for their proposed research. Some of these instruments are represented in the following table. The development of such instruments has proved to be beneficial in ascertaining the different variables related to educational phenomena. However, it seems to be the general principle that the instruments are only used by the actual researchers who developed them. It may be of further interest to see what additional information is obtained if the same instruments are used by other researchers under similar conditions. Conclusions ultimately reached may then have more wide-reaching applications.

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1. Lazarowitz, R. and Lee, A.E. 1976, op.cit.
 2. Symington, D.J. and Fensham, P.J. 1976, op.cit.
 3. Piper, M.K. and Butts, D.D. 1976, op.cit.

Table 1: A Representative Summary of the Developed Instruments In the Area of Science Teaching-Learning Processes

Instrument	Validity of the Instrument	School Level	Task to Measure	Number of Items/ Categories/and Scales	Developed by
1. Inquiry Science Teaching Strategies Instrument ISTS	Alpha 0.48-0.85	Secondary pupils	Teachers' Inquiry Approach	40 Likert-like items	Lazarowitz and Lee (1976) ¹
2. Escala De Actitudes De Allison (EOAA)	Alpha 0.80 and 0.89	College age pupils	Attitudes of Spanish-Speaking Population	38 Items	Anderson and Herrera (1976) ²
3. Based on the Cooley and Kolpfers Instruments "Test On Understanding of Science"	KR-20 0.55-0.61 Cross-Validation 0.51-0.62	Secondary school pupils	Pupils' Understanding of Science	3-Subscales, 10 items each a. philosophical b. Historical - Social, and c. Normality of Scientists	Fraser (1978) ³
4. Classroom Process Scale (CPS)			Contents presented and Teaching Methods Pupils -Teachers	3.Objectives a. Informational b. Conceptual, and c. Procedural	Anderson and Scott (1978) ⁴
5. Analysing verbal Classroom Interaction			Analyzing Methods of Teaching	3.Models a. Impression, b. Insight, and c. Role	Munby (1975) ⁵

1. Lazarowitz, R. and Lee, A.E. 1976, op.cit.
2. Anderson, E.J. and Herrera, D.B. 1976, op.cit.
3. Fraser, B.J. 1978, op.cit.
4. Anderson, L.W. and Scott, C.C. 1978, op.cit.
5. Munby, Hugh A, 1975, op.cit.

CHAPTER IIIPupils' Involvement in The Evaluation of Classroom InteractionsSynopsis

This chapter covers:-

- 1) An overview of the field.
- 2) Justification of pupils' participation in the evaluation system in a classroom.
- 3) Arguments concerning the validity and reliability of pupils' evaluation of teachers:
 - a) pupils' ability to evaluate teachers,
 - b) fluctuation of pupils' opinions over time,
 - c) biasing of pupils' perceptions of teachers' behaviours by variables unrelated to teaching excellence.
- 4) Pupil evaluation and its effect on teacher's behaviour as well as,
- 5) Teacher involvement in the evaluation process.

3.0 INTRODUCTION

In the study of classroom processes, more information is needed to know what is actually happening during daily classroom interactions. With such information available, teaching may be described in a more appropriate way, and thus, greater opportunity taken for its modification.

Although educators have tried to describe what constitutes effective teaching, not enough attention, however, has been paid to the pupils who are at the centre and, of course, the main target of the educational process. Tisher and his colleagues (1972)¹ verify this by stating that "Rarely, if ever, do students have any say in how the game will be played."² Denton and his associates (1977)³ confirm this by expressing that:

"Although pupils play an instrumental role in determining the degree of success experienced by the teaching candidate, these participants in the instructional process are rarely called on to assess the effectiveness of the teacher on various teaching functions occurring within the classroom." 4

This neglect, is especially marked in the area of pupils' perceptions of what constitutes good or effective teaching. Taba (1932)⁵ confides that it is a serious mistake to assume that "the learner is but a passive recipient and assimilator of the detailed patterns fixed in advance by those conducting

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1. Tisher, P.R.; Power, N.C.; and Endean, L. 1972, "Fundamental Issues in Science Education". John Wiley and Sons, Australia PTY Ltd.
 2. Ibid. (p.123).
 3. Denton, J.J.; Calarco, J.F.; and Johnson, C.M. 1977, "Pupils' Perception of a Student-Teacher's Competence". Journal of Educational Research, Vol.70, pp.180-185.
 4. Ibid. (p.180).
 5. Taba, H. 1932, op.cit.

education."¹

3.1 Teachers' Responsibility in the Classroom and Pupils' Perception

Studies of classroom atmosphere are, after all, studies of the various conditions within which learning takes place. It is obvious that a teacher is a very important factor if not the most important one in school, since he can affect the learning procedure, and he is the one who is directly engaged in interactive behaviour with pupils. Moreover, a teacher has many responsibilities in the classroom to facilitate and to accomplish effective teaching. One of the most important responsibilities a teacher ought to be aware of is the teaching activities he has to handle, such as motivating (Bruce and Howard, 1977; and Breuning, 1978)^{2,3} guiding (Woodring, 1962)⁴, planning, informing, leading, disciplining, counselling and evaluating (Amidon and Hunter, 1967; and Tisher et al., 1972).^{5,6} Thus, the way teachers behave may be of greater importance in the teaching-learning exchange than they often believe. A teacher needs to acquire and develop the necessary communication skills in order to facilitate the learning process. Therefore, in order to accomplish his job, a teacher must have a thorough knowledge of his pupils (Shavelson, et al., (1977)⁷,

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1. Taba, H. 1932, op.cit. (p.150).
 2. Bruce, A.C.; and Howard, M.B. 1977, op.cit.
 3. Breuning, F.S. 1978, op.cit.
 4. Woodring, P. 1962. "The Need for a Unifying Theory of Teacher Education". In: Teacher Education, A Reappraisal Report of a Conference Sponsored by The Fund for the Advancement of Education, Elmer, R.S.(ed.), Harper & Row (Pub.) New York, and Vanston.
 5. Amidon, E. and Hunter, E. 1967, op.cit.
 6. Tisher, P.R.; Power, N.C.; and Endean, L. 1972, op.cit.
 7. Shavelson, J.R.; Cadwell, J.; and Izu, T. 1977. "Teachers' Sensitivity to the Reliability of Information in Making Pedagogical Decision". American Educational Research Journal, Vol.14, No.2, pp.83-97.

such as their capacity for learning, interest, and performance with regard to methods of communication (Robert and Becker, 1976; and Anderson, 1959)^{1,2}... and so forth.

Initially, teachers' activities in classrooms may be unconsciously dictated. Thus they may show an unawareness (Hughes et al., 1959)³ of pupils' needs and problems. Teachers, after all, are only human beings, and they need help and advice to see themselves as their pupils see them (Hayes, et al., 1967).⁴ Often they also need to know what their pupils think or expect of them (Kenny et al., 1972).⁵ Medley and Mitzel (1963)⁶ believe that:-

"The possibility of judging a teacher's skill by watching him teach is a fallacy belief, because no matter how skilled or professional the observer is in the field of education, he cannot give the right impression of what goes on in classrooms because of so many reasons, such as, his limited observation, changes that a teacher might do to give the right impression about his potentiality and the like." 7

Since attempts to evaluate teaching by the use of supervisors' or principals' ratings have proved to be, somehow, abortive, for one reason or another, a search for other new criteria that may in some measure

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1. Robert, L.C.; and Becker, L.S. 1976, op.cit.
 2. Anderson, G.J. 1959, op.cit.
 3. Hughes, M.M.; Devaney, E.F.; Fletcher, J.R.; Miller, L.G.; Rowan, T.N. and Welling, L. 1959, op.cit.
 4. Hayes, R.B.; Keim, F.N.; and Neiman, A.M. 1967. "The Effects of Student Reactions to Teaching Methods". Bureau of Research Administration and Coordination, Department of Public Instruction, Harrisburg, Pennsylvania, Cooperative Research, No.6 - 2056.
 5. Kenny, J.; Hentschel, G; and Elpers, K. 1972, "How Students See Teachers", U.S. Department of Health, Education and Welfare, National Institute of Education, ED 077 921, SP 006 626.
 6. Medley, D.M. and Mitzel, H.E. 1963, op.cit.
 7. Ibid. (p.257).

avoid the deficiencies inherent in the evaluation process should be sought.

We may find a useful way of evaluating effective teaching, for instance, by looking at the teaching-learning situation from the point of view of the "intended recipient of the instruction cues in the classroom"¹ namely, the pupils (Remmers, 1963)². A pupil can identify problems with which he wishes to concern himself (Remmers, 1963)³. We can achieve this by trying to find out his perceptions, judgements, and preferences with regard to the educational process as it appears to him and impinges upon his consciousness.

By asking pupils to participate in the teaching-learning process's evaluation, we may make learning more significant to the learner by giving him greater responsibility. Therefore, measuring pupils' perceptions and evaluations may provide greater hope of getting more reliable information about what pupils want, and about what is really happening in the classroom (Tisher and associates 1972).⁴

3.2 Justification for Pupils' Participation In the Evaluation System in A Classroom

Some educators, clearly state their concern about most of the observational schemes for classifying activities. These schemes do not measure the psychological significance (Tisher, et al., 1972)⁵ of classroom

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1. Anderson, G.J. and Walberg, H.J. 1974, "Learning Environments". In: Walberg, H.J. (ed.), Chapter 6, Evaluating Educational Performance, McCutchen, Berkeley.
 2. Remmers, H.H. 1963, op.cit.
 3. Remmers, H.H. 1963, op.cit.
 4. Tisher, P.R.; Power, N.C. and Endean, L. 1972, op.cit.
 5. Tisher, P.R.; Power, N.C.; and Endean, L. 1972, op.cit.

activities to the pupil. Tisher and his colleagues for instance claim that "an important question, then, for the researcher, is how to determine the significance which classroom events have for individual pupils? One way, according to several writers, is to ask pupils."¹

If we are really concerned with the improvement of the teaching-learning process, we should pay some attention to the pupils themselves. We should encourage pupils to participate in the evaluation and the improvement of the educational process (Remmers, et al., 1966 and Remmers 1963)^{2,3}. We should not depend exclusively on ratings by trained adult observers (Veldman and Peck, 1957)⁴ in evaluating classroom events.

Pupils' evaluation of teacher effectiveness is not a new phenomenon, it has been accepted by "instructors as helpful indicators of performance" (Marsh, et al., 1978).⁵ It also has both empirical and theoretical support (Denton, et al., 1977)⁶ dating back over a period of sixty years or so. This is because pupils' evaluation has many advantages over any other forms of evaluation carried out by a trained observer.

Anderson and Walberg (1974)⁷ by asserting that no matter how highly trained the observer is, he is only a single judge, who knows very little about the classroom and is likely to be less sensitive to what is

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1. Ibid., (p.161).
 2. Remmers, H.H.; Gage, N.L.; and Rummel, F.J. 1966, op.cit.
 3. Remmers, H.H. 1963, op.cit.
 4. Veldman, D.J. and Peck, R.F. 1967, op.cit.
 5. Marsh, H.W.; Overall, J.U.; and Kesler, S.P. 1978. "The Validity of Students' Evaluations of Instructional Effectiveness: A Comparison of Faculty Self-Evaluations and Evaluations by their Students". Paper Presented at The Annual Meeting of The Association for Instructional Research, Houston, Texas.
 6. Denton, J.J.; Calarco, F.J.; and Johnson, C.M. 1977. op.cit.
 7. Anderson, G.J. and Walberg, H.J. 1974, op.cit.

important in a particular class. Pupils' evaluations surely offer a more comprehensive (Veldman and Peck, 1967; Donald and Penny, 1977; and Denton et al., 1977)^{1,2,3} picture of classroom events, and of their teachers' proficiency with technology. They can also gauge the teachers' strengths and weaknesses which cannot be reliably traced by a trained observer.

Veldman and Peck (1963)⁴ after using the Pupil Observation Survey Report (POSR) to evaluate student teachers, express their conclusions by stating that:-

"No one would seriously argue that the pupils taught by a teacher are inevitably the best judges of her effectiveness or ability. Nevertheless, the pupils have one major advantage over the observer: they see the teacher perform on many different occasions, as she encounters a wide variety of problems, as she deals with individuals known personally to the observer. Not only does each pupil have the advantage of many separate observations upon which to base his judgement, the use of pupils as observers also affords the increased reliability and reduction of bias that multiple judges afford." 5

Veldman and Peck (1967)⁶ voiced their previous opinion a few years later by claiming that pupils' evaluations are not the products of only "one-or-two-shots" observations like those carried out by a trained observer, but they are the products of several classroom observations under normal conditions.

Anderson and Walberg (1974)⁷ claim that pupil response is a

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1. Veldman, D.J. and Peck, R.F. 1967, op.cit.
 2. Donald, J.G. and Penny, M. 1977 "Instructional Analysis Kit". McGill U.V. Montreal (Quebec). Centre for Learning and Development. ED.157 904 TM 007 194.
 3. Denton, J.J.; Calarco, F.J. and Johnson, C.M. 1977, ibid.
 4. Veldman, J.D. and Peck, F.R. 1963, op.cit.
 5. Ibid. (p.347).
 6. Veldman, J.D. and Peck, F.R. 1967, op.cit.
 7. Anderson, G.J. and Walberg, H.J. 1974, op.cit.

realistic way of judging and assessing the classroom environment. They observe that:

"The student is the intended recipient of instruction cues in the classroom, particularly social stimuli; and he may be the best judge of the learning context - compared with a short term observer - he weighs in his judgement not only the class as it presently is but how it has been since the beginning of the year.... He and his classmates from a group of twenty or thirty sensitive, well informed judges of the class." 1

Pupils are the ones who see their teachers day after day, on different occasions; they are the only persons who are in a unique position (Davidoff, 1970)² to express a real and most valuable picture of what goes on in any classroom.

Shingles (1977)³ also affirms the importance of pupil participation in the evaluative process. He states that:

"Students after all are the principal recipients of the teaching process and it is they (not administrators or colleagues) who spend the most time observing faculty in the performance of their teaching role." 4

Pupils' evaluation is of both practical and theoretical importance (Whitely and Doyle, 1976)⁵ even if pupils are not old enough and are not trained like

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1. Anderson, G.J. and Walberg, H.J. 1974, op.cit. (p.86).
 2. Davidoff, S.H. 1970, "The Development of an Instrument Designed to secure Student Assessment of Teaching Behaviour that Correlate with Objective Measures of Student Achievement". U.S. Department of Health, Education and Welfare, Office of Education, Philadelphia School District, PA. Office of Research and Evaluation, ED 039 170 SP 003 834.
 3. Shingles, R.D. 1977. "Faculty Ratings: Procedures for Interpreting Student Evaluations". American Educational Research Journal, Vol.16, No.4, pp.459-470.
 4. Ibid. (pp.468-469).
 5. Whitely, S.E. and Doyle, K.D. 1976. "Implicit Theories in Student Ratings". American Educational Research Journal, Vol.13, No.4, pp.241-253.

other adult observers, they "can see, feel, and care more than we ordinarily believe".¹

Nuthall (1970)² also believes that a pupil's opinion is very important in the development of effective teaching. He stresses his belief by stating that "Any theory which purports to explain the nature of classroom learning should include some account of the pupils as actively selective participants."³ Also Deiaico (1973)⁴ in his report on student's rating scale of teachers concludes that it is necessary to provide frequent and intensive help to teachers in order to improve teacher behaviour and effectiveness.

Finally, Winne (1977)⁵ is among several educators who believe in the importance of pupils' participation in the evaluation system of classroom interaction; he emphasises his position by stating that:

"Students' preferences for one or another kind of teaching may influence learning and attitudes differently when the teaching they receive corresponds to their preferences versus when it does not." 6

3.30 The Validity and Reliability of Pupils' Evaluation of Teachers

Thus many educators state that there is empirical and local support for the practice of collecting and using pupil evaluations. Some educators, however, still suspect the validity and reliability of this type

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1. Hughes, M.H.; Devaney, E.F.; Fletcher, J.R.; Miller, L.G.; Rowan, T.N.; and Welling, L. 1959, op.cit. (p.58).
 2. Nuthall, G.A. 1970, op.cit.
 3. Ibid. (p.28).
 4. Deiaico, G. 1973. "A Student's Rating Scale of a Teacher". Second Year Report, ESEA Title III, Project No.59-70-0162, Sheboygan Public Schools. pp.1-8.
 5. Winne, H.P. 1977. "Aptitude - Treatment Interactions in an Experiment on Teacher Effectiveness", American Educational Research Journal, Vol.14, No.4, pp.389-409.
 6. Ibid. (p.390).

of evaluation (Marsh, 1977; and Shingles, 1977).^{1,2} These educators claim that:

- i) many pupils may lack the proper prospective to evaluate the effectiveness of their teachers' behaviour;
- ii) pupils' opinions may change or fluctuate from one occasion to another; and
- iii) some unrelated factors to teaching excellence may colour pupils' opinions of their teachers' performance; these factors include, subject matter, sex, achievement level, grade level, class size, teacher popularity, grades received from teachers,...and the like.

3.31 Pupils' Ability to Evaluate Teachers

The first argument listed above against pupil evaluation may be disproved by glancing at the results reached by other investigators. For example, according to Veldman and Peck (1967)³, ratings of junior and senior high-school teachers by their pupils agreed well with ratings of these same teachers by their university supervisors. Veldman and Peck declared that pupils "can provide reliable and valid indices for use in research applications which compare groups."⁴ Therefore, pupils do seem capable of making reasoned judgements about teacher behaviour, which in many cases is similar to that obtained through other means.

Masters (1977)⁵ even goes a step further, by confirming that when

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- 1. Marsh, H.W. 1977. "The Validity of Students' Evaluations: Classroom Evaluations of Instructors Independently Nominated as Best and Worst Teachers by Graduating Seniors." American Educational Research Journal Vol.14, No.4, pp.441-447.
 - 2. Shingles, R.D. 1977, op.cit.
 - 3. Veldman, D.J. and Peck, R.F. 1967, op.cit.
 - 4. Veldman, D.J. and Peck, R.F. 1967, op.cit. (p.22).
 - 5. Masters, J.R. 1977. "Improving Instruction Through Student Observation of Teaching Methods." Pennsylvania State Department of Education, Harrisburg, Bureau of Information Systems, ED 146 136 SP 011 776 (pp.1-44).

high-school pupils were asked to respond to the St OTT format, these pupils were not only capable of giving global ratings of their teachers, but were also reacting to the specific content of each item.

Aleamoni and Yimer (1973)¹ conducted a study at the University of Illinois, to evaluate those nominated faculty members whom it was felt (by their colleagues) deserved a commendation. Both students and other faculty members were required to evaluate the nominated member of staff. Both evaluations were then analyzed. It was found that colleagues' ratings were significantly related to academic rank and research productivity of the evaluated instructors. This proves that staff evaluation is often affected by their colleague's reputation. On the other hand, students' ratings were found not to be affected by the instructor's academic rank nor by his reputation. These results support the idea that students evaluate teachers on the basis of their actual performance, rather than unrelated superficial factors.

When Centra (1977)² conducted a similar study on 54 faculty members, who were evaluated separately by three colleagues on different occasions, he found that there was good agreement among the evaluations of the same colleague on different visits. On the other hand, there was little agreement between the evaluations of different colleagues for the same teacher.

Marsh and his colleagues (1975)³ believed that pupils' evaluations

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1. Aleamoni, L.M. and Yimer, M. 1973. "An Investigation of the Relationship Between Colleague Rating, Student Rating, Research Productivity, and academic Rank in Rating Instructional Effectiveness": *Journal of Educational Psychology*, Vol.64, No.3, pp.274-277.
 2. Centra, J.A. 1977. "Student Ratings of Instruction and Their Relationship to Student learning". *American Educational Research Journal*, Vol.14, No.1, pp.17-24.
 3. Marsh, H.W.; Fleiner, H.; and Thomas, C.S. 1975. "Validity and Usefulness of Student Evaluations of Instructional Quality". *Journal of Educational Psychology*, Vol.67, No.6, pp.833-839.

can be used as a fruitful way of:

- i) Providing valid information of instructional quality by which effective teaching can be recognized and rewarded, and
- ii) Providing valid feedback to teachers to improve their behaviour.

The same writers also believed that there is considerable evidence that pupils can validly evaluate their teachers. Their belief was built upon the results of a study which dealt with two different groups of pupils, taking a computer programming course. Marsh and his associates stated that, as a general conclusion, a positive validity coefficient between 0.25 and 0.41 was found for most of the evaluation items. They also stated that teachers given feedback from their classes were rated more positively compared with teachers in "no feedback" classes.

Centra (1976)¹ maintained that, regardless of the use to be made of pupils' evaluations, they tend to be consistent, and are not susceptible to the "leniency" effect. Hayes and his colleagues (1967)² affirmed the honesty and the reliability of pupils' evaluation. They also believed that, although pupils are not experts on teaching, they can furnish their teachers with valuable information on their behaviour in the classroom. Moreover, when the investigators analyzed the results of the 2400 pupils participating in the evaluation process of their teachers, and compared them with the results of the Principals, who were also asked to participate (in the evaluation of the same teachers), they found that the correlation between pupils' ratings and principals' ratings indicated reasonable similarity. Thus, these results showed the validity of pupils' ratings.

Remmers (1963)³ goes as far as to conclude that pupil ratings are as good as the best educational and mental tests available at present.

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- 1. Centra, J.A. 1976. "The Influence of Different Directions of Student Ratings of Instruction". *Journal of Educational Measurement*, 13, pp.277-282.
 - 2. Hayes, R.B.; Keim, F.N.; and Neiman, A.M. 1967, op.cit.
 - 3. Remmers, H.H. 1963, op.cit.

Among a large number of studies affirming the validity of pupil ratings is the study of Denton and his associates (1977)¹, in which secondary-school pupils were asked to react to a Likert-type questionnaire designed to reveal their perceptions of their teachers. Pupils' reactions when compared with those of supervisors (of the same teachers), indicated a logical relation between them.

A similar conclusion was noted by Hayes and his colleagues (1966)², when they compared pupils' ratings of teachers with principals' ratings of the same teachers by using the Hayes Pupil-Teacher Reaction Scale. A reasonable correlation was found between the two ratings. This significant correlation, in addition, provides further evidence on the validity of pupils' evaluations.

Marsh, Overall and Kesler (1978)³ adopted new criteria for validating pupils' evaluation at the College level. The teachers who were evaluated by their pupils, were asked to evaluate themselves and their own instructions. According to the researchers, the mean of the pupils' evaluations, which aimed at indicating the most and the least effective instructors, when compared with the mean faculty self evaluation showed a high correlation of 0.77. The writers assumed that this correlation implied that both pupils and faculty members agreed upon what the faculty, as a whole, did best or worst.

Finally, Shaw (1973)⁴ confirmed the importance and reliability of pupils' role in evaluating their teachers' behaviour by stating that:

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1. Denton, J.J.; Calario, J.F.; and Johnson, C.M. 1977, op.cit.
 2. Hayes, R.B.; Keim, F.N.; and Neiman, A.M. 1966. "The Effects of Student Reactions to Teaching Methods". Bureau of Research, Department of Public Instruction, Harrisburg, Pennsylvania, Project No.50096.
 3. Marsh, H.W; Overall, J.U.; and Kesler, S.P. 1978, op.cit.
 4. Shaw, J.S. 1973. "Students Evaluate Teachers and (better sit down) it Works." Nation's Schools, April, Vol.91, No.4, pp.49-53.

"If you still doubt that students should have a role in evaluating teacher performance, take another look at the evidence. It strongly suggests that students can reliably evaluate teachers and - don't faint - that many teachers actually welcome constructive student criticism." 1

Moreover, Shaw also suggested that those, who doubt this, should come along and look at the growing numbers of schoolmen who are involving pupils in their evaluation programme. Furthermore, Freedman and Stumph (1978)² confirmed Shaw's opinion about the importance and reliability of pupils' evaluations of instructors and classes along various dimensions. They confirmed this by stating that "the importance of student evaluations in higher education is evidenced by the development, validation, and use of a number of instruments."³

3.32 Fluctuation of Pupils' Opinions over Time

Knowledge, or at least uncertainty, that pupils' evaluations of teachers may be unstable and that it may fluctuate over time, is probably common belief among some educators. But the work of several investigators confirms and reassures both the validity and the stability of pupils' evaluations. As for example, Masters (1977)⁴ found a correlation of 0.70 for four of the St OTT five items, that he applied to 33 pupils, when they were asked to rate the same teachers. Not only this, but Masters also found that teachers who received the highest mean scores on the first St OTT administration tended to receive the highest scores as well on the second

1. Ibid. p.49.

2. Freedman, R.D. and Stumph, S.A. 1978. "Student Evaluations of Courses and Faculty Based on a Perceived Learning Criterion: Scale Construction, Validation and Comparison Results". Applied Psychological Measurement, Vol.2, No.2, pp.189-202.

3. Ibid., p.189.

4. Masters, J.R. 1977. op.cit.

St OTT administration.

Findings of Hayes and his colleagues (1967)¹ agreed with those of Masters. From the responses of elementary pupils, Hayes and his colleagues computed a coefficient of consistency ranging from 0.58 (with 21 weeks duration between the first and second ratings) to 0.85 (with 5 weeks duration).

Davidoff (1970)² and Shingles (1976)³ also shared the same belief and that pupils' ratings of teachers' behaviours are very stable over time.

3.33 Biasing of Pupils' Perceptions of Teachers' Behaviours by Variables Unrelated to Teaching Excellence

As for this third argument, Marsh and his colleagues (1978)⁴ considered that the most common criticism of pupils' evaluations, besides the feeling that they lack validity, is that they are biased by variables unrelated to teaching excellence.

Remmers (1963)⁵; Shaw (1973)⁶; Thompson (1974)⁷; and Centra (1973)⁸

1. Hayes, R.B.; Keim, F.N.; and Neiman, A.M. 1967, op.cit.
2. Davidoff, S.H. 1970, op.cit.
3. Shingles, R.D. 1976, op.cit.
4. Marsh, H.W.; Overall, J.U.; and Kesler, S.P. 1978, op.cit.
5. Remmers, H.H. 1963, op.cit.
6. Shaw, J.S. 1973, op.cit.
7. Thompson, E.J. 1974, "Student Evaluation of Teachers", NASSP National Association of Secondary Principals Bulletin, Vol.58, Part 384, pp.25-30.
8. Centra, J.A. 1973. "Effectiveness of Student Feedback in Modifying College Instruction". Journal of Educational Psychology, Vol.65, No.3, pp.395-401.

produced similar results, when they conducted different projects. Their results, thus, give encouragement and empirical support for the use of pupils' evaluations in measuring excellence in teaching.

According to Goldsmid and his colleagues (1977)¹, when pupils were asked to evaluate their faculty as a step towards the nomination of members for an award of distinguished teaching, the researchers found that pupils' evaluations of the nominated teachers are not affected by subject matter, grades received by teachers, pupil load, or class size.

Weber (1953)² conducted a similar study to that of Goldsmid. One hundred college graduates were asked to select two teachers from all their undergraduate teachers. One of these they were to characterize as their best liked teacher, while the other, they were to characterize as the least liked teacher. Weber concluded, from the analysis of the questionnaire, that pupils' opinions concerning the best liked teachers are not affected by unrelated factors. What really affects them is his personality.

Moreover, Marsh (1977)³ conducted a study as part of a university wide programme of instructional evaluation. Graduate pupils were asked to recommend instructors in their major departments. These instructors were recommended either as "most or least" outstanding. A similar evaluation process was carried out at the end of the following year, with other graduate seniors. The new graduates were asked to evaluate the teachers already nominated by the previous-year graduates. However, when the two evaluation results were collected and compared, no significant

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1. Goldsmid, C.A.; Gruber, J.E.; and Wilson, E.K. 1977. "Perceived Attributes of Superior Teachers (PAST): An Inquiry into the Giving of Teacher Awards". American Educational Research Journal, Vol.14, No.4, pp.423-440.
 2. Weber, C.A. 1953. "Some Characteristics of College Teachers". Journal of Educational Research, Vol.46, pp.685-692.
 3. Marsh, H.W. 1977, op.cit.

differences on 14 of the 15 background items (grade point average; course work load; course difficulty; grade expected;...and the like) characterising pupils, courses, and instructors, were found to affect the evaluation process.

Elmore and Lapointe (1974)¹ also indicated that the pupils' assessment ratings are just as valid and reliable as adult judges, and that sex of pupils or teachers do not have an effect on the evaluation process. The same authors also indicated a year later that particular characteristics of a teacher, such as, warmth and his interest in pupils, weigh heavily in his favour (Elmore and Lapointe, 1975).²

Moreover, some unrelated factors to teaching excellence were examined by Veldman and Peck (1967)³. These researchers developed a Pupil Observation Survey (POSR), which was administered later to pupils in order to evaluate their teachers. The rating scores of pupils of their teachers were then compared with the grades, that the participant pupils received from their teachers. It was found that pupils' ratings were not affected by the grades they received from their teachers. The investigators of the study, also concluded from an analysis of early (POSR) data, that there were no important interactions between sex of both pupils and teachers, and pupils' evaluations of teachers' behaviour.

Marsh and his colleagues (1975)⁴ also believed that, there was considerable evidence confirming that pupils' evaluations had little or no

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1. Elmore, B.P. and Lapointe, A.K. 1974, "Effects of Teacher Sex and Student Sex on the Evaluation of College Instructors". *Journal of Educational Psychology*, Vol.66, No.3, pp.386-389.
 2. Elmore, B.P. and Lapointe, A.K. 1975, "Effects of Teacher Sex and Teacher Warmth on the Evaluation of College Instructors". *Journal of Educational Psychology*, Vol.67, No.3, pp.368-374.
 3. Veldman, D.J. and Peck, R.E. 1967, op.cit.
 4. Marsh, H.W.; Fleiner, H.; and Thomas, C.S., 1975, op.cit.

significant correlation with sex, grade received by teachers, grade expected by pupils, or work load.

Shingles (1977)¹ also considered that as long as teachers were to receive constructive criticism, or feedback on teaching behaviour in the classroom, then pupils' evaluation ought to be accurate and reliable.

In this context, those who doubt the reliability and validity of pupils' evaluations may only be right in their doubts, if the evaluation system of a scale is developed in an irrelevant manner, by including factors beyond teachers' control (Shingles, 1977),² such as, class size, grading system, course difficulty and course requirement. These factors will only, then, serve to bias the system. However, if pupils are approached properly (Hayes, et al., 1966)³ and if the evaluation system used is developed to measure relevant aspects of behaviour, particularly those that a teacher can control in his classroom (Marsh, et al., 1975)⁴, then the pupils' evaluation process is both valid and reliable.

It is necessary to understand, however, that pupils' ratings should not be used where inaccurate and unjust decisions may have to be taken, since this in turn may damage teachers' careers. Nevertheless, they could be used in other constructive ways. Examples of these ways are numerous e.g., giving faculty feedback on texts, teaching techniques, helping pupils to choose among different courses, and the like.

3.40 Pupil Evaluation and Its Effect on Teachers' Behaviour

Using pupils' ratings of instruction as inputs into the evaluation

1. Shingles, R. 1977, op.cit.

2. Shingles, R. 1977, op.cit.

3. Hayes, R.B.; Keim, F.N.; and Neiman, A.M. 1966, op.cit.

4. Marsh, H.W.; Fleiner, H.; and Thomas, C.S., 1975, op.cit.

of teachers, have now become standard practice at different levels of education in an attempt to improve the educational process. But the question which many educators may ask is whether or not teachers of various subjects will modify their teaching as a result of feedback drawn from such ratings of their classroom performance.

There is some evidence of the value of a pupil evaluative system and its feedback effect on teachers' behaviour. A review of the research that has been done indicates that teachers, who have been evaluated by their pupils, do change their behaviour in one way or another (Flanders, 1967)¹ to match the needs of their pupils.

Shaw (1973)², for example, asserts that some schools have indicated changes and modifications in teachers' attitude, and classroom practice resulting from pupils' evaluations of teacher performance. Shaw affirms for example that:

- a) "At San Mateo School, mathematics teachers have made their classes far more creative since students rated them lower than others;
- b) At Adams School, substantive changes in guidance Counsellors' functions and an increase in vocational education offerings have come about because of a student questionnaire that probed the entire school environment; and
- c) At Shorewood, a teacher moved from a generalized to an individualized language arts approach." 3

Hayes and his colleagues (1966)⁴ have attempted to study the effects of pupils' reactions on both teaching methods and teachers' behaviour. They concluded from the results of a teacher questionnaire and interview schedule that teachers gained many valuable ideas to improve their teaching.

1. Flanders, N.A. 1967, op.cit.

2. Shaw, J. 1973, op.cit.

3. Ibid., (p.53).

4. Hayes, R.B.; Keim, F.N.; and Neiman, A.M. 1966, op.cit.

Moreover, when Hayes and his associates (1967)¹ later conducted a similar experiment, they confirmed that eighty-eight percent of the sixty teachers receiving feedback, reported that their pupils' evaluations did provide them with a critical analysis of their teaching. Hayes, et al., also found that ninety percent of the teachers indicated that their pupils had accurately pointed out their teaching strengths and weaknesses, and that they had an objective basis for changing their behaviour.

Flanders (1967)² found that most teachers receiving feedback learned more about themselves, about their classroom behaviour, and about their pupils' reactions. Flanders thought that this knowledge was rewarding in itself.

Parakh (1967)³ considered pupils' evaluations were profitable approaches, especially when they provided objective feedback to teachers during both their pre- and inservice training.

Finally, Best (1974)⁴ claimed that when a number of Australian teachers were asked to participate in a pupils' evaluation project (for the purpose of developing the Biology Activity Check List, applied to schools offering matriculation biology 12th grade) more teachers than needed showed enthusiasm to be included in the project; such enthusiasm possibly arose because these teachers felt that they would benefit from the project by gaining more information from their pupils about classroom interaction.

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1. Hayes, R.B.; Keim, F.N.; and Neiman, A.M. 1967, op.cit.
 2. Flanders, N.A. 1967, op.cit.
 3. Parakh, J.S. 1967, op.cit.
 4. Best, E.D. 1974. "Student Perception of Activities and Outcomes in South Australian Matriculation Biology Classes". Research in Science Education, Vol.4, pp.151-159.

3.50 Teachers' Involvement In The Evaluation Process

It may be very revealing to know how many teachers concern themselves with the effectiveness of what they are doing in their classrooms. Also it may be of interest to know how many teachers try to evaluate their work in the classroom either by asking their pupils to evaluate them, or by welcoming some of their colleagues to do so. Unfortunately, only a few possibly do so. This may be because, when teachers adopt a certain style of teaching, they tend to think that it is the best possible style, and that nobody should criticise their techniques. Stake (1970)¹ found out that "teachers may be wrong in choosing what they choose, but they are not wrong in thinking that what they have chosen is important. They made it so."²

Therefore, one way of making teachers accept criticism of their style of teaching or behaviour, is to encourage them to believe in the benefit of self-criticism which is one of the chief assets of an educated person.

Good, Biddle and Brophy (1975)³ believe firmly that teachers should become researchers in their own classroom, by finding out and assessing what their pupils think of their behaviour in the classroom, thus becoming more effective and thus producing more desirable pupil outcomes.

Hill and Blake (1976)⁴ claim that there might be a solution for the lack of liaison between "teachers and educational teachers,"⁵ by involving more teachers in the research process. Likewise, Greenberg

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1. Stake, R.E. 1970. "The Need for Teacher Evaluation". In: Gallagher, Nuthall and Rosenshine. Monograph Series on Curriculum Evaluation, Rand McNally Education Series, B.Othanel Smith (ad.ed.).
 2. Stake, R.E. 1970, op.cit. (p.2).
 3. Good, T.L.; Biddle, B.J.; and Brophy, J.E. 1975. "Teachers Make a Difference", New York, Holt, Rinehart and Winston, Inc.
 4. Hill, M.D. and Blake, D.J.A. 1976. "Undergraduate Research Experience for future Science Teachers: A First Effort". Research in Science Education, Vol.6, pp.1-5.
 5. Ibid. (p.1).

(1970)¹ states that "teachers should be trained to read and understand research findings, thus eventually obviating the need for interpreters of research."²

3.60 Summary

Pupils at whom the educational process is aimed, are seldom called upon or approached for their opinion about the various conditions under which learning takes place (Tisher, Power, and Endean, 1972; Denton, Calarco, and Johnson, 1977; and Taba, 1932).^{3,4,5}

3.61 Teacher's Responsibility in the Classroom and Pupils' Perceptions

Since a teacher is the one who carries the main responsibilities for the teaching process in the classroom (Woodring, 1962; Amidon and Hunter, 1967; Tisher, Power and Endean, 1972; Bruce and Howard, 1977; and Breuning, 1978),^{6,7,8,9,10} he/she should have a thorough knowledge of the recipients of the learning process, i.e., pupils (Richard, Joel, and Izu, 1977),¹¹

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1. Greenberg, B.S. 1970. "Selected Studies of Classroom Teaching: A Comparative Analysis". Scaranton (Pa) International Textbook.
 2. Greenberg, B.S. 1970, op.cit. (p.39).
 3. Tisher, P.R.; Power, N.C.; and Endean, L. 1972, op.cit.
 4. Denton, J.J.; Calarco, J.F.; and Johnson, C.M. 1977, op.cit.
 5. Taba, H. 1932, op.cit.
 6. Woodring, P. 1962, op.cit.
 7. Amidon, E. and Hunter, E. 1967, op.cit.
 8. Tisher, P.R.; Power, N.C.; and Endean, L. 1972, op.cit.
 9. Bruce, A.C. and Howard, M.B. 1977, op.cit.
 10. Breuning, E.S. 1978, op.cit.
 11. Richard, J.S.; Joel, C. and Izu, T. 1977, op.cit.

and their abilities and needs (Kenny, Hentschel, and Elpers, 1972),¹ so as to be able to carry out his/her teaching appropriately (Anderson, 1959; and Robert and Baker, 1976).^{2,3}

Also as pupils are the only individuals who interact constantly with teachers day after day during the school year, they are the only ones who can give the most reliable information on what goes on in their classes (Remmers, 1963; Medley and Mitzel, 1963; Kenny, Hentschel, and Elpers, 1972 and Tisher, Power and Endean, 1972).^{4,5,6,7}

3.62 Justifications for Pupils' Participation in the Evaluation System

In a Classroom

The encouragement of pupils' participation in both the evaluation and in the development of the educational process has been widely recommended because of the benefits that can be gained from pupils' responses, which provide a more comprehensive picture of classroom events including teachers' characteristics and behaviours (Remmers, Gage, and Rummely, 1966; Remmers, 1963; Veldman and Peck, 1967; Whitely and Doyle, 1976; Denton Calarco, and Johnson, 1977; Donald and Penny, 1977; and Marsh, Overall

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1. Kenny, J., Hentschel, G., and Elpers, K. 1972, op.cit.
 2. Anderson, G.J. 1959, op.cit.
 3. Robert, L.C. and Baker, L.S. 1976, op.cit.
 4. Remmers, H.H. 1963, op.cit.
 5. Medley, D.M. and Mitzel, H.E. 1963, op.cit.
 6. Kenny, J., Hentschel, G., and Elpers, K. 1972, *ibid*.
 7. Tisher, P.R., Power, N.C., and Endean, L. 1972, *Ibid*.

and Kesler, 1978).^{1,2,3,4,5,6,7}

Pupils' remarks are surely more realistic than those of other trained observers who only visit and observe classrooms on a few separate occasions (Hughes, Devaney, Fletcher, Miller, Rowan, and Welling, 1959; Veldman and Peck, 1963 and 1967; Nuthall, 1970; Davidoff, 1970; Anderson and Walberg, 1974; and Shingles, 1977).^{8.9.10.11.12.13.14}

Moreover, pupils' evaluation is undoubtedly a great help to teachers in improving their teaching proficiency to the ultimate benefit of their pupils (Deiaico, 1973; and Winne, 1977).^{15,16}

3.63 The Validity and Reliability of Pupils' Evaluation of Teachers

Pupils are found to be capable of evaluating reliably their teachers. The presence of significant agreement between pupils' evaluation of their

1. Remmers, H.H.; Gage, N.L.; and Rummel, F.J. 1966, op.cit.
2. Remmers, H.H. 1953, op.cit.
3. Veldman, D.J. and Peck, R.F. 1967, op.cit.
4. Whitely, S.E.; and Doyle, K.D. 1976, op.cit.
5. Denton, J.J.; Calarco, J.F.; and Johnson, C.M. 1977, op.cit.
6. Donald, J.G. and Penny, M. 1977, op.cit.
7. Marsh, H.W.; Overall, J.M.; and Kesler, S.P. 1978, op.cit.
8. Hughes, M.M.; Devaney, F.F.; Fletcher, J.R.; Miller, I.G.; Rowan, T.N.; and Welling, L.; 1959, op.cit.
9. Veldman, D.J. and Peck, R.F. 1963, op.cit.
10. Veldman, D.J. and Peck, R.F. 1967, op.cit.
11. Nuthall, G.A. 1970, op.cit.
12. Davidoff, S.H. 1970, op.cit.
13. Anderson, G.J. and Walberg, H.J. 1974, op.cit.
14. Shingles, R.D. 1977, op.cit.
15. Deiaico, G. 1973, op.cit.
16. Winne, H.P. 1977, op.cit.

teachers and those of other observers, such as supervisors (Veldman and Peck, 1967; Denton, Calarco, and Johnson 1977)^{1,2} or principals (Hayes, Keim, and Neiman, 1966)³ of the same teachers, indicate clearly that pupils do not lack the ability to evaluate their teachers in a reliable and honest way (Marsh, Fleiner, and Thomas, 1975; Centra, 1977; Masters, 1977; and Marsh, Overall and Kesler, 1978).^{4,5,6,7}

Furthermore, pupils' evaluations of teachers are consistent over time (Hayes, Keim, and Neiman, 1967; Davidoff, 1970; Shingles, 1976; Centra, 1976; and Masters, 1977)^{8,9,10,11,12} and are found to be uncontaminated by factors beyond the control of the evaluated teacher (Weber, 1953; Remmers, 1963; Veldman and Peck, 1967; Centra, 1973; Shaw, 1973; Aleamoni and Yimer, 1973; Elmore and Lapointe, 1974 and 1975; Marsh, Fleiner, and Thomas, 1975; Marsh, 1977; Shingles, 1977; and Marsh, Overall,

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1. Veldman, D.J. and Peck, R.F. 1967, op.cit.
 2. Denton, J.J.; Calarco, J.F.; and Johnson, C.M. 1977, op.cit.
 3. Hayes, R.B.; Keim, F.N.; and Neiman, A.M. 1966, op.cit.
 4. Marsh, H.W.; Fleiner, H.; and Thomas, C.S. 1975, op.cit.
 5. Centra, J.A. 1977, op.cit.
 6. Masters, J.R. 1977, op.cit.
 7. Marsh, H.W.; Overall, J.U.; and Kesler, S.P. 1978, op.cit.
 8. Hayes, R.B.; Keim, F.N.; and Neiman, A.M. 1967, op.cit.
 9. Davidoff, S.H. 1970, op.cit.
 10. Shingles, R.D. 1977, op.cit.
 11. Centra, J.A. 1976, op.cit.
 12. Masters, J.R. 1977, op.cit.

and Kesler, 1978).^{1,2,3,4,5,6,7,8,9,10,11,12}

3.64 Pupils' Evaluation and Its Effect on Teachers' Behaviour

From a review of some recent studies related to the effects that pupils' evaluation have on teachers, it is evident that teachers not only welcome pupils' evaluation but they also try to benefit from such evaluations, in one way or another, to improve the efficiency of their teaching (Hayes, Keim and Neiman, 1966 and 1967; Flanders, 1967; Parakh, 1967; Shaw, 1973; and Best, 1974).^{13,14,15,16,17,18}

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1. Webber, C.A. 1953, op.cit.
 2. Remmers, H.H. 1963, op.cit.
 3. Veldman, D.J. and Peck, R.F. 1967, op.cit.
 4. Centra, J.A. 1973, op.cit.
 5. Shaw, J.S. 1973, op.cit.
 6. Aleamoni, M.L. and Yimer, M. 1973, op.cit.
 7. Elmore, B.P. and Lapointe, A.K. 1974, op.cit.
 8. Elmore, B.P. and Lapointe, A.K. 1975, op.cit.
 9. Marsh, H.W.; Fleiner, H.; and Thomas, C.S. 1975, op.cit.
 10. Marsh, H.W., 1977, op.cit.
 11. Shingles, R.D. 1977, op.cit.
 12. Marsh, H.W.; Overall, J.U.; and Kesler, S.P. 1978, op.cit.
 13. Hayes, R.B.; Keim, F.N.; and Neiman, A.M. 1966, op.cit.
 14. Hayes, R.B.; Keim, F.N.; and Neiman, A.M. 1967, op.cit.
 15. Flanders, N.A. 1967, op.cit.
 16. Parakh, S.J. 1967, op.cit.
 17. Shaw, J.S. 1973, op.cit.
 18. Best, D.E. 1974, op.cit.

3.65 Teacher's Involvement In the Evaluation Process

The only way that a teacher can improve his/her teaching quality is by realizing his/her strengths and weaknesses. This cannot be done unless this teacher sees himself/herself from the perspectives of others, such as either his/her pupils or colleagues. Teachers, therefore, should be encouraged to carry out the responsibilities of an evaluation process for themselves and not to have to wait for an outside observer to do so (Stake, 1970; Greenberg, 1970; Good, Biddle, and Brophy, 1975; and Hill and Blake, 1976).^{1,2,3,4}

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1. Stake, E.R. 1970, op.cit.
 2. Greenberg, B.S. 1970, op.cit.
 3. Good, T.L.; Biddle, B.J. and Brophy, J.E. 1975, op.cit.
 4. Hill, M.D. and Blake, D.J.A. 1976, op.cit.

CHAPTER IVSystematic Classroom Observation:Discussion of The Systems Used in the StudySynopsis

This chapter contains a discussion of the use of systematic classroom observations.

The first part of this chapter gives an overview of classroom observation and rating systems. It covers:

1. Evaluation and effective teaching.
2. Use of evaluation.
3. Methods of evaluation
 - (a) direct or indirect evaluation.
4. Systematic classroom observation system
 - (a) types of classroom observation system.
5. Rating systems
 - (a) types of rating scales.

The second part discusses the instrument used in this project (i.e. S.T.O.S.) and outlines the manner in which the system was used during the study. It covers:

1. Reasons for choosing the Science Teaching Observation Schedule system.
2. The S.T.O.S. training procedure.
3. The use of S.T.O.S.
4. Events recording: procedures for the use of S.T.O.S.
5. Analysis and display of S.T.O.S. data.
6. Features of the S.T.O.S. system.

Measurement and evaluation have been rapidly increasing in the field of education during this century (Remmers et.al., 1966)¹. Although Meux (1963)² argues that "the variety of things evaluated, contents, and evaluative terms"³ makes definition of evaluation difficult, Travers (1955)⁴ sees evaluation as "the process whereby the values inherent in an event are determined".⁵

Use of Evaluation

Evaluation is an essential process in our lives; we evaluate ourselves continuously to ascertain our position in relation to our goals (Tuckman, 1979).⁶ Without this evaluation we would not be able to tell whether or not what we are doing is right or wrong. Evaluation answers many questions, such as, what and how much progress we are making (Remmers, et.al., 1966).⁷ Accordingly, weakness can be corrected and strengths consolidated. Parakh (1967)⁸ agrees with Good and Brophy (1974)⁹ that

1. Remmers, H.H.; Gage, N.L. and Rummel, F.J. 1966 op.cit.
2. Meux, M. 1963. "The Evaluation Operation in the Classroom". In: Bella, A.A. (ed.). Theory and Research in Teaching, Bureau of Publications, Teacher College, Columbia University, New York.
3. Ibid. (p.11).
4. Travers, R.M.W. 1955 "Educational Measurement". The MacMillan Company New York.
5. Ibid. (p.6).
6. Tuckman, B. Wayne, 1979. "Evaluating Instructional Programs". Allyn & Bacon, Inc.
7. Remmers, H.H.; Gage, U.L. & Rummel, F.J. 1966 op.cit.
8. Parakh, J.S. 1976. op.cit.
9. Good, T.L. and Brophy, J.E. 1974. "Changing Teacher and Student Behaviour: An Empirical Investigation". Journal of Educational Psychology, Vol. 66, No.3, pp.390-405.

evaluation is a profitable approach in providing teachers with objective feedback. Teachers may be unaware of how they interact with their pupils (Withall, 1956)¹, because they do not know the needs and aptitudes (Remmers, et.al., 1966)² of their pupils. Accordingly they may underestimate or overestimate the extent to which they differentiate treatments for different pupils. Evaluation may provide the guidance that teachers need to uncover pupil growth and progress (Fickers, 1952)³. Evaluation, then, is an integral part of the job of a "good" teacher. The "good" teacher is the one who makes use of self evaluation in order to make his teaching more effective, and "to evaluate what he does is as important as doing it."⁴ Travers (1955)⁵ goes even a step further by claiming that evaluation in education "is not merely a process of determining what the actual outcomes are, but also involves a judgement of the desirability of whatever outcomes are demonstrated to occur."⁶

Methods of Evaluation

4.20 Introduction

Evaluation of classroom behaviours can be achieved by a variety of techniques. Systematic observation systems and rating scales constitute the main approaches. Medley and Mitzel (1963)⁷ describe the systematic

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1. Withall, John, 1956. "An objective Measurement of a Teacher's classroom interactions". Journal of Educational Psychology, Vol.47, pp.203-212.
 2. Remmers, H.H.; Gage, N.L.; and Rummel, F.J. 1966. op.cit.
 3. Fickers, James A. 1952. "Deciding How to Evaluate: The Comparative Effectiveness of Appraisal Methods in Elementary School". Journal of Educational Research, Vol.46, pp.133-139.
 4. Remmers, H.H.; Gage, N.L.; and Rummel, F.J. 1966. ibid.
 5. Travers, R.M.W., 1955. op.cit.
 6. Travers, R.M.W., 1955. op.cit.
 7. Medley, M.D. and Mitzel, H.E., 1963. op.cit.

observation approach as a way of observing, recording, and analyzing classroom events, but not as a way of judging what happens in classrooms. In other words, systematic observation only "provides a description of what is, and not a perception of what ought to be."¹ Moreover, rating systems are another form of personality inventory whereby evaluation of a certain person (Borg, 1963)² is made by a rater according to certain aspects or characteristics illustrated by a series of qualitative terms (see, Good, 1959),³ as for example, excellent, strong, average, ... and the like.

4.21 Direct and Indirect Evaluation

Evaluation can be carried out either through direct or indirect observation. In direct observation, the investigator sits in the classroom and records the various events and interactions as they occur. Medley and Mitzel (1963)⁴ believe that direct-observation procedures are the more obvious approach to observe "teachers while they teach and pupils while they learn",⁵ (see, also - Meux, 1963 and Rosenshine, 1970(a)).^{6,7}

In the case of indirect observation, the rater does not record events to be evaluated directly as they happen, but he records his impression of both the situation and the subject at a later time; thus a gestation period is allowed to provide a more objective picture.

Another approach of indirect observation is by administering

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1. Parakh, S.J. 1967. op.cit. (p.193).
 2. Borg, Walter, R. 1963. "Educational Research". An Introduction, Chairman, Bureau of Educational Research, Utah State University, David McKay Company, Inc.
 3. Good, Carter, V. 1959. "Introduction to Educational Research". Applenton-Century, Crofts, Inc. New York.
 4. Medley, M.D. and Mitzel, H.E. 1963. op.cit.
 5. Ibid. (p.247).
 6. Meux, M. 1963. op.cit.
 7. Rosenshine, B. 1970(a). op.cit.

different forms of questionnaires and inventories to those who are involved to varying degrees in the educational process, such as, pupils, supervisors, colleagues, headmasters, ... and so forth (see Barr, 1950).¹

Finally, measurement and evaluation of classroom interaction can be achieved either by setting up a special test situation, as for example applying a new curriculum, or specific teaching method, from which observations are recorded (see Thorndike and Hagen; 1969, Parakh, 1967; Medley and Mitzel, 1963; Rosenshine, 1970(a); and Rosenshine and Furst, 1974),^{2,3,4,5,6} or by relying upon the observation of classroom behaviour taken in their daily setting (Soar and Soar, 1972).⁷

4.22 Systematic Classroom Observation System

The climate of opinion accepting systematic classroom observation instruments as respectable procedures of research in education for observing and measuring educational outcomes, started in the late fifties. Since then the acceptability of this evaluative method has rapidly

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1. Barr, A.A. 1950. op.cit.
 2. Thorndike, R.L. and Hagen, E. 1969. op.cit.
 3. Parakh, J.S. 1967. op.cit.
 4. Medley, M.D. and Mitzel, H.E. 1963. op.cit.
 5. Rosenshine, B. 1970(a). op.cit.
 6. Rosenshine, B. and Furst, N. 1974. "The Use of Direct Observation to study Teaching". In: Second Handbook of Research on Teaching, Travers (ed.), A Project of American Educational Research Association, Rand McNally and Company, Chicago, pp.122-183.
 7. Soar Robert and Soar Ruth, M. 1972. "The Empirical Analysis of Selected Follow Through Program: An Example of a Process to Evaluation." In: IRA J. Gordon (ed.). Early Childhood Education. The Seventy-First Yearbook of The National Society for the Study of Education, Part II, University of Chicago Press, Chicago, Illinois.

increased. Travers (1955)¹ endorses this by saying "although it was once possible to distinguish different types of observational instruments now, things fall apart, the centre cannot hold."²

The dissatisfaction with the traditional educational research, which Parlett and Hamilton (1972)³ called the "agricultural botany paradigm"⁴ held by many educational leaders, was the impulse behind the trend towards systematic classroom observation.

A large number of psychologists, educators, and researchers involved in training teachers, were worried about the sterility of the dominant pattern of educational research which relied mainly on monadic variables, i.e. data of one particular type of variable (see Gage and Unruh, 1967; Dunkin and Biddle, 1974; Withall and Lewis, 1963; Galton and Eggleston, 1979; Welch and Walberg, 1972; Waimon, 1969; and Parlett and Hamilton,

1. Travers, R.M.W. 1955. op.cit.

2. Ibid. (p. 132).

3. Parlett, M. and Hamilton, D. 1972. "Evaluation as Illumination: A New Approach to the Study of Innovatory Programms". Centre for Research in the Educational Sciences, University of Edinburgh, Occasional Paper-9.

4. Ibid. (p.4).

N.B.: Parlett and Hamilton see that the most common form of agricultural-botany type treats students by giving them pre-tests (the seedlings are weighed or measured) and then submitting them to different experiences (treatment conditions). Subsequently, after a period of time, their attainment (growth or yield) is measured to indicate the relative efficiency of the methods (fertilizers) used. Studies of this kind are designed to yield data of one particular type (pp.3-4).

1972)^{1,2,3,4,5,6,7.}

This led to the practice of going into the classroom to:

- (i) observe classroom interaction directly;
- (ii) discover any unique features, and
- (iii) find out the most effective methods used by teachers in the classroom.

Accordingly, several investigators from different parts of the world, especially from the United States of America, the United Kingdom and Australia have started developing new systems for measuring and investigating the verbal interactions of individuals in the classroom situation. These investigated and measured the processes by which teachers interacted with pupils in the teaching-learning situation.

4.23 Types of classroom observation systems

Systematic observational systems, used in studying classroom

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1. Gage, N.L. and Unruh, W.R. 1967. "Theoretical Formulations for Research in Teaching", Review of Educational Research, 37, No.3, pp.358-370.
 2. Dunkin, J.M. and Biddle, J.B., 1974. op.cit.
 3. Withall, J. and Lewis, W.W. 1963. "Social Interaction in the Classroom". In: N.L. Gage (ed.), Handbook of Research on Teaching, American Educational Research Association. Chicago, Rand McNally, pp. 683-714.
 4. Galton, M. and Eggleston, J. 1979. "Some Characteristics of Effective Science Teaching". European Journal of Science Education, Vol.1, Part 1, pp.75-83.
 5. Welch, W.W. and Walberg, H.J. 1972. "A National Experiment in Curriculum Evaluation". American Educational Research Journal, Vol.9, pp.373-383.
 6. Waimon, M.D. 1969. "Judging the Effectiveness of Teaching". Journal of Curriculum Studies, pp.269-277.
 7. Parlett, M. and Hamilton, D. 1972. op.cit.

interaction, differ from each other according to the objectives of the measurement involved (see, Gallagher, 1970; Dunkin and Biddle, 1974; and Nuthall, 1970).^{1,2,3.}

Some of the systems are general and can be used in different classroom situations, as for example, the Flanders' system (Flanders, 1970)⁴.

Other systems are developed for specific areas (Rosenshine, 1970(a); and Parakh, 1967)^{5,6} such as, information and ideas given in classroom, thought levels, cognitive and attitudinal variables and so forth.

Delamont (1973),⁷ for example, is one of those investigators who constructed her own system. She explains her own reasons for doing so in the following way:

" I needed a coding system which would tap, like FIAC, the socio-emotional aspects of pupil talk, but also, as the existing evidence suggested that many of their contributions would be on the factual and cognitive aspects of the lesson, their speech in that area too. In addition, I wanted to record information about each girl as an individual, that is with the codings attached to a name, with the data on the behaviour of the pupils as a group also available. I did not want to use observation of individual girls simply as a form of sampling the whole, as do many of the existing system." ⁸

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1. Gallagher, J.J. 1970. op.cit.
 2. Dunkin, J.M. and Biddle, J.B. 1974. op.cit.
 3. Nuthall, G.A. 1970. "A Review of Some Selected Recent Studies of Classroom Interaction and Teaching Behaviour", In: Classroom Observation, Gallagher, Nuthall and Rosenshine, Rand McNally, Education Series, B. Othanel Smith, Advisory Editor, (pp.6-29).
 4. Flanders, N.A.
 5. Rosenshine, B. 1970(a). op.cit.
 6. Parakh, J. 1967. op.cit.
 7. Delamont, S.K. 1973. "Academic Conformity Observed: Studies in the Classroom, Ph.D. Dissertation, University of Edinburgh.
 8. Delamont, S.K. 1973. op.cit. (pp.211-212).

Delamont developed her own system because of her specific interest in studying the language of pupils in their classrooms.

Similarly, several independent groups of investigators have attempted to develop coding systems to reveal and to encourage the growth of intellectualism¹ in classroom affairs because of their belief in the importance of this particular aspect of classroom behaviour. Therefore, some of these investigators made use of Bloom's Taxonomy (Bloom, et.al, 1956)² of educational objectives for developing their own instruments. The modified system called Teacher Pupil Question Inventory (TPQI) was developed and based on the type of information and ideas discussed and used by both partners in the interactive process, namely, pupils and teachers (Davis and Tinsley, 1968).³ Moreover, the Florida Taxonomy of Cognitive Behaviour (FTCB) (Brown, et.al, 1968)⁴ was developed to be applied to information and ideas in classrooms.

The Guilford Model (Guilford, 1956)⁵ was also constructed in the belief that intellectual ability consisted of performing a particular

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1. Intellectualism is the power of knowledge and the capacity for intelligent thought especially when highly developed.
 2. Bloom, S.B.; Engelhart, D.M.; Furst, J.E.; Hill, H.W.; and Krathwohl, R.D.(eds.), 1956. "Taxonomy of Educational Objectives; The Classification of Educational Goals". Handbook 1, Cognitive Domain, David McKay Company Inc., New York.
 3. Davis, O.L.Jr. and Tinsley, D.C. 1968. "Cognitive Objectives Revealed by Classroom Questions Asked by Social Studies Student Teachers." In: R.T. Haymar (ed.), Teaching Vantage Points for Study, Philadelphia; J.B. Lippincott.
 4. Brown, B.; Obler, R.; Soar, R.; and Webb, J.N. 1968. "The Florida Taxonomy of Cognitive Behaviours". Institute for Development of Human Resources, The University of Florida, Gainesville.
 5. Guilford, J.P. 1956. "The Structure of Intellect" Psychological Bulletin, Vol.53, pp.267-293.

type of cognitive operation upon a particular type of content so as to produce a particular type of outcome.

Taba and her colleagues (Taba, et.al., 1964; Taba, 1966)^{1,2} worked on a system that dealt with both classroom performance and curriculum development. They were also concerned with thought levels, and their enhancement.

Smith and Meux (1964; 1962, and Smith et.al. 1967)^{3,4,5} and Bellack, et.al. (1966)⁶ were interested in logic in the classroom. Meux and Smith perceived the study of logic in the classroom as "the governing of thought or of overt behaviour"⁷. They also saw that language may be used for many purposes. "Some of these are clearly logical in character;

1. Taba, H.; Levine, S.; and Elzey, F.F. 1964. "Thinking in Elementary School Children". U.S. Department of Health, Education, and Welfare, Office of Education, San Francisco State College, Cooperative Research Project, No. 1574 .
2. Taba, H. 1966. "Teaching Strategies and Cognitive Functioning in Elementary School Children". U.S. Department of Health, Education and Welfare, Office of Education, San Francisco State College, Cooperative Research Project, No. 2404.
3. Smith, B.O. and Meux, M., 1964. "Logical Dimensions of Teacher Behaviour": in: B.J. Biddle and W.J. Ellena (eds.), Contemporary Research on Teacher Effectiveness, New York. Holt, pp.127-164.
4. Smith, B.O. and Meux, M. 1962. "A Study of the logic of Teaching " Urbana, Illinois, University of Illinois Press.
5. Smith, B.O.; Meux, M.; Coombs, J.; Nuthall, G. and Percians, R. 1967. "A Study of The Strategies of Teaching". U.S. Department of Health, Education and Welfare, office of Education, Bureau of Education Research, College of Education, University of Illinois, Urbana, Illinois, Project No. 1640.
6. Bellack, A.A.; Human, R.T.; Smith, F.L. Jr.; and Kliebard, H.H. 1966. "The Language of the Classroom" Final Report, USOE Cooperative Research Project No. 2023, New York, Teacher College, Colombia University (see p.8a).
7. Smith, B.O. and Meux, M. 1964. op.cit. (p.131).

to define a term, to carry on a course of reasoning, to prove the truth of proposition"¹. Furthermore, Bellack and his associates (1966)² regarded the study of logic as the study of the teaching process through the analysis of the linguistic behaviour of teachers and pupils in the classroom when both speak about what, how much, under what conditions, and with what effects.

However, although Smith and Meux and Bellack, et.al. worked separately using different observational instruments, both teams believed in the idea that classroom interaction could be broken into a series of moves that represented the communication emitted by a single actor in a classroom. An example of the concern for cognitive and attitudinal variables is the Gallagher study (Gallagher, 1965).³ Gallagher developed a battery of tests in which the results of the two styles of variables were related to classroom performance.

Travers (1955)⁴ maintained that the only way by which we could differentiate between the various types of observational techniques, was by looking at "the recording procedure, the scope, and specificity of terms and the format used to code individual events".⁵

4.24 Rating System

Remmers (1966)⁶ claims that no approach has been used more often

1. Smith, B.O. and Meux, M. 1964. op.cit.
2. Bellack, A.A.; Hyman, R.T.; Smith, F.L.Jr. and Kliebard, H.H. 1966. op.cit.
3. Gallagher, J.J. 1965. "Productive Thinking in Gifted Children". Cooperative Research Project, No. 965. Institute for Research on Experimental Children, U.V. of Illinois, Urbana.
4. Travers, R.M.W. 1955. op.cit.
5. Ibid. (p.132).
6. Remmers, H.H.; Gage, N.W.; and Rummell, F.L. 1966. op.cit.

than the "rating" method to measure variables in research on teaching. Ratings are often "retrospective summarizing the impression developed by a rater over an extended period of contact with the ratee".¹ The use of rating systems is very valuable in the assessment of teaching effectiveness. Rosenshine (1970,a)² held that "The optimum strategy for research and description"³ may be the use of both "category" system, and "rating" systems. Rating is a process used to "probe for unknown complexes of variables that appear to be significant correlates of outcome variables."⁴ In a rating procedure, judgements have to be made as to where the individual stands on a scale in respect to specific characteristics (Remmers, et.al. 1966)⁵ which shows the degree of liking or disliking, approval or disapproval, acceptance or rejection,... and the like, by the ratee.

4.25 Types of Rating Scales

Considerable efforts have been devoted to the development of rating scales. Remmers (1963)⁶, in reviewing the literature of rating procedures, found a considerable number of techniques that have been developed as a part of classroom interaction evaluation.

Rating scales use a wide range of techniques, each of which differ in the manner of recording, analyzing, judging and reporting (Travers,

1. Thorndike, R.L.; and Hagen, E. 1969. op.cit. (p.432).
2. Rosenshine, B. (1970(a), op.cit.
3. Ibid. (p.288).
4. Ibid. (p.288).
5. Remmers, H.H.; Gage, N.L.; and Rummel, F.L. 1966. op.cit.
6. Remmers, H.H. 1963 "Rating Methods in Research on Teaching". In: Handbook of Research on Teaching, N.L. Gage (ed.), Rand McNally and Company, Chicago. pp. 329-378

1955)¹ classroom events. Examples of these scales are, the cumulated points rating scale, the multiple choice rating scales, the graphic rating scales, ... and so forth (see, Remmers, 1963; Travers, 1955; Rosenshine, 1970(a); and Thorndike and Hagen, 1969)^{2,3,4,5}. Questionnaires, inventories and checklists are also being widely used in the evaluative process (Remmers, et.al., 1966).⁶

4.30 Reasons for Choosing the Science Teaching Observation Schedule System

One of the main aims of this project was to give a descriptive account of the daily behaviours within science classrooms in some Kuwaiti high schools. Although many instruments were available for the measurement of classroom interaction, these schedules were felt to be inappropriate, in one way or another, to be adopted in this study for the following reasons:

- i. most of the available instruments were developed to be used in grade levels other than secondary schools;
- ii. other instruments were constructed to measure non-science classes;
- iii. most of the available schedules lacked the corresponding measure of the activity intended for pupil involvement;
- iv. other available instruments were concerned with aspects of behaviour other than intellectual transaction in science classes;
- v. most of the available instruments were found to be inappropriate for the use in laboratory classes; and finally

1. Travers, R.M.W. 1955. op.cit.

2. Remmers, H.H. 1963. op.cit.

3. Travers, R.M.W. 1955. op.cit.

4. Rosenshine, B.O. 1970(a). op.cit.

5. Thorndike, R.L.; Hagen, E. 1969. op.cit.

6. Remmers, H.H.; Gage, N.L.; and Rummel, F.L. 1966. op.cit.

- vi. almost all classroom observation schemes were not accompanied with detailed directions of training on prerequisite skills (i.e. ability to use the schedules reliably) necessary for their adoption.

Therefore, a decision was taken to use the Science Teaching Observation Schedule, partly because the STOS instrument was widely known, and proved to be appropriate for use in different countries such as in the United Kingdom (Eggleston, et.al.,1976)¹ and in Canada (Hacker, 1980)².

STOS is easy to learn by following various training procedures (discussed later in this chapter), and is well suited for adoption in Kuwaiti high schools. Furthermore, one of the strongest aspects of STOS is that it is not an evaluation instrument, but mainly a descriptive tool. Thus, the rating of teachers and their teaching methods will be analyzed fairly objectively. Brueckner (1929)³ made it clear, when he criticised the available rating scales of teaching methods, that often the discrimination between teachers themselves and their teaching methods depended entirely on the subjective evaluation of the rater. Brueckner states that "perhaps the outstanding difficulty in securing a rating of a teacher is the elimination of the part that prejudice, tradition, and the attitude of the rater have in determining the estimate. This is particularly true where the rater is an exponent of some particular method or procedure".⁴ Moreover, the STOS instrument enables the researcher to differentiate between teachers according to their adopted style of teaching.

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1. Eggleston, J.F.; Galton, M.J.; and Jones, M.E. 1976. op.cit.
 2. Hacker, R.G. 1980. "Cognitive Interaction In Science: Classroom Practices and Some Prescriptions of Theories of Learning". Mount Allison University. University of Western Australia. (Unpublished, but it has been accepted by the Alberta Journal of Educational Research 1980).
 3. Brueckner, L.J. 1929. "Scales for the Rating of Teaching Skills". Minneapolis, The University of Minnesota Press. Second Ed.
 4. Brueckner, L.J. 1929. op.cit. (p.4).

Finally, teachers' styles of teaching based on the behavioural categories included in STOS will be correlated in this present study with pupils' perceptions and outcome. Not only this, but also a comparison between the introduction of science in Kuwait and other countries (such as that of the United Kingdom) will be more easily accomplished.

4.40 The Science Teaching Observation Schedule

The Science Teaching Observation Schedule, commonly abbreviated as STOS, was constructed by Eggleston and his colleagues¹ to be used in the United Kingdom. The STOS was developed initially from an empirical analysis of videotaped recordings of science lessons, and lesson transcripts. The STOS tool was designed specifically to differentiate between styles of intellectual transactions in science classrooms. In other words, STOS is only concerned with the intellectual patterns of science classroom transactions, and not with the managerial and socio-emotional aspects of classroom communications (see, Eggleston, 1979)².

The development of the STOS schedule was based on the following considerations:

1. the authors' dissatisfaction with the previous observational instruments for the analysis of classroom behaviour³, because none of the available instruments focused on those aspects of teaching

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1. Eggleston, J.F.; Galton, J.M. and Jones, E.M. 1975. "A Science Teaching Observation Schedule", School Council Research Studies, Macmillan Education.
 2. Eggleston, J.F. 1979. "Studies of Science Teaching Processes". A Paper presented to the International Symposium on World Trends in Science Education. Halifax, Nova Scotia, p.11.
 3. Eggleston, et.al., 1975. op.cit.

which Eggleston and his associates speculated to be among the more effective determinants of achievement in science, and

2. the absence of an instrument which might be used by a large team of observers, and at the same time could record satisfactorily aspects of teaching as intellectual behaviour in science classrooms, questioning styles, interactions taking place between teacher-pupil or pupil-pupil, pupil-resources and different styles of science teaching.

Eggleston and his colleagues developed a multi-dimensional instrument to facilitate the recording of a broad range of cognitive behaviours, which might be expected to occur in science classrooms. The design of the STOS tool is based on two assumptions. Firstly, that a student's cognitive growth in science depends largely on the opportunities provided in the classroom to practise the various intellectual skills associated with science and scientific inquiry. Secondly, that recent developments in science teaching accept the processes of science as an integral part of science learning.

Accordingly, the STOS instrument which contains 23 categories emerged. The instrument is concerned not only with teacher-pupil interaction but with both pupil-pupil and pupil-resources interactions. Thus, the 23 categories were grouped into two main branches on the bases of these events^{1,2}. Teacher talk is divided into three major areas, which are, (a) teacher's questions, (b) teacher's statements and (c) teacher's directions. These major areas are in turn subdivided into fifteen minor categories, seven of them deal with teacher's questions, a₁₋₇, four of them

1. Eggleston et al. 1975. op.cit. p.5.

2. Eggleston et al. 1976. ibid. p.36.

deal with teacher's statements b_{1-4} , while the last four categories deal with teacher directions c_{1-4} .

The "pupil talk and activity" branch is divided into two main areas, "pupils seek information or consult", and "pupils refer to teacher". Each major area is again subdivided into 4 minor categories (d_{1-4} , and e_{1-4}).

An examination of the category definitions given in table II (see p. 110) reveals certain assumptions which underlie the technique. Among these assumptions, is the stress on verbal interaction, such as the monologue (talk involving one person) and the dialogue (talk involving two or more persons).

The instrument is also intended for use during periods of silent seat-work or carrying on of an experiment either by a teacher or by several separate groups, as well as during private tutoring and the giving of directions by the teacher to his/her pupils. Thus, one can recognize that STOS implicitly does not reflect the traditional idea of a classroom as belonging to the "chalk and talk"¹ paradigm, but allows for more flexible teaching procedures. In other words, an examination of the STOS tool shows that these categories have the potentiality to tap simultaneously important aspects of typical science classroom behaviour.

Furthermore, Eggleston and his colleagues have developed a speculative model, which relates the five major categories of the schedule to three major dimensions of science teaching, practical/theoretical, heuristic/didactic, and pupil-directed/teacher-directed (see, figure 1 - p.109).

Finally, one interesting feature is the coding of the first and the third major category (teacher questioning, teacher directing). In the

1. Delamont, S. 1973. op.cit. p.194.

first major category the observer has to pay attention to the responses actually made by pupils, and to observe whether they are recalling information and ideas or are engaged in activities such as problem solving, before coding the "questioning style" under any of the corresponding minor categories. In the third major category, the purpose of the directive is determined by the pupil's interpretations and the teacher's subsequent reaction to what they do, rather than by the observer's interpretation of the teacher's intention.

4.41 The STOS Training Procedure

The Schools Council Project for the evaluation of science teaching methods, produced three videotapes for the purpose of training observers in the use of the Science Teaching Observation Schedule.

Tape 1

The first part of this videotape is recorded for the purpose of training in the five major categories (1 a, 1 b, 1 c, 1 d, and 1 e, see, figure II, p. 111). These are described as below:-

- 1a teacher asks questions (or invites comments) which are answered by ...
- 1b teacher makes statements ...
- 1c teacher direct pupil to sources of information for the purpose of ...
- 1d pupils seek information or consult for the purpose of ...
- 1e pupils refer to teacher for the purpose of

The second part of the videotape is recorded for the purpose of a more detailed training in the "teacher talk" categories (1a, 1b, 1c). In each case the videotape shows a lesson extract and the observer is asked to attempt a classification of the activities. The intellectual

exchanges in the lesson are then analyzed and the correct classification justified. In the case of the first tape, the observer can watch the activities as much as he likes, until he finds himself being able to get the correct coding of the categories.

Tape 11

In the second tape, some science-lessons extracts are recorded in order to help the observer to train himself on the fourth and fifth main categories, together with the correspondent minor categories (d_{1-4} and e_{1-4}). The same procedure is followed as on tape one. The remaining part of the tape consists of examples of various teaching episodes to enable the observer to practise coding the correct categories.

Tape 111

This tape contains reliability trials; it consists of three lessons featuring biology, chemistry and physics.

Reliability data for this tape are also available - if asked for - so that a trainee observer may compare his results with those of other trained observers. However, this tape can only be seen once - and only once - at the end of the practice period.

4.42 The use of STOS

Before using the STOS instrument, some essential conditions have to be borne in mind by the observer, who intends to obtain valid information about classroom interactions.

- a. The use of the STOS instrument demands that any observed lesson should not constitute any special performance, i.e. it should be a typical daily behaviour of teacher and class involved.
- b. An important condition for the use of this technique requires that the observer seats himself where he can get as much information as possible about classroom behaviour without intruding or disturbing either

teacher or pupils.

- c. The authors of the schedule also strongly advise that researchers who want to use STOS should give an account - on the back of the observation sheet - of any events of the lesson which may affect the nature of the intellectual transaction during that period.

4.43 Events Recording: Procedures for the use of STOS

The observer sits in the classroom with a stop watch, and writes down his classification of the interactions every three minutes. Classroom behaviour is only recorded once on the first occasion it occurs no matter how frequently the events occur during that time-sampling unit. Thus, any number of the twenty-three classified behaviours may occur at any time during the sampling unit.

To demonstrate briefly how the twenty-three categories shown in figure 1 are used, an example of some simple interactions extracted from three different science lessons are given below. These examples are also drawn on to illustrate the training and practice videotapes:¹

1. Lesson one (biology), taught by teacher one, covers the process of digestion:
2. Lesson two (integrated science), taught by teacher two in which the properties of nitrogen, oxygen and carbon dioxide are being tested; and
3. Lesson three, taught by teacher three, deals with the properties and growth of crystals.

1a Teacher asks questions (or invites comments) which are answered by ...

(a₁) Recalling facts and principles

TEACHER 1 These blood vessels round the intestine, where were they?

1. Eggleston, J.F.: Galton, M.J.; and Jones, E.M. 1975. op.cit. (pp.25-31).

Where was the richest blood supply?

PUPIL In the small intestine.

(a₂) Applying facts and principles to problem solving

TEACHER 2 I've got two jars here, two little tubes with no labels on. Start thinking. We've got only two tubes. Can you think of two tests we could do to find out which of these three gases is in each tube, but I don't know which one? Could you think of two tests which could tell us perhaps which of the gases it was?

(a₃) Making hypothesis or speculation

TEACHER 1 Now notice how even this cut is (examining locusts feeding in jars). I wonder what decides whether it cuts exactly this much every time it takes a bite, as it were. You see, for it to be as regular as this, the cut being the same depth all the way along, how do you think that was organized?

PUPIL Has it got something to do with the palps?

(a₄) Designing of experimental procedure

TEACHER 3 Look here, you've got this crystal and it's so small you would need a microscope to look at the shape. You've not got one so what are you doing to do about it?

PUPIL Grow it.

TEACHER 3 Well then, how are you going to do that?

PUPIL First we'd get a saturated solution ...

(a₅) Direct observation

TEACHER 2 But what happened when you poured the lime water in there ... It changed to what? ... What would you say?

PUPIL Kind of blue.

(a₆) Interpretation of observed and recorded data

TEACHER 3 Here's a graph showing the solubility of Potash alum at different temperatures. Tell me then, how much salt will you need for a saturated solution at room temperature?

PUPIL A little over ...

(a₇) Making inferences from observations or data

TEACHER 2 We've said already that we don't think number four is much use as a test. What about number one? Well, would you use that as a test to distinguish these? What do you think, Ronald?

PUPIL Sir, you could use it in some but in others you could not.

TEACHER 2 You could use it in some but not in others. You certainly could not tell whether it was carbon dioxide or nitrogen. Mm?

1b Teacher makes statements...(b₁) Of fact and principle

TEACHER 1 Right, if you look at the board, you can see my version. You'll notice its a sort of scientist's impression and not an artist's impression (a drawing of the mouse digestion system). The idea was to make what we had discovered and agreed upon as clear as possible. I have just now introduced the names, so let's try and get used to them. The tube that leads through the thorax from the mouth to the stomach is called the oesophagus. Don't ask me why ...

(b₂) Of problems

TEACHER 1 This is the problem we have got, therefore, how are fish and chips or other food materials changed into the kind of substances which can apparently help a big toe or any other part of your body to grow?

(b₃) Of hypothesis or speculation

TEACHER 1 Either this is where most of the digestion is or there is another possibility, that this is where... what else might be happening? Come on, it follows ... what happens to it?

PUPIL -----

TEACHER 1 Perhaps, perhaps that's ... it could be either where the digestion is going on mainly, or it could be where most of the absorption is going on. In other words, where the somewhat, I supposed, changed fish and chips will pass through the alimentary canal into the bloodstream. We don't know, but the rich blood supply rather suggests that this is what might be happening.

(b₄) Of experimental procedure

TEACHER 2 ... these tubes. It says it's to hold the jar upside down, so you will have to turn the tube upside down to hold it with its neck under water. Now you must get the open neck under water before you pull the bung out, or of course the gas inside whatever it is, will mix up with the gas in the room.

1c Teacher directs pupils to sources of information for the purpose of ...

(c₁) Acquiring or confirming facts or principles

TEACHER 2 For homework I want you to read chapter ... in your books and make notes of the properties of these gases.

(c₂) Identifying or solving problems

TEACHER 1 Well, the thing to do now is to see if they move in and out, to try and move them in and out (referring to locust's mandibles).

(c₃) Making inferences, formulating or testing hypotheses

TEACHER 1 Right, we've got a short film showing some locusts feeding. I want you to look at it in your groups and then try to come up with some suggestions as to how the mouth parts cut the grass.

(c₄) Seeking guidance on experimental procedure

TEACHER 1 ... so you get rid of all the mouthparts (of the locust) at one time and when you have got them laid out you can then refer back to this sort of diagram. But you can see if you refer to this diagram where you are. You've removed this bit and you're now left with these two structures here, which if you look at the diagram are called mandibles, though they're not labelled on there but here are the mandibles ...

2d Pupils seek information or consult for the purpose of ...(d₁) Acquiring or confirming facts or principles

PUPIL 1 Is that its nose then (viewing the film loop on locusts feeding)?

PUPIL 2 Yes, I think so ...

(d₂) Identifying or solving problems

PUPIL 1 If you heat up some of the solution (potash alum) and then let it cool, we can see whether we get a precipitate. If we do, it must be saturated.

PUPIL 2 Yes.

(d₃) Making inferences, formulating or testing hypotheses

(Pupil watching film of locust feeding).

PUPIL 1 I think they are moving.

PUPIL 2 It must be tasting it all the time.

PUPIL 3 Yes, I suppose so.

PUPIL 2 It looks as if they're always touching it.

PUPIL 1 They must be attached to the triangular things.

PUPIL 3 Yes.

2e Pupils refer to teacher for the purpose of ...(e₁) Acquiring or confirming facts or principles

PUPIL Is this lime water cloudy, sir?

TEACHER 2 What do you think?

PUPIL We think it is.

(e₂) Seeking guidance when identifying or solving problemsPUPIL We've tried lime water and it's gone cloudy so it can't
be oxygen, sir.

TEACHER 2 Good, well done ...

(e₃) Seeking guidance when making inferences, formulating or
testing hypothesesPUPIL Well, we think it's either carbon dioxide or oxygen so
we're going to try litmus. We don't know if it will
dissolve.

TEACHER 2 Well, you'll have to take my word for it ...

Once data have been collected and classroom interaction has been classified
in this manner, the data obtained can be further analyzed.

4.44 Analysis and Display of STOS Data

The data collected are subjected to cluster analysis in an attempt to differentiate between different styles adopted in classrooms. The position of individual teachers on these style dimensions will be known from the description, by the observer, of classroom activities at the end of each lesson.

From these descriptions some estimate of the time spent by teachers or pupils on particular activities is made and expressed as a percentage of the total observation period. For example, if a teacher is observed for a total period of three hours, i.e. the teacher has been observed for 60 three minute 'time sampling units', and if, for example, in 36 of these units the teacher adopts a certain category - let us say for example a_1), his use of category a_1 is recorded as:

$$\frac{3 \times 36 \times 100}{180} = 60\%$$

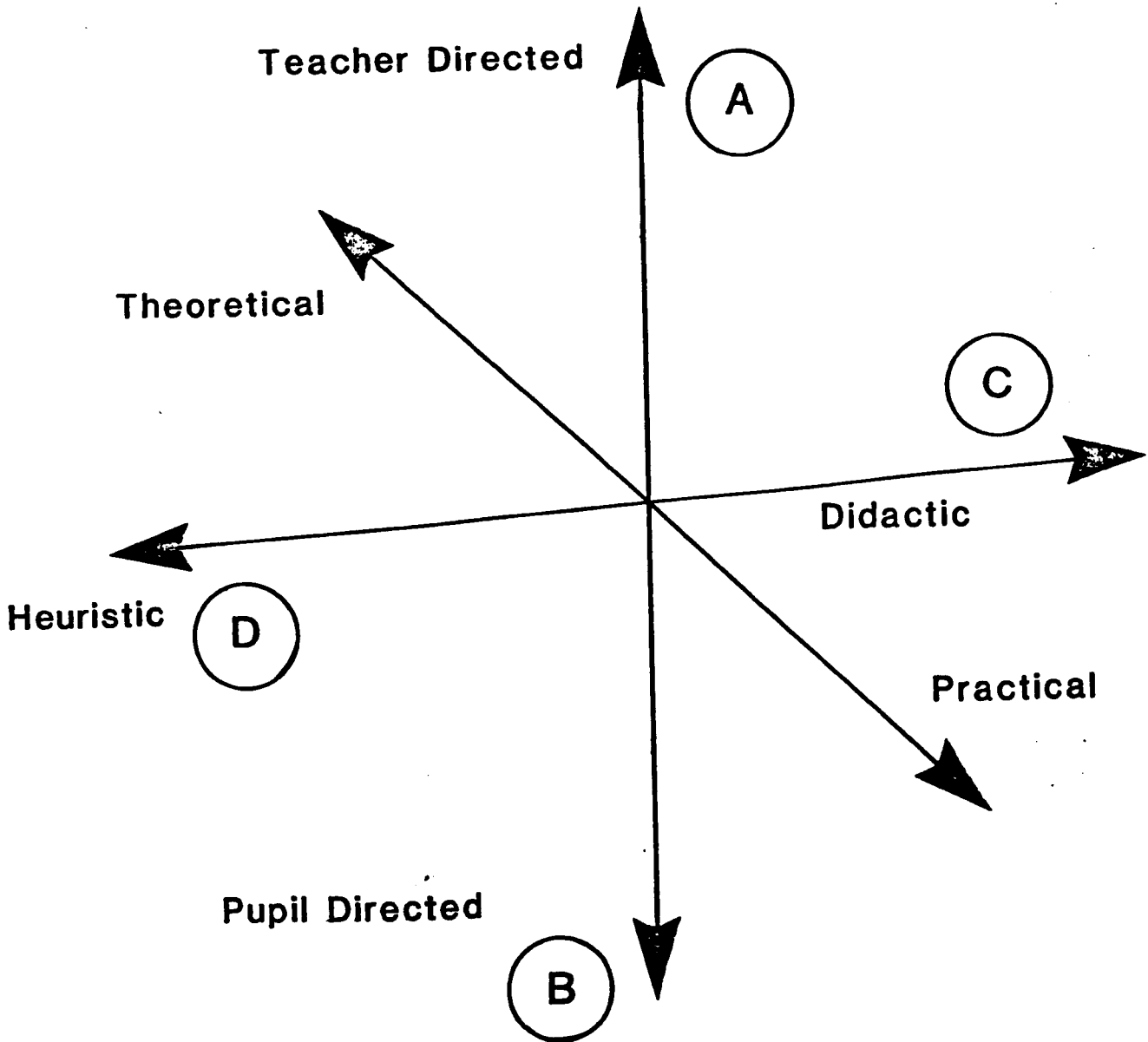
The simplest way of displaying STOS data is by drawing a histogram, showing the percentage of events made of each category during a specified lesson(s).

The histogram used by Eggleston and his colleagues is a 5% interval; e.g. an interval of 10-15% will include teachers or pupils using the category more than 10% but not more than 15% of the total time units (see Eggleston et al. 1976, pp.42-45, 50-53, 56-59).

4.45 Features of the STOS System

From the twenty three minor categories, one can select certain categories which might relate to a particular teaching style¹, where it

1. The classification of teachers and their classes into groups is according to the predominant features of the cognitive style of interaction.

Fig-1

A model to describe possible outcomes of different teaching styles
(taken from Eggleston, Galton, and Jones, 1976)

teacher:.....
subject:.....

1a Teacher asks questions (or invites comments) which are answered by:

- 1b Teacher makes statements:

- 1c Teacher directs pupils to sources of information for the purpose of:

- ## 2 TALK AND ACTIVITY INITIATED AND/OR MAINTAINED BY PUPILS

- 2e Pupils refer to teacher. for the purpose of:

- e1 acquiring or confirming facts or principles
e2 seeking guidance when identifying or solving problems
e3 seeking guidance when making inferences, formulating or testing hypotheses
e4 seeking guidance on experimental procedure

[illegible]

would be possible to examine teachers/classes in general (i.e. on the basis of the STOS 23-categories) or in particular (i.e. on the basis of any of the STOS 23-categories). Some of the STOS categories enable fairly detailed records to be made from the data gained, as for example, teachers' questioning styles, pupils' questions involving different thought processes, and the like.

STOS in itself is not an evaluation instrument. It is rather a method of recording, with a high degree of accuracy,¹ those intellectual exchanges which take place in science classrooms, such as, observing, constructing hypotheses, speculating, designing experiments, inferring, and so forth.

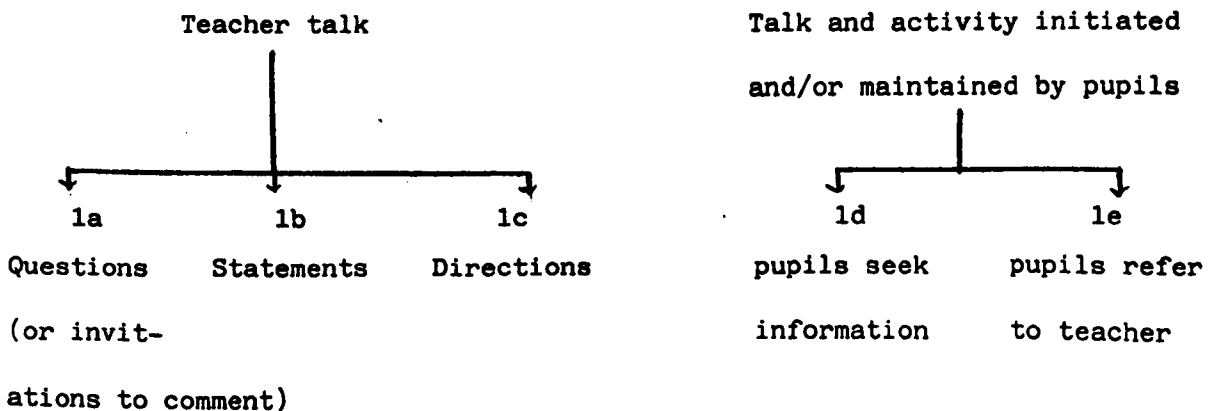
The results, derived from using the schedule, can be analyzed in relation to the adopted style of teaching. Moreover, the teaching outcomes, resulting from such teaching methods, may be distinguishable.

The instrument is not concerned with either affective responses, or with managerial behaviours.

Fig. 11

Main features of the classification used in the STOS

All observed events



1. The accuracy of the data depends on the reliability of STOS in the hands of trained observers.

4.50 SummaryEvaluation and Effective Teaching

There is no doubt that evaluation plays an important role in our lives. By evaluation we may ascertain our position (Tuckman, 1979)¹, find out how much progress we are making (Remmers, et. al. 1966; and Fickers, 1952)^{2,3}, and discover whether or not we are doing the right things.

Through evaluation, a teacher may receive an objective feedback that uncovers certain facts, in relation to his/her pupils' abilities and needs (Remmers, et. al. 1966)⁴, which in turn may help that teacher in changing his/her behaviour to achieve better outcomes (Parakh, 1967; and Good and Brophy, 1974).^{5,6}

4.51 Methods of Evaluation

Classroom events can be described and evaluated directly or indirectly by the use of systematic classroom observational systems or rating scales. These evaluation processes are either carried out under a natural classroom setting (Soar and Soar, 1974; Meux, 1963; Rosenshine, 1970(a);

1. Tuckman, B.W. 1979. op.cit.
2. Remmers, H.H.; Gage, N.L.; and Rummel, F.L. 1966. op.cit.
3. Fickers, J.A. 1952. op.cit.
4. Remmers, H.H.; Gage, N.L.; and Rummel, F.L. 1966. op.cit.
5. Parakh, S.J. 1967. op.cit.
6. Good, T.L. and Brophy, J.E. 1974. op.cit.

and Medley and Mitzel, 1963)^{1,2,3,4}, or by creating a special test situation (Thorndike and Hagen, 1969; Parakh, 1967; Medley and Mitzel, 1963; Rosenshine, 1970(a); and Rosenshine and Frust, 1974).^{5,6,7,8,9}.

4.52 Systematic classroom observation systems

A dissatisfaction with the traditional classroom research, for one reason or another (Gage and Unruh, 1967; Dunkin and Biddle, 1974; Withall and Lewis, 1963; Galton and Eggleston, 1979; Welch and Walberg, 1972; Waimon, 1969; and Parlett and Hamilton, 1972),^{10,11,12,13,14,15,16}, constituted the main factor behind the development of the current systematic

1. Soar, R.S. and Soar, R.M. 1972. op.cit.
2. Meux, M. 1963. op.cit.
3. Rosenshine, B. 1970(a). op.cit.
4. Medley, D.M. and Mitzel, H.E. 1963. op.cit.
5. Thorndike, R.L. and Hagen, E. 1969. op.cit.
6. Parakh, S.J. 1967. op.cit.
7. Medley, D.M. and Mitzel, H.E. 1963. op.cit.
8. Rosenshine, B. 1970(a). op.cit.
9. Rosenshine, B. and Frust, N. 1974. op.cit.
10. Gage, N.L. and Unruh, W.R. 1967. op.cit.
11. Dunkin, M.J. and Biddle, B.J. 1974. op.cit.
12. Withall, J. and Lewis, W.W. 1963. op.cit.
13. Galton, M. and Eggleston, J. 1979. op.cit.
14. Welch, W.W. and Walberg, H.J. 1972. op.cit.
15. Waimon, M.D. 1969. op.cit.
16. Parlett, M. and Hamilton, D. 1972. op.cit.

classroom observation system, by which classroom events could be recorded directly by the observer. These systematic systems were developed either to be used by the researcher himself to serve a specific purpose (Rosenshine, 1970(a); Parakh, 1967; Delamont, 1973; Gallagher, 1965; Smith and Meux, 1962 and 1964; Smith et. al., 1967; Bellack et. al., 1966; Brown et. al., 1968; Guilford, 1956; Taba, et. al., 1964; and Taba, 1966),^{1,2,2,3,4,6,7,8,9,10,11,12,} or to be used in more general situations (Flanders, 1970; and Bloom, et. al., 1956).^{13,14.}

Moreover, the systematic observation systems only give an account of what actually goes on, and not what should go on in the classroom (Parakh, 1967).¹⁵

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1. Rosenshine, B. 1970(a). op.cit.
 2. Parakh, S.J. 1967. op.cit.
 3. Delamont, S.K. 1973. op.cit.
 4. Gallagher, J.J. 1965. op.cit.
 5. Smith, B.O. and Meux, M. 1962. op.cit.
 6. Smith, B.O. and Meux, M. 1964. op.cit.
 7. Smith, B.O.; Meux, M.; Coombs, J.; Nuthall, G.; and Percians, R. 1967. op.cit.
 8. Bellack, A.A.; Hyman, R.T.; Smith, F.L. Jr.; and Kliebard, H.H. 1966, op.cit.
 9. Brown, B.; Obler, R.; Soar, R.; and Webb, J.N. 1968. op.cit.
 10. Guilford, J.P. 1956. op.cit.
 11. Taba, H.; Ievine, S.; and Elzey, F.F. 1964. op.cit.
 12. Taba, H. 1966. op.cit.
 13. Flanders, N.A. 1970. op.cit.
 14. Bloom, S.B.; Engelhart, D.M.; Furst, J.E.; Hill, H.W.; and Krathwohl, R.D. (eds.) 1956. op.cit.
 15. Parakh, S.J. 1967. op.cit.

4.53 Rating System

A rating system is a very fruitful technique (Rosenshine, 1970(a))¹ that gives valuable information describing any subject. Through the use of rating scales, the qualities of any individual (Borg, 1963)² can be measured according to values prespecified by the observer (Good, 1959).³ These qualities can be used later on by the rater in making judgements or explaining the outcomes of any specific measured situation (Rosenshine, 1970(a)).⁴ As with classroom observation systems, different rating scales were developed by many researchers to both evaluate and judge several educational events (Travers, 1955; Remmers, 1963; Thorndike and Hagen, 1969).^{5,6,7.}

4.53 . Reasons for the Selection of the Science Teaching Observation Schedule

Although many classroom observational systems were available, most were found to be inappropriate to the aims of the present study.

S.T.O.S. (developed by Eggleston and his associates) was adopted in this research for the following reasons:

- (1) The intellectual interactions, between pupil-pupil and pupil-teacher, that take place in any science classroom can be described objectively.
- (2) The duration for recording the intellectual interactions is reasonable (i.e. recording duration is 3 minutes).

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1. Rosenshine, B. 1970(a). op.cit.
 2. Borg, W.R. 1963. op.cit.
 3. Good C.V. 1959. op.cit.
 4. Rosenshine, B. 1970(a). op. cit.
 5. Travers, R.M.W. 1955. op.cit.
 6. Remmers, H.H. 1963. op.cit.
 7. Thorndike, R.L. and Hagen, E. 1969. op.cit.

- (3) The three videotapes provided by the Schools Council Project for the evaluation of science teaching methods are of great help to an observer in obtaining mastery of the use of the categories, so that reliability of application can be achieved.
- (4) The adopted teaching methods (by the teachers) can be objectively recognized.
- (5) Pupils' achievements and perceptions of their teachers can then be correlated with the adopted methods of teaching.

S.T.O.S. contains 23 categories, describing two major areas, namely, activities initiated and/or maintained by a teacher and activities initiated and/or maintained by pupils.

The first major area is divided into three minor ones, namely,

- a. teacher's questions (a_{1-7});
- b. teacher's statements (b_{1-4}) and
- c. teacher's directions (c_{1-4}).

The second major area is divided into two minor ones, namely,

- d. pupils' consultations (d_{1-4}) and
- e. pupils' reference to teachers.

CHAPTER VProcedures Used in the Construction of the Achievement Tests
and the Perception Questionnaire Used in this StudySynopsis

This chapter is divided into three parts.

The first part covers:

- (1) Assumptions of the Study.
- (2) Questions to be Answered by the Study.
- (3) Statement of Hypotheses.

The second part covers:

- (1) The Development of the Achievement Tests.
 - a. Introduction
 - b. Reasons for constructing the new achievement tests.
- (2) Steps Taken in the Development of the Achievement Tests.
 - a. Conducting the pilot study
 - b. Administration of the test items to the pilot study sample.
- (3) Item analysis of the Developed Test Items.
 - a. Measurement of item discriminating power
 - b. Measurement of item difficulty index
 - c. Computation of the standard deviation for individual items
 - i. Measurement of the reliability of the achievement tests
 - ii. The standard error of measurement
 - iii. Measurement of the standard deviation of the test items
 - iv. Measurement of the validity of the tests
 - v. Measurement of the correlation coefficients between each test item and the total score of the test
 - vi. Improvement of test reliability.

- d. Assembling and re-arranging of the test items
 - e. Measurement of the reliability of the final version of the newly-constructed achievement tests
- (4) The Construction of a Perception Questionnaire.
- a. Reasons for Constructing a New Instrument to Measure Pupils' Perceptions of their Science Teachers' Behaviour
- (5) Pilot Study for the Construction of a New Instrument to Measure Pupils' Perceptions of their Science Teachers' Behaviour.
- a. Introduction
- (6) Steps Taken in the Construction of Pupils' Perception Questionnaire.
- a. Pupils' perceptions of a 'good' 'bad' science teacher
 - b. Categorization of the collected data for the Perception Questionnaire from the pilot study
- (7) Item-analysis procedures applied to the pupils' perception scale.
- (8) The remaining forty-six items selected for the final form of the Pupils' Perception Questionnaire.
- (9) Estimation of the reliability of the finalized form of the Pupils' Perception Questionnaire.
- a. The split-half technique
 - b. The Kuder-Richardson reliability coefficient
 - c. Item-category and total sub-scale correlation.

5.10 Assumptions of the Study.

The following assumptions form the basis of the present research:-

1. A teacher's behaviour is observable and, thus, it may be recorded and categorized.
2. By virtue of being daily recipients of instruction, pupils are in the unique position of being able to provide valuable information about their teacher's behaviour, i.e. pupils' evaluations may reveal specific strengths and weaknesses in the teacher's behaviour. In addition to that, pupils' needs may be identified through their participation in the evaluation procedure.
3. Pupils, in the fourth-grade level, have the ability to evaluate their teachers' behaviours in the classroom as reliably as the science supervisors in Kuwaiti high schools.
4. Male and female pupils will gain knowledge, during the school year, regardless of their teachers' behaviours and the methods of teaching these teachers adopt.
5. The amount of improvement in pupils' intellectual achievement may be affected by the teaching methods adopted in the classroom.
6. Sex of pupils may have a considerable effect on pupils' achievements.

5.11 Questions to be Answered in the Present Study

1. How is science in the observed Kuwaiti high schools being taught?
2. Are there any differences between the teaching of biology, chemistry and physics to pupils at fourth-grade level in Kuwait?
3. What teaching behaviours do pupils in Kuwaiti high schools expect of their science teachers during the teaching-learning process? In other words, what are the most important characteristics of a "good" science teacher that pupils in Kuwait state through their definitions of a good/bad science teacher?

4. Do pupils' perceptions of the qualities of a "good" science teacher agree with that of both science supervisors and the observed science teachers in Kuwait?
5. Is there significant agreement between pupils' and supervisors' ratings of the characteristics of the same observed science teachers (i.e. teachers who taught the observed science areas to pupils in the fourth-grade level in Kuwait)?
6. Does sex of pupils have any effect on their intellectual achievements in biology, chemistry, and physics?
7. Do the teaching methods that the observed science teachers adopt have any effects on pupils' intellectual outcomes?
8. Does sex of pupils/teachers have a significant effect on the perception of pupils as to the characteristics of their science teachers?
9. Can pupils' achievements in the observed science areas be predicted from teachers' variables? Do teachers' variables have the same effect on pupils' achievement in biology, chemistry, or physics?
10. Can pupils' achievements in the observed science areas be predicted from teacher-pupil classroom variables? Do teacher-pupil classroom variables have the same effect on pupils' achievement in each of the subjects biology, chemistry, or physics?

5.12 Statement of Hypotheses

The research hypothesis is recognized by Mason and Bramble (1978)¹ as a tentative declaration statement concerning the relationship between two or more variables. The same research hypothesis is looked upon by Tatsuka and Tideman (1963)² as a source of prediction by which a researcher

1. Mason, E.J. and Bramble, W.J. 1978 "Understanding and Conducting Research". McGraw-Hill, London.
2. Tatsuka, M.M. and Tideman, D.V. 1963. op.cit.

may predict the existence or the lack of relationships between the measured or studied variables. Research hypotheses are either stated in a directional or non-directional form. The directional form (i.e. alternative) is believed to state the existence of a certain relationship between the different studied variables. The non-directional, on the other hand, is believed to state the lack of such a relationship.

Hypotheses are often stated, in many behavioural sciences and in educational research, in the non-directional form, whereby the researcher formulates a negative (Tatsuka and Tideman, 1963)¹ belief in chosen research variables to test a non-directional hypothesis which is often referred to as a null hypothesis.

The above questions, which were the basis for the major hypotheses of this study, are each stated in the form of a null hypothesis and in an alternative form as follows:-

- 1: H_0 - Teachers in Kuwaiti high schools adopt the same teaching method when teaching the observed science areas to their pupils.
 H_i - Teachers in Kuwaiti high schools adopt different teaching methods when teaching the observed science areas to their pupils.
- 2: H_0 - Male and female teachers, of the same subject area in Kuwaiti high schools, teach science subjects to their pupils in a similar way.
 H_i - Male and female teachers, of the same subject area in Kuwaiti high schools, do not teach science subjects to their pupils in a similar way.
- 3: H_0 - There is no significant agreement between the ratings of pupils, science teachers and science supervisors as to the characteristics of a "good" science teacher.
 H_i - Pupils, science teachers, and science supervisors agree significantly on the ratings of the characteristics of a "good" science teacher.

1. Tatsuka, M.M. and Tideman, D.V. 1963. *ibid.*

- 4:H₀ - There is no significant agreement between the ratings of both pupils and science supervisors on the ratings of the observed science teachers' characteristics.
- H_i - Pupils and science supervisors in the observed Kuwaiti high schools, agree significantly on the ratings of biology, chemistry, and physics teachers' behaviours.
- 5:H₀ - There are no significant gains in pupils' intellectual achievements after studying the three science subject areas during a four-month duration.
- H_i - There are significant gains in pupils' intellectual achievements after studying the observed biology, physics, and chemistry subjects for a period of four months.
- 6:H₀ - There are no significant differences between the achievements of pupils who were taught the same subjects by different methods of teaching.
- H_i - There are significant differences between the achievements of pupils who were taught the same subjects in the three studied areas by different teaching methods.
- 7:H₀ - There are no significant differences between the achievements of male and female pupils in biology, chemistry, and physics.
- H_i - There are significant differences between the achievements of male and female pupils in biology, chemistry, and physics.
- 8:H₀ - There are no significant differences between the perception of male and female pupils of their teachers' behaviours in the classroom.
- H_i - There are significant differences between the perception of male and female pupils of their teachers' behaviours in the classroom.
- 9:H₀ - Teachers' characteristics variables have the same effect on the achievements of both male and female pupils in biology, chemistry, and physics.

- H_1 - Teachers' characteristics variables have different effects on the achievements of both male and female pupils in biology, chemistry, and physics.
- 10: H_0 - Teachers-pupils classroom interaction variables have the same effect on the achievements of both male and female pupils in biology, chemistry, and physics.
- H_1 - Teachers-pupils classroom interaction variables have different effects on the achievements of both male and female pupils in biology, chemistry, and physics.

In order to answer the above questions and to test the related null hypotheses, the following steps were taken.

First, an appropriate category system had to be found to analyze the actual science classroom interactions, and to describe the behaviours of both pupils and teachers engaged in the science teaching-learning processes in Kuwaiti.

Second, pupils' perceptions of the behaviours of their science teachers had to be assessed.

Third, a measure of pupils' intellectual outcomes had to be designed.

Consequently, the science teaching observation schedule was considered, by the researcher, to be the most appropriate instrument in order to observe and categorize the conduct of science in Kuwaiti high schools (see Ch. IV, table II, p. 109 and pp.95-97).

A "perception" questionnaire was developed for the measurement of pupils' perceptions of their science teachers' behaviours (see Ch. V). Furthermore, criterion-referenced achievement tests were devised to measure the intellectual outcomes of the observed pupils in biology, chemistry, and physics (see Ch. V, and Appendix B. 1, 2, and 3).

A pilot study was carried out on a representative sample (discussed later in this chapter) to ensure the effectiveness of the main study. According to Wood and Skurnik (1969)¹ a pilot study is "not intended to lead to firm conclusions about the efficiency of the idea under examination - that is the purpose of other studies which follow on".²

Finally, it is important to note that this study was conducted in a normal classroom setting. That is to say, the observer was given the opportunity by the Administration of the twelve schools involved, to attend the observed classes during the research period, i.e. January - April, without having to turn up at specific times. Consequently, the findings of the study were all the more reliable because visits were organised randomly and without prior warning. Hence neither teachers nor pupils were unusually or specially prepared for the observations that took place.

5.20 The Development of The Achievement Tests

Introduction

" An achievement test is a systematic procedure for determining the amount a student has learned."³

In other words, it is a way of determining a pupils' "present level of performance".⁴

The main criterion used in the construction of the achievement test was to obtain a wide range of items that would differentiate between pupils' abilities measured in terms of their intellectual outcomes.

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1. Wood, R. and Skurnik, L.S. 1969 "Item Banking". A Method of Producing School-based Examinations and Nationally Comparable Grades. National Foundation for Educational Research in England and Wales.
 2. Ibid. (p.7.)
 3. Gronlund, E. Norman, 1977 "Constructing Achievement Tests", Second Edition, Prentice-Hall, Inc., Englewood Cliffs. (p.1).
 4. Best, W. John, 1970. "Research in Education", Prentice-Hall, Inc., Englewood Cliffs, New Jersey. (p.189).

5.21 Reasons for Constructing the New Achievement Tests

A criteria-reference test was constructed, rather than using a standardized one, for the following reasons:

1. As a result of the differences in curriculum and syllabus in Kuwait compared with those in other countries, such as in the United Kingdom, the internationally accepted standard tests (e.g. the British Ordinary Level Examination) could not be used.
2. Test items should be constructed so as to be relevant to the objectives of the topics taught in Kuwait.
3. Apart from this, tests which could be suitable to determine pupils' achievement (constructed in previous years for the Secondary School Certificate Examination) are often available to pupils in school libraries. Consequently, applying any of the Kuwaiti standard tests would defeat the purpose of this investigation.

5.30 Steps Taken in the Development of the Achievement Tests

Before constructing the achievement tests,

- (a) a table of specifications was developed to specify the subject areas/topics to be observed (see - Appendix A, 1, 2, and 3) and
- (b) the objectives to be attained within each subject area were clearly stated.

Moreover, all suggestions offered by Gronlund (1977)¹, concerning the construction of achievement tests (see Gronlund, 1977, Chapter 1, 2, 3 and 4), were studied and taken into consideration.

Preliminary achievement-test items were constructed with the help of six science supervisors² from the Ministry of Education in Kuwait.

1. Gronlund, E. Norman, 1977. op.cit.
2. Those science supervisors were members of the committee, who participated in the development of the science curriculum for high schools in Kuwait.

A total of ninety items were developed covering the three areas (i.e. biology, chemistry, and physics) intended to be observed during the period January - April 1981.

During the development of the achievement test, the following factors were taken into consideration:-

I. Two kinds of test items (for measuring the desired learning outcomes) were developed:-

(a) The first type of test item was questions which had to be answered by pupils, either by recalling or by recognizing some ideas, terms, facts, principles, theories and rules, with which they had experience in the educational process. In other words, they consisted of lower level thinking-ability questions.

(b) The second type of test item was questions requiring more effort from pupils to achieve correct responses, such as, data manipulation and problem solving. These kinds of questions are often referred to as higher level thinking-ability questions.

Altogether, a total of fifteen lower thinking-ability questions, and fifteen higher thinking-ability questions were developed for each subject area.

II. The developed items had to cover the major topics within the subject areas intended to be studied and observed (during the period January - April 1981).

III. The tests were designed to cover the goals to be reached (as mentioned in the text-books used by the pupils) through the study of the three courses.

All of the achievement-test items were of the objective type, where pupils had to select the most appropriate answer from among the four alternative responses given for each question. The reasons behind constructing such an objective achievement test and not using a traditional essay test, were that when an essay test is constructed many factors such as

spelling, grammar, arrangement, punctuation ... and the like may affect the degree by which one judges the examined pupil. "However, the newer objective-type of test gets rid of some of these misleading elements".¹ Moreover, a much longer time would be required for the completion of an essay-type test than for an objective-type one.

Also during the construction of the test items, precautions offered by Gronlund (1977)² and Long and Sandiford (1935)³, were also taken into consideration. These suggestions were that each item should:-

1. measure an important learning outcome included in the table of specifications (Appendix A, 1, 2, and 3);
2. be appropriate for the particular learning outcome to be measured;
3. present a clearly-formulated task, where all pupils understood the task they were being called upon to perform;
4. be stated in simple and clear language;
5. be free from extraneous clues that may lead pupils to the correct response;
6. have difficulty level appropriate to the learning task and to the age group to be examined;
7. be independent of other items, i.e. free from overlapping; and
8. cover the main objectives, which are considered to be important ones, of the course.

1. Long, A. John and Sandiford, Peter, 1935. "The Validation of Test Items". Bulletin No.3, of The Department of Educational Research, The Department of Educational Research, University of Toronto Press, (p.8).
2. Gronlund, E.N. 1977. op.cit.
3. Long, A. John and Sandiford, Peter, 1936. *ibid.*

5.40 Conducting the Pilot Study

Wood and Skurnik (1969)¹ believe that there are two cardinal principles to observe when pre-testing or carrying out a pilot study, and these are:-

- a - to try out the selected or constructed items on "a sample of people who are reasonably representative of the type of people who are to be measured with the ultimate test or examination."²
- b - to carry out an item analysis, in order to find out whether or not the chosen items are "pitched at the right level of difficulty and discrimination".³

Therefore, in this study, the test items were subjected to an initial trial. A sample of 190 science major pupils (other than pupils involved in the main stage of this project) participated in this stage (in October 1980).

These pupils were randomly selected from Kuwait University (Psychology Department); Commercial Institute for Females; Commercial Institute for Males; Teacher Institute for Females; and Teacher Institute for Males (20, 30, 60, 75, and 15 pupils respectively).

This sample was chosen to participate in the pilot study for the following reasons:-

1. Since these pupils had just taken their Secondary School Certificate Examination (in Science) in June 1979-1980 they were expected to have sufficient knowledge of the subjects in hand;
2. They represent difference ranges of abilities. In other words, usually in Kuwait pupils who achieve better results in their Secondary School Certificate Examination are accepted in the University (minimum grades for acceptance are 60% in the literature departments and 70%

1. Wood, R. and Skurnik, L.S. 1969. op.cit.

2. Wood, R. and Skurnik, L.S. 1969. ibid. (p.43).

3. Wood, R. and Skurnik, L.S. 1969. ibid. (p.48).

in the science departments) and those who achieve lower results are accepted in other Institutes;

3. their age ranged between 16-22 years, the same as the main sample pupils; and finally
4. the science subject areas included in the constructed achievement tests in which these pupils were examined, contained the same topics that the sample of the main project would study in the following academic year, i.e. 1980-1981. (Normally, in Kuwait, the curriculum is revised each year, by supervisors or members from Kuwait University, who may include or exclude certain topics).

The pilot-study population had passed their Secondary School Certificate Examination in the academic year 1979-1980. It was taken into consideration, however, that these pupils did not take extra lessons (during the period June - October 1980) in the three mentioned subject areas, i.e. biology, chemistry and physics. This being the case, no factors other than pupils' knowledge (depending on the information and skills they gained during the previous academic year) and understanding should have any effect on their responses to the test items.

5.41 Administration of the Test Items to the Pilot-Study Sample

Pupils were informed that the results of the test were for research purposes, and that these would not affect their University/Institute grades.

Directions:-

Pupils were given the following directions for each test:-

- (1) There are thirty multiple-choice questions and you have 60 minutes to complete the test: (2) For each item, select the response that best completes the statement or answer to the question, and then put a tick in the opposite box, as for example (in the chemistry achievement test)

1. lime water is a clear saturated solution of calcium:-

- a - oxide
- b - carbonate
- c - bicarbonate
- d - hydroxide.

(3) Since your score will be the number of items answered correctly, be sure to attempt all the items.

Pupils were given the three achievement tests (on three separate occasions) in the presence of the observer only. Pupils' responses (during the period October - November 1980) were collected (see, Table 3, p.131) and subjected to an item analysis.¹

5.42 Item Analysis of the Developed Test Items

Item analysis is seen by Youngman (1979)² as " a procedure for selecting suitable items"³ for a test. In other words, it "is a preliminary stage designed to identify items which do not meet certain criteria and which therefore are likely to reduce reliability or validity"⁴ of the test.

Item analysis was undertaken on data which became available from the piloting stage (see Table 3), to enable the selection of the most suitable items for inclusion in the final form of the test and to enable it to carry out as effectively as possible the purpose for which it was designed.

1. Data analysis was computed by Kuwait University Center for Evaluation and Measurement.
2. Youngman, B. Michael, 1979. "Analysing Social and Educational Research Data", McGraw-Hill Book Company (UK) Limited.
3. Youngman, B. Michael, 1979. *ibid.* (p.183).
4. Youngman, B.M. and Eggleston, F.J. 1979. "Constructing Tests and Scales", Rediguide 10: Guides in Educational Research, Nottingham University, School of Education, (p.14).

Table 3. Frequency of Pupils Obtaining Total Scores Between 0 and 30
on each of the Three Achievement Tests

Total scores	Frequency of Pupils		
	Biology	Chemistry	Physics
0	-	-	-
1	-	1	-
2	-	-	-
3	-	1	-
4	-	2	1
5	-	-	4
6	2	2	2
7	-	7	8
8	-	5	16
9	6	11	16
10	3	9	3
11	6	16	15
12	7	14	21
13	5	12	6
14	9	7	4
15	9	6	7
16	13	1	5
17	17	1	4
18	6	-	-
19	12	-	1
20	9	2	-
21	8	-	-
22	2	-	1
23	2	1	1
24	4	-	-
25	3	-	1
26	2	-	-
27	-	-	-
28	2	-	-
29	-	-	-
30	-	-	-

Scoring of the test items:-

a value of "one" was given to any right answer and a value of "zero" was given to any wrong item, i.e. the maximum score for any pupil, in any given test, would be 30, while the minimum score would be zero.

The item-selection technique, using the extreme-groups (27%) method was applied to determine each "item discrimination power"¹ and its "difficulty level".² Long and Sandiford (1935)³ believe that the idea behind "all the upper and lower methods is that the good item is one on which the good pupils do well, and the poor pupils do poorly".⁴ The upper and lower 27% technique was preferred to that of the upper and lower halves, because in the latter technique scores accumulating around the middle (50%) of the range tend to make the difference between the percentages of "good" pupils passing the item and the percentages of "poor" pupils who also answer the item correctly, smaller than it would be if the middle range was not included when analysing the suitability of an item. The standard deviation of each item was also computed. Thus the main calculations involved the following procedures.

5.43 Measurement of Item Discriminating Power

For the measurement of each item discriminating index (power), the following formula given by Gronlund (1977)⁵ was adopted

$$\text{i.e. } D = \frac{R_U - R_L}{\frac{1}{2}T}$$

where

-
1. Item discrimination power, referred to as item's ability to discriminate between the upper twenty seven percent group and the lower twenty seven percent group of the pilot population sample.
 2. Item difficulty index (level), was referred to as the percentage of pupils who answered the item correctly. However the smaller the percentage figure, the most difficult the item.
 3. Long, J.A. and Sandiford, P. 1935. op.cit.
 4. Long, J.A. and Sandiford, P. 1935. ibid. (p.31).
 5. Gronlund, E.N., 1977. op.cit. (see pp.112-113).

D = the index of discriminating power;

R_U = the number in the upper group who answered the item correctly;

R_L = the number in the lower group who answered the item correctly;

and

$\frac{1}{2}T$ = one half of the total number of pupils included in both the top and bottom 27% of the total item-analysis sample.

The following procedure was followed for the calculation of item discrimination power (an example of the analysis procedure is given in table 4).

1. All test papers were arranged in order from the highest to the lowest total scores.
2. The top twenty-seven percent and the bottom twenty-seven percent of papers based on the total scores were selected.
3. For each item, the number of pupils' responses for each alternative (i.e. A - D) in the top and bottom group separately were counted (see table 4, item No. 1 in physics).
4. Item discriminating power was measured
 - (a) by subtracting the number of right responses in the bottom group from the number of right responses in the top group (for item 1, $15-11=5$) and
 - (b) by dividing the result of step 4(a) (i.e. 5) by the number in each group (i.e. 31). In other words, the item discriminating power in this example would be $\frac{5}{31} = 0.16$.

Table 4. The Responses at the Top and Bottom 27% pupils to Item One in Physics

Item alternatives	A	B	C*	D	Omit**	Total
Top 27%	6	2	16	7	-	31
Bottom 27%	10	3	11	7	-	31
Total	16	5	27	14	-	62

WHERE:- (*) = Correct answer; and

(**) = number of pupils who did not respond to the item.

5.44 Measurement of Item Difficulty Index

Item difficulty index was determined by the percentage of pupils who answered each item correctly. This was done by following the steps given by Gronlund (1977)¹ as follows:-

1. the total number of pupils was calculated for the top and the bottom groups (for item 1, above, $31 + 31 = 62$);
2. the number of pupils who selected the correct responses from the two groups were then summed (for item 1, above, $16 + 11 = 27$);
3. the first sum was divided into the second one and multiplied by 100 (for item 1, above, $\frac{27}{62} \times 100 = 44\%$).

The formula used in this procedure was

$$P = \frac{R}{T} \times 100 \quad (2)$$

where

P = the percentage who answered the item correctly;

R = the number who answered the item correctly and

T = the total number who tried the item.

5.45 Computation of the Standard deviation for Individual Items

There are two ways of judging the item fitness in a test. These are:

- a. the item discriminating index and
- b. the standard deviation.

Since the standard deviation is one of the "most valuable measures of variability"³, it is used to describe the spread of scores in the group. i.e. the deviation of each item score from the mean score for the whole group on that item. In measuring the standard deviation of each item, the

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1. Gronlund, N.E. 1977. op.cit.
 2. Gronlund, N.E. 1977. ibid. (p.112).
 3. Edwards, L. Allen, 1967, "Statistical Methods", Second Edition, Holt, Rinehart and Winston, Inc. (p.8).

following procedure (explained by Gronlund, 1977)¹ was followed:-

Since the variance is equal to the proportion of correct answers multiplied by the proportion of wrong answers, i.e.

variance = Proportion of correct answers x proportion of wrong answers

∴ Standard deviation = $\sqrt{\text{variance}}$

(in item number 1, above, variance = $0.44 \times 0.56 = 0.25$ and the standard deviation = $\sqrt{0.25} = 0.50$).

5.50 Measurement of The Reliability of The Achievement Test

Educational investigators apply various definitions for the reliability of a test. All of them, however, reach similar conclusions on the definition of the reliability of a test as the degree of consistency of the pupils' measured responses from one occasion to another (Long and Sandiford, 1935; Wood and Skurnik, 1969; Ary, Jacobs and Razavieh, 1972; Tuckman, 1978; and Youngman, 1979.^{2,3,4,5,6} The consistency of a whole test can be determined by the degree of the consistency of each of its items. One way of doing so is by applying one of the Kuder-Richardson formulae (i.e. K-R20 or K-R21). The Kuder-Richardson coefficient is seen by Poham (1975)⁷ as "probably the most frequently employed estimate of

1. Gronlund, E.N. 1977. op.cit.
2. Long, J.A. and Sandiford, P. 1935. op.cit.
3. Wood, R. and Skurnik, L.S. 1969. op.cit.
4. Ary, Donald; Jacobs, Lucy Cheser; and Razavieh, Asghar, 1972 "Introduction to Research in Education" Holt, Rinehart and Winston, Inc.
5. Tuckman, W. Bruce, 1978 "Conducting Educational Research" Second Edition, Harcourt Brace Jovan-Ovich, Inc.
6. Youngman, B. Michael, 1979. op.cit.
7. Poham, J.W. "Educational Evaluation", Prentice-Hall, Inc. Englewood Cliffs, New Jersey.

internal consistency"¹ or of "inter item consistency"² of a test.

The reliability of the three achievement tests (i.e. biology, chemistry, and physics) used in this study, was computed by using the K-R21 formula as follows:-

$$r_{xx} = \frac{n}{n-1} \left[1 - \frac{\bar{X} (n-\bar{X})}{nSx^2} \right] \quad (3)$$

where:-

\bar{X} = mean test score;

Sx^2 = Variance of scores on test (defined as $\frac{\sum (X-\bar{X})^2}{n}$) ;

n = number of items.

The results of the computation procedures are represented in table 5 as follows (see also Appendix - A, a, b, and c).

Table 5. Statistical Summary of the Achievement Tests Data Used for Computing The Kuder-Richardson Coefficient

	Biology	Chemistry	Physics
Number of Examinees	127	98	116
Number of Items	30	30	30
Mean of The Test Score	16.71	11.10	11.10
Variance of The Test Score	20.16	11.44	13.63
Standard Deviation	4.49	3.38	3.69
Standard Error of Measurement	3.40	3.10	3.20
Reliability Coefficient	0.66	0.40	0.50

1. Popham, J.W. 1975. *ibid.* (p.119).
2. Anastasi, Anne, 1976, "Psychological Testing", Fourth Edition, Macmillan Publishing Company, Inc., New York (p.117).
3. Ferguson, A. George, 1981, "Statistical Analysis In Psychology and Education" Fifth Edition, McGraw-Hill Book Company (p.439).

The computed reliability coefficients, for the achievement tests of the piloting sample population, were 0.66, 0.40, and 0.50, respectively, for biology, chemistry, and physics.

5.51 The Standard Error of Measurement

"The standard error of measurement and the reliability coefficient are obviously alternative ways of expressing test reliability"¹ writes Anastasi (1976). The standard error of measurement, however, is a useful way of helping us to determine the difference between the obtained and the true scores, i.e. the accuracy of prediction (Ferguson, 1981)². Ferguson (1947),³ defines the standard error of measurement as "the difference between the hypothetical true value and any single fallible (i.e. liable to error) estimate of this value".⁴ In other words, the standard error of measurement "indicates the amount of error to allow for when interpreting individual test scores."⁵ These types of test errors are usually attributed to sources of variations such as marking procedure "other than that due to the intended demands of the test."⁶

The standard error of measurement, in this study, was obtained for each test (3.40, 3.10 and 3.20, for biology, chemistry and physics) respectively) by using the following formula:-

-
1. Anastasi, A., 1976. op.cit. (p.129).
 2. Ferguson, G.A., 1981. op.cit.
 3. Ferguson, G.A., 1947. "The Reliability of Mental Tests". University of London Press, Ltd.
 4. Ferguson, G.A., 1947. ibid. (p.3).
 5. Gronlund, E.N. 1977. op.cit. (p.142).
 6. Youngman, B.M. and Eggleston, F.J. 1979. op.cit. (p.10).

$$S_{y_x} = S_y \sqrt{(1-r^2)} \quad (1)$$

where:-

S_y = is the standard deviation of the test scores; and

r = is the reliability coefficient of the test.

5.52 Measurement of The Standard Deviation of The Tests

Variance and standard deviation are very valuable measures of variability. However, by computing the standard deviation of the test items, the deviation of each item score from the mean of the test can be described (Ary, Jacobs and Razavieh, 1972; Tuckman, 1978).^{2,3} Therefore, the standard deviation is considered to be a useful tool for describing the overall characteristics of the data (Hamburg, 1970)⁴.

The standard deviation for the threetests (i.e. biology, chemistry and physics) was measured by using the following formula:-

$$S = \sqrt{\frac{\sum (f_i x_i)^2 - \frac{(\sum f_i x_i)^2}{N}}{N - 1}} \quad (5)$$

where:-

S = the standard deviation;

$\sum (f_i x_i)^2$ = sum of the squares of each score; and

$\sum (f_i x_i)$ = sum of score squared.

1. Ferguson, G.A. 1981. op.cit. (p.130).
2. Ary, D.; Jacobs, L.C.; and Razavieh, A. 1972. op.cit.
3. Tuckman, W.B. 1978. op.cit.
4. Hamburg Morris, 1970, "Statistical Analysis for Decision Making" An Introduction to classical and Bayesian Statistics, Harcourt, Brace and World, Inc.
5. Selkirk, K.E., 1978, "Descriptive Statistics", Rediguide 21: Guides in Educational Research, University of Nottingham School of Education (p.23).

Table 6. Statistical Summary of The Chemistry Data Used for Measuring
the Standard Deviation (Number of items = 30)

1	2	3	4
x_i	f_i	$f_i x_i$	$f_i x_i^2$
0	-	-	-
1	1	1	1
2	-	-	-
3	1	3	9
4	2	8	32
5	-	-	-
6	2	12	72
7	7	49	343
8	5	40	320
9	11	99	891
10	9	90	900
11	16	176	1939
12	14	168	2016
13	12	156	2028
14	7	98	1372
15	6	90	1350
16	1	16	256
17	1	17	289
18	-	-	-
19	-	-	-
20	2	40	800
21	-	-	-
22	-	-	-
23	1	23	529
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
29	-	-	-
30	-	-	-
Total	98	1086	13144

WHERE:-

 x_i = total score f_i = number of pupils

The following example (see table 6) shows the steps taken in calculating the standard deviation for the chemistry test.

The standard deviations of each test calculated from the selected items making up its final form were 4.58; 3.38; and 3.68 for biology, chemistry and physics respectively.

These steps were as follows:-

1. The correct responses were calculated for each question in the three test areas; namely, physics, chemistry, and biology;
2. scores of each test (students' sum of correct responses) were arranged in column number one from lowest to highest to get the value of x_i ;
3. score frequencies were recorded in column number two; this was done by calculating the number of students who obtained the same score to get the value of f_i ;
4. each frequency (in column number two) was then multiplied by its score (in column number one) to get the value (in column number three) of $f_i x_i$;
5. each score in column number three ($f_i x_i$) was then multiplied by scores in column number one (x_i) to get the value (in column number four) of $f_i x_i^2$;
6. finally, the sums of f_i , $f_i x_i$, and $f_i x_i^2$ were calculated separately and
7. the standard deviation was then obtained (by substituting in Selkirk's suggested formula) as follows:-

$$\begin{aligned}
 S &= \sqrt{\frac{13144 - \frac{(1086)^2}{98}}{97}} \\
 &= \sqrt{\frac{1109}{97}} \\
 &= \sqrt{11.43} \\
 S &= 3.38
 \end{aligned}$$

5.53 Measurement of The Validity of The Tests

Many definitions are applied by educational researchers, to the term validity. For example, Long and Sandiford (1935)¹ define validity as "the aspect of a test which insures that it will actually measure what it claims to measure".² Wood and Skurnik (1969)³ state that a test is valid "when it measures what it is presumed to measure".⁴ Best (1970)⁵, on the other hand, holds the opinion that "a test possesses validity to the extent that it measures what it claims to measure".⁶ Ary and his associates (1972)⁷ refer to the validity of a test as "the extent to which a measuring device is consistent in measuring whatever it measures".⁸ And finally, Tuckman (1978)⁹ believes that "the validity of a test represents the extent to which a test measures what it purports to measure".¹⁰ However, "The voices may differ, but they sing the same tune, for all their definitions boil down to the simple statement that the validity of a test is the degree of accuracy with which it measures what it purports to measure".¹¹ In other words, a test is valid when "it measures what we

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1. Long, J.A. and Sandiford, P., 1936. op.cit.
 2. Long, J.A. and Sandiford, P. 1935 ibid. (p.7).
 3. Wood, R. and Skurnik, L.S., 1969. op.cit.
 4. Wood, R. and Skurnik, L.S., 1969 ibid. (p.71).
 5. Best, W.J. 1970. op.cit.
 6. Best, W.J. 1970 ibid. (p.193).
 7. Ary, D.; Jacobs, L.C.; and Razavieh, A. 1972. op.cit.
 8. Ary, D.; Jacobs, L.C.; and Razavieh, A. 1972. ibid. (p.190).
 9. Tuckman, W.B. 1978. op.cit.
 10. Tuckman, W.B. 1978 ibid. (p.163).
 11. Long, J.A. and Sandiford, P. 1935. op.cit. (p.7).

actually want to measure".¹

In this study, validity of the test was ensured by starting with a table of specifications (see Appendix A.1, 2, and 3). The table specified first of all the subject topics to be studied during the period January - April 1981.

Moreover, the educational goals to be attained from studying the specified subject topics, were also taken into consideration. Those goals were expressed in terms of knowledge to be recalled (i.e. pupils ability to recall certain facts, terms, theories, principles ... etc.), and cognitive operations to be performed (i.e. pupils' ability to manipulate the data available and to solve problems).

Ary and his associates (1972)² and Tuckman (1978)³ consider four sources of validity that one should look for when constructing test items, namely predictive⁴ validity, concurrent⁵ validity, construct⁶ validity and content validity. The content validity of a test is related to the appropriateness of the constructed test items in terms of whether or not the major aspects of the content area are included, the proportion of items that cover each area is reasonable and the degree to which the major objectives of instructions are covered.

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1. Thomas, C.K. 1978, "Attitude Assessment", Rediguide 7, Guides in Education, Nottingham University School of Education. (p.7).
 2. Ary, D.; Jacobs, L.C.; and Razavieh, A. 1972. op.cit.
 3. Tuckman, W.B., 1978. op.cit.
 4. Predictive validity:- the extent to which a test can predict the future performance of the examinees.
 5. Concurrent validity:- the relationship between scores on a measuring scale and a criterion available at the same time.
 6. Construct validity .'. is the extent to which a test reflects constructs presumed to underlie the test performance and also the extent to which it is based on theories regarding these constructs.

Youngman's (1978)¹ opinion in relation to the validity of a science achievement test is that it should be "assessed in terms of face validity". Face validity is considered by Ary, et al. (1972)² as a subdivision of content validity. The content validity of any test can be examined by asking judges or experts (Davis, 1946)³ to examine the appropriateness of the scale items. Therefore, in this study, the content validity of the constructed achievement tests (i.e. biology, chemistry, and physics) was secured by involving six science supervisors from the Ministry of Education in Kuwait to supervise the construction of the test items.

5.54 Measurement of the Correlation Coefficients Between Each Test Item and the Total Score of the Test.

Although the Pearson Product Moment Correlation, which is the most commonly used correlation technique and which is considered by Wiseman (1966)⁴ as "the most reliable of all coefficients, and to be preferred to all others",⁵ it was not used in this part of the project for measuring the reliability of the constructed tests. Ary, et al. (1977)⁶

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1. Youngman, B.M. 1978. "Designing and Analysing Questionnaires", Rediguide 12, Guides in Educational Research, Nottingham University School of Education (p.27).
 2. Ary, D.; Jacobs, L.C.; and Razavieh, A. 1972. op.cit.
 3. Davis, B. Frederick, 1946. "Item-Analysis Data", Their Computation, Interpretation, and Use in Test Construction. Graduate School of Education, Harvard University, Cambridge, Mass.
 4. Wiseman, Stephen, 1966. "Correlation Methods" Statistical Guides In Educational Research No.1, Manchester University Press.
 5. Wiseman, S. 1966. ibid. (p.1).
 6. Ary, D.; Jacobs, L.C.; and Razavieh, A. 1972. op.cit.

and Poham and Sirotnik (1973)¹ indicate that the Pearson's Technique can only be used when the variables to be correlated, i.e. "x" and "y" are of either interval or ratio type. However, the two variables which were correlated in this study were two different types (i.e. one continuous and one dichotomous). Thus, another procedure other than the Pearson's technique had to be found to calculate the correlation coefficient between pupils' responses to each of the test items and their total score on the whole test. The Point Biserial Coefficient which is considered to be one of the special measures indicating the strength of relationships between two variables, was found to be the most appropriate measure that could be applied for the two different types of variables, i.e. the continuous and the dichotomous variables (Long and Sandiford, 1935; Lindquist, 1940; Wiseman, 1966; and Wood and Skurnik, 1969),^{2,3,4,5} used in this study. Pupils' total score on the whole test was referred to as the continuous variable while pupils' reaction to each of the test items was referred to as the dichotomous variable. The dichotomous variable is the one in which pupils' responses are classified in only two ways or categories (Youngman, 1979; Wiseman, 1966; and Lindquist, 1940),^{6,7,8}

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1. Poham, J.W., and Sirotnik, A.K. 1973. "Educational Statistics" Use and Interpretation, Second Edition, Harper and Rose (Pub.), New York.
 2. Long, J.A. and Sandiford, P., 1935. op.cit.
 3. Lindquist, F.E. 1940. "Statistical Analysis in Educational Research" Houghton Mifflin Company.
 4. Wiseman, S. 1966. op.cit.
 5. Wood, R. and Skurnik, L.S. 1969. op.cit.
 6. Youngman, B.M. 1979. op.cit.
 7. Wiseman, S. 1966. ibid.
 8. Lindquist, F.E. 1940. ibid.

e.g., Yes/No; right/wrong, one/zero and so on. The Point Biserial Correlation Coefficient was computed for the three newly-constructed tests by using the following formula:-

$$r_{pb} = \frac{\bar{Y}_1 - \bar{Y}_0}{S_y} \sqrt{Pq} \quad (1)$$

where:-

\bar{Y}_1 = is the mean y score of individuals in the upper category (i.e. "1").

\bar{Y}_0 = is the mean y score of individuals in the other category (i.e. "0").

P = the proportion of individuals in the upper "1" category.

q = the proportion of individuals in the other "0" category.

S_y = the standard deviation of the continuous variable.

Using this formula, the overall homogeneity of the items within the three tests (i.e. the average correlation values for all the item-total test correlations) was found to be 0.39, 0.33, and 0.36 for biology, chemistry and physics respectively.

5.55 Improvement of Test Reliability

The obtained reliability of any test can be improved if it does not meet the minimum required level (i.e. 0.8). In the case of the three achievement tests, the reliability obtained (from the pilot study) for each test was 0.66, 0.40, and 0.50 for biology, chemistry, and physics respectively. Thus the reliability of each test had to be improved.

1. Tate, W. Merle, 1965. "Statistics in Education and Psychology". A First Course. The MacMillan Company, New York. Collier MacMillan Canada, Ltd., Toronto, Ontario. (p. 164)

Several educators indicated that the reliability of any test may be maximised either by adding or removing some items from the test scale (Long and Sandiford, 1935; Youngman, 1978; and Youngman and Eggleston, 1979)^{1,2,3} i.e. by selecting, what is considered to be the most appropriate items in the test pool. Since the constructed tests had more items (30 items in each tested area) than this study needed (18 items in each studied area), the decision was, therefore, taken to remove the extra items from each pool.

In this study however, the selection of the items to be administered to the sample of the main study depended on more than one factor. The main criteria for the selection of items were that they should:-

1. have reasonable discrimination powers (i.e. more than 20%);
2. have standard deviations of about 0.50 or near;
3. have different difficulty levels (to be appropriate for administration to pupils with different range of abilities);
4. cover the main content and objectives of the studied curriculum;
and
5. maintain the distribution of items reflected in the table of specifications.

5.56 Assembling and Rearranging of the Test Items

The most appropriate remaining items were then collected and

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1. Long, J.A. and Sandiford, P. 1935. op.cit.
 2. Youngman, B.M. 1978 "Statistical Strategies" Rediguide 20; Guides in Educational Research, University of Nottingham School of Education.
 3. Youngman, B.M. and Eggleston, F.J. 1979. op.cit.

arranged (see table 7 a, b, and c; table 8 a, b, and c; and Appendix A 1, 2 and 3). The arrangements of the items depended on the following factors:-

1. Items that measure the same learning outcomes were placed together. Thus items of lower-thinking ability were groups together (i.e. questions 1-9) resulting in those of higher-thinking ability also being classified under one group (i.e. questions 10-18).
2. Each sub-test started off with the easier questions for motivational purposes but ended up with the most difficult ones for challenging purposes (see table 6 a, b, and c). This procedure was suggested by Long and Sandiford (1935)¹ as is evident when they state that:-

"Nothing succeeds like success, and if the pupil succeeds with the earlier and easier questions he is encouraged to continue at white heat with the later and harder ones".²

However, before the final arrangement of the test items was decided upon, follow-up procedures were undertaken to correct for pupils guessing the correct responses. This correction factor was then used in calculating the difficulty indices (see table 8 a, b, and c) by using the following formula:

$$Np = R - \frac{W}{K-1} \quad (3)$$

where:-

- Np = the numerator of the proportion of success,
 R = the number of testees that answer the item correctly,
 W = the number of testees that answer the item incorrectly,
 K = the number of choices in the item (in this study four choices are given for each question).

1. Long, J.A. and Sandiford, P. 1935. op.cit.
2. Long, J.A. and Sandiford, P. 1935. op.cit. (p.11).
3. Davis, B.F. 1949. op.cit. (p.4).

5.57 Measurement of the Reliability of the Final Version of the
Newly-Constructed Achievement Tests

To measure the reliabilities of the final forms of the achievement tests, they were administered in November 1980 to 156¹ (96 girls and 60 boys) science major pupils from the psychology department in Kuwait University (37 girls); the Teacher Institute for Females (33); the Teacher Institute for Males (39); the Commercial Institute for Females (24) and the Commercial Institute for Males (21). These pupils had the same characteristics as the previous pilot-sample population (see p.128). The data obtained were then collected (see table 9 a) and analyzed. The reliabilities of the three administered tests were computed using the K-R21 formula (see p.136). Also the standard errors of measurement were computed for each of the three tests (see p.139).

The computed reliability coefficients were found to be 0.82; 0.86, and 0.83 for biology, chemistry and physics respectively (see table 10). It is important to stress that pupils were given the same directions as to how to respond to the test item as were given to the first pilot sample (see p.129).

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1. During the administration of the biology test, 15 pupils missed the exam; on the other hand 9 pupils could not partake in the physics test.

Achievement Test in BiologyTable of SpecificationsTable 7 a.

MAJOR CONTENT AREAS	Item No.	Specified Subject Topics	Student's Behaviour	
			L.T.A.Q.	H.T.A.Q.
ECOLOGY (ORGANISM AND ITS ENVIRONMENT)	3	Association (relationships between organisms in the environment	I	
	9	Animal and plant distribution	I	
	14	Food chains and Food webs		I
	18	Balance in nature		I
HEREDITY	1	Protein synthesis	I	
	8	Blood group inheritance	I	
	12	Nucleic acid (RNA)		I
	16	Pedigrees		I
	17	Linkage and crossing over		I
ANIMAL BEHAVIOUR	2	Learned behaviour	I	
	15	Conditioned reflex behaviour		I
ASEXUAL AND SEXUAL REPRODUCTION	4	Vegetative propagation	I	
	5	Ovulation	I	
	10	The Sexual cycle in Human female		I
	11	Egg fertilization		I
EVOLUTION	6	Evolution evidences	I	
IMMUNOLOGY	13	Antigen-Antibody Interaction		I
IRRITABILITY AND CO-ORDINATION	7	Hormonal control	I	

Where:-

L.T.A.Q. = Lower thinking ability questions

H.T.A.Q. = Higher thinking ability questions

Achievement Test in ChemistryTable of SpecificationsTable 7 b

MAJOR CONTENT AREAS	Item No.	Specified Subject Topics	Student's Behaviour	
			L.T.A.Q.	H.T.A.Q.
THEORIES OF ACIDS AND BASES	01	Lewis's Theory	I	
	09	Bronsted-Lowry Theory	I	
	03	Basicity of Acids	I	
	02	Salts	I	
	15	Strength of Acids		I
OXIDATION AND REDUCTION REACTIONS	14	Oxidation and Reduction Reactions		I
ELECTRO-CHEMISTRY	05	Electrode Potentials	I	
	11	Faraday's Second Law		I
	12	Galvanic Cells		I
	10	Galvanic Cells		I
PREPARATION OF METALS FROM ITS ORES	04	Lead	I	
	06	Lead	I	
	13	Sodium		I
	17	Iron		I
INDUSTRIAL CHEMISTRY	07	Petroleum Industry	I	
NUCLEAR CHEMISTRY	16	Critical Mass		I
	09	Nuclear Reactor	I	
	18	Radioactive Particles		I

Where:-

L.T.A.Q. = Lower Thinking Ability Questions

H.T.A.Q. = Higher Thinking Ability Questions

Achievement Test in PhysicsTable of SpecificationsTable 7 c

MAJOR CONTENT AREAS	Item No.	Specified Subject Topics	Student's Behaviour	
			L.T.A.Q.	H.T.A.Q.
ATOMIC PHYSICS	1	Photoelectric Emission	I	
	9	Photoelectric Emission	I	
	15	Photoelectric Emission		I
	17	Bohr's Model of the Atom		I
	5	Bohr's Model of the Atom	I	
HYDRODYNAMICS	7	Applications of Bernoulli's Theorem	I	
	11	Applications of Bernoulli's Theorem		I
	13	Equation of Continuity		I
CENTRAL FORCES AND GRAVITATION	2	Kepler's Laws	I	
	6	Satellites Motion round the Earth	I	
	14	Universal law of Gravitation		I
ELECTRONICS	18	Diode		I
	4	Triode	I	
SOLIDS	16	Transistor		I
NUCLEAR PHYSICS	3	Nuclear Reaction	I	
	8	Nuclear Forces	I	
	10	Nuclear Disintegration		I
	12	Nuclear disintegration		I

Where:-

L.T.A.Q. = Lower Thinking Ability Questions

H.T.A.Q. = Higher Thinking Ability Questions

Table 8 aItem-Analysis Indices for Items Selected In Final Form of the BiologyAchievement Test (Number of Items = 18, see Appendix B, 1, 2, and 3)

Item Number	Difficulty Index (before correction for guessing)	Discrimin- ation Value	Variance	Standard Deviation	Difficulty Index $Np=R \frac{W}{K-1}$
1	0.81	0.26	0.19	0.44	0.51
2	0.74	0.24	0.24	0.44	0.44
3	0.63	0.62	0.22	0.47	0.35
4	0.59	0.53	0.25	0.50	0.31
5	0.56	0.47	0.25	0.50	0.28
6	0.50	0.24	0.25	0.50	0.23
7	0.50	0.47	0.25	0.50	0.23
8	0.47	0.29	0.25	0.50	0.20
9	0.41	0.59	0.24	0.49	0.15
10	0.72	0.44	0.17	0.41	0.43
11	0.60	0.50	0.22	0.22	0.32
12	0.57	0.47	0.25	0.50	0.29
13	0.54	0.38	0.25	0.50	0.27
14	0.53	0.53	0.25	0.50	0.25
15	0.50	0.41	0.25	0.50	0.23
16	0.49	0.50	0.25	0.50	0.21
17	0.44	0.53	0.23	0.48	0.17
18	0.31	0.50	0.23	0.48	0.05

Table 8 bItem-Analysis Indices for Items Selected in Final Form of the ChemistryAchievement Test (Number of Items = 18, see Appendix B, 1, 2 and 3)

Item Number	Difficulty Index (before correction for guessing)	Discrimin- ation Value	Variation	Standard Deviation	Difficulty Index $Np=R \frac{W}{K-1}$
1	0.73	0.39	0.20	0.44	0.33
2	0.65	0.46	0.22	0.47	0.28
3	0.65	0.38	0.24	0.49	0.28
4	0.44	0.65	0.25	0.50	0.13
5	0.42	0.38	0.24	0.49	0.12
6	0.40	0.58	0.24	0.49	0.11
7	0.35	0.46	0.23	0.48	0.07
8	0.29	0.35	0.21	0.46	0.03
9	0.29	0.35	0.20	0.45	0.03
10	0.73	0.54	0.20	0.44	0.33
11	0.69	0.31	0.21	0.46	0.31
12	0.67	0.50	0.22	0.47	0.29
13	0.62	0.62	0.20	0.45	0.22
14	0.54	0.62	0.25	0.50	0.20
15	0.52	0.35	0.25	0.50	0.15
16	0.42	0.42	0.24	0.49	0.11
17	0.40	0.42	0.24	0.49	0.11
18	0.37	0.50	0.23	0.48	0.08

Table 8 c

Item-Analysis Indices for Items Selected in Final Form of the PhysicsAchievement Test (Number of Item = 18, See Appendix B, 1, 2 and 3)

Item Number	Difficulty Index (before correction for guessing	Discrimin- ation Value	Variance	Standard Deviation	Difficulty Index $Np=R \frac{W}{K-1}$
1	0.71	0.45	0.18	0.43	0.38
2	0.60	0.68	0.25	0.50	0.27
3	0.48	0.77	0.25	0.50	0.20
4	0.45	0.71	0.25	0.50	0.17
5	0.44	0.68	0.24	0.49	0.15
6	0.42	0.58	0.25	0.50	0.14
7	0.36	0.52	0.21	0.46	0.08
8	0.31	0.42	0.21	0.46	0.05
9	0.27	0.35	0.21	0.49	0.02
10	0.69	0.55	0.21	0.46	0.27
11	0.48	0.45	0.24	0.49	0.19
12	0.48	0.26	0.25	0.50	0.19
13	0.45	0.32	0.24	0.49	0.17
14	0.44	0.42	0.24	0.49	0.15
15	0.40	0.48	0.24	0.49	0.13
16	0.39	0.26	0.25	0.50	0.11
17	0.35	0.32	0.23	0.48	0.09
18	0.32	0.45	0.22	0.47	0.06

Table 9

Frequency of Pupils Obtaining Various Total Scores on Final
Form of the Three Achievement Tests

Total Scores	Frequency of Pupils		
	Biology Achievement Test	Chemistry Achievement Test	Physics Achievement Test
0	3	5	11
1	-	1	9
2	2	3	8
3	5	15	16
4	3	16	11
5	16	19	11
6	9	20	10
7	6	13	2
8	9	9	7
9	6	11	9
10	5	1	12
11	9	7	17
12	11	5	7
13	15	2	11
14	16	2	4
15	17	5	2
16	7	5	-
17	2	17	-
18	-	-	-

N.B.

In scoring the test items, a value of "one" was given for a right answer and a value of "zero" was given for a wrong response. Therefore the maximum score expected for any pupil in any one of the three tests, was "eighteen", on the other hand, the corresponding minimum expected score, for any pupil, was "zero".

Table 10

Statistical Summary of the Data Used for the Computation
of the Kuder-Richardson Reliability Coefficients for the
Final Form of the Three Achievement Tests

	Biology	Chemistry	Physics
Number of Examinees	141	145	147
Number of Items	18	18	18
Mean of the Test Scores	10.2	7.9	6.8
Standard Deviation	4.4	4.82	4.37
Variance of the Test Scores	19.36	23.18	19.08
Standard Error of Estimate	3.61	2.46	2.44
Reliability Coefficient	0.82	0.86	0.83

5.60 The Construction of a Perception Questionnaire.

5.61 - Reasons for Constructing a New Instrument to Measure Pupils' Perceptions of Their Science Teachers' Behaviour.

The question worth asking is what do students in Kuwaiti high schools expect of their science teachers and in particular how do they perceive the behaviour of such teachers. To answer this question, a perception scale was constructed and administered to pupils in Kuwaiti high schools to gain information about their reactions to science teachers' behaviour when teaching science subjects.

So far there is no appropriate instrument that measures students' perceptions of their teachers' behaviour available in the Arabic language. Therefore, either one of the existing instruments (in a language other than Arabic) had to be translated into Arabic and introduced to Kuwaiti pupils or a new instrument had to be developed.

Kuwait, where this project was conducted, is one of the Arabic countries that has its own culture as well as its own traditions. However, Kuwait not only differs completely from European, American and other foreign countries, but it also differs from some other Arabic countries to some extent in its culture and traditions.

Therefore, the use of an existing instrument would be inappropriate for the following reasons:-

1. The problem in translating an instrument from one language into another is not just a translation problem, but it also involves the evaluation of many items which are bound to a particular culture and tradition (see: Anderson and Herrera, 1976).¹

1. Anderson, E.J; and Herrera, D.B., 1976. op.cit.

2. There is a language problem where so many words when translated into Arabic do not give the precise meaning as the original language of the questionnaire.
3. The educational system in Kuwait differs to some extent also from that of other countries such as the United States of America or the United Kingdom. In these countries, pupils in high schools may have the opportunity to choose among certain subjects and may have the chance to choose the teachers with whom they may be enrolled. However, in Kuwait, high school students only have the chance to choose between two major subjects (in the last two years of their four-year secondary education), namely science and literature. Therefore, students have to study all the subjects assigned to one or other of these two majors.

For example, when a student chooses to study science he has to study chemistry, physics, biology, mathematics, religion and arabic, in addition to some other subjects which are prerequisites for his graduation from high school. Indeed, students often have to study these subjects with teachers who have been assigned by the school administration to teach these particular subjects. Furthermore, students do not have the opportunity to choose their classes or their classmates; they attend classes assigned to them by the school administration at the beginning of each year (on the basis of their results of the previous year).

4. Female and male students in Kuwait attend separate schools. Hence, male students are taught by male teachers and female students are taught by female teachers. In other words, there are no mixed government school in Kuwait (other than kindergartens).

For these reasons the need for a new instrument was found to be essential for this project.

5.62 Pilot Study for the Construction of a New Instrument to Measure Pupils' Perceptions of Their Science Teachers' Behaviour

Introduction:-

It is obvious that one has to define the main characteristics of teachers' effectiveness which one wants to look for. However, the choice of important qualities of "good" and "bad" teachers in this project was left to the pupils to decide upon. In other words, the researcher believed that pupils were the persons who were best able to define "good" and "bad" teachers. This belief was built upon the following factors.

1. The problem of defining the "good" teacher still exists and there is little known of the teaching qualities which pupils, in Kuwait, consider as of great importance when science is taught to them.
2. The idea of imposing some characteristics which the researcher (or others) considered of significant importance in characterizing the "good" teacher was dismissed as probably arbitrary, based on subjective bias and perhaps out of context.
3. A large number of studies were appearing in many periodicals in recent years calling for more use of pupils' participation in the improvement of the educational process.
4. Pupils usually proved to be good judges of teachers because of "their day-long contact with teachers"¹ and because they are the only ones who interact with more than one teacher each day. Thereby they have the best opportunity to observe teaching behaviour regularly. The teaching behaviour may be more typical and reliable than the more

1. Witty, A. Paul, 1948 "Evaluation of Studies of the Characteristics of the Effective Teacher", Improving Educational Research. American Educational Research Association Official Report, (p.199).

artificial and incidental behaviours observed by a researcher.

5. Pupils' ratings are based on previous experiences with different teachers.

A pilot study was considered essential at this stage, from which the researcher hoped to obtain some comprehensive meaningful dimensions of "good" and "bad" teachers' characteristics (especially those which were believed to have an effect on pupils' outcomes in one way or another) from a series of pupils' opinions.

5.63 Steps Taken in the Construction of Pupils' Perception Questionnaire

The pilot study was carried out using a representative sample of Kuwaiti high school pupils. An initial sample of 210 (100 females and 110 males) fourth-grade¹ pupils from the same grade level but other than pupils involved in the main study, were randomly selected from four Kuwaiti high schools (2 male and 2 female schools) to participate in this stage of the project during the period September-October (see Map of Kuwait, p.xxix).

An open-ended questionnaire was administered to the pilot population. These pupils were simply asked (see Chapter V, pp.161) to think of some good science teachers with whom they either worked or wished to work and then to state five of the most important qualities of these teachers.

1. There were two main reasons for the preference of the fourth-grade pupils to be enrolled in this project:-
 - a. the fourth-grade pupils would have more experience with different teachers than pupils in other grades; and
 - b. the fourth-grade pupils' final achievement would depend only on their Secondary School Certificate Examinations and not on their school work, therefore these pupils would evaluate their teachers objectively (with no fear from their teachers).

Pupils were also asked to think of some inappropriate teachers with whom they did not enjoy working with or with whom they did not wish to work. They were then asked to describe each category of teacher (i.e. "good" and "bad") in five statements.

Pupils' Perception of a "good "bad" Science Teacher

Dear Pupil:-

This study is an attempt to improve the teaching of science in Kuwaiti high schools. This will be fulfilled by providing some ideas about what you really think constitutes good teaching.

This questionnaire is designed to help develop a new pupils' evaluation instrument. This instrument will be applied later on to students from the same grade level as yourself.

However, to get an idea about what you consider to be important for effective teaching, I would like you to:-

first, think of some good teachers, whom you enjoyed working with, or would like to have worked with because of their adopted behaviour in the classroom. Also, I would like you to think of some inadequate teachers whom you did not enjoy working with or would not wish to work with because of their adopted behaviour in the classroom.

Secondly, I would like you to state five of the most important qualities a teacher should and should not possess.

As for example:-

a. I enjoyed working with or would like to have worked with:-

- 1 - Teachers who gave students a chance to discuss their opinion in the classroom without being interrupted.

b. I did not enjoy working with or would not wish to work with:-

- 1 - Teachers who do not provide variety in the daily routine.

Pupils' Perceptions of a "good" "bad" Science TeacherPage (1)I enjoyed working with or would like to have worked with teachers who:-

- 1 -

 2 -

 3 -

 4 -

 5 -

Page (2)I did not enjoy working with or would not wish to work with teachers who:-

- 1 -

 2 -

 3 -

 4 -

 5 -

5.64 Categorization of The Collected Data for the Perception Questionnaire from the Pilot Study

More than 2100 statements were collected.¹ Consequently a scale with a total of 126 statements was obtained. Minor statements that were mentioned by less than 20% of pupils were not included in the newly-constructed scale.

The collected statements were divided into the following three subscales:-

I - Teacher's efforts before coming into the classroom.

This area covers:

- a. Teacher's knowledge of the subject matter and
- b. Teacher's plans, preparation and organization of the subject matter and class activities.

II - Teacher's efforts in the classroom.

This area covers:-

A - Teacher's classroom behaviour

This category includes:-

- a. encouraging pupils' participation;
- b. clarity of explanations;
- c. evaluation system (exams, questions);
- d. ability to stimulate interest and
- e. handling laboratory work.

B - Teacher's personality

This category covers teacher's ability to:-

- a. maintain order, enforce discipline, and utilize classtime effectively;

1. Some pupils gave more than 5-5 statements, while some pupils gave more than one character in the same statement.

- b. create a pleasant educational environment and
- c. have self-confidence.

C - Teacher's attitude

This category includes teacher's:-

- a. attitude towards his pupils and
- b. fairness towards pupils.

III - Pupils' required work outside the classroom.

This category covers:-

- a. class assignments and
- b. outside reading.

The developed statements were then given to ten judges from Kuwait University (nine judges were from the Department of Education and one judge was from the Computer Centre). These judges were asked to check each item for clarity, sign¹, and then to place each item in one of the five categories.² Judges' responses were then collected, and the degree of agreement among them was calculated. Statements, however, with less than 70% agreement were removed. A total of ninety-nine statements survived, i.e. twenty-seven statements were removed on the basis of the initial judgement and these statements are mentioned in Appendix C - Table 1. The remaining ninety-nine items were then administered to the same 210 pupils (in November 1980) that participated in the first stage of the

-
1. Statement's signs were stated according to pupils' initial responses i.e. statements that characterized the inappropriate teacher by most of the pupils were signed negatively (in the perception questionnaire that was given to the pupils in the second stage of the study), and statements that characterized the good teacher were signed positively.
 2. The first category is located in subscale one, the second, third and fourth categories are located in subscale two and finally, the fifth category is located in subscale three. These five categories however, were initially selected by the observer and were approved later by the participant judges.

project¹. These pupils were directed to react to the statements on a five-point scale (ranging from strongly agree to strongly disagree).

These pupils were asked:-

first, to read every item carefully that characterises science teachers (as other students see them).

second, to state their degree of agreement or disagreement (on each item) by making a tick under one of the five responses provided to them (see p.166).

5.65 Item Analysis Procedures Applied to the Pupils' Perception Scale.

To investigate the performance of each item and to weed out inappropriate items, an item-analysis procedure was carried out on the data arising from pupils' responses. A Pearson product Moment Correlation Coefficient was computed for each item.

This was done by

- a. calculating each individual item's total score,
- b. calculating the total score for each subscale, and then
- c. computing the correlation between each individual item's total score and the total subscale score to find out the degree of association between each item and its subscale.

Items that correlated with a magnitude of 0.2 or more ($p < 0.05$) with their subscale total score were retained (see Anastasi, 1968, pp.130-131).²

1. From the 210 pupils who participated in this stage, only the responses of 160 pupils were taken into consideration. This resulted from forty-eight pupils having missed some items, therefore their responses were not calculated.
2. Anastasi, A. 1968. "Psychological Testing" Third Edition, The Macmillan Company, New York.

Pupils' Perception of a Good Science Teacher

Dear Student

You have ninety-nine statements that characterise the good science teacher. I would like you:-

First to read these statements carefully.

Second to state your response on each statement by making a tick in one of the five columns you are given. So

1. if you strongly agree with the statement put a tick (✓) in the first column;
2. if you only agree with the statement put a tick (✓) in the second column;
3. if you are not sure whether you agree or disagree put a tick (✓) in the third column;
4. if you don't agree with the statement put a tick (✓) in the fourth column; and
5. if you strongly disagree with the statement put a tick (✓) in the fifth column.

For example:-

The good science teacher is the one who

- a. gives me a piece of chocolate
when I give the right answer.
- b. always put his white coat on.

S.A.	A.	N.S.	D.	S.D.
---	✓	---	---	---
---	---	✓	---	---

Thank you for your cooperation.

Moreover, the correlation between each item from a certain subscale was computed with total scores from another subscale, e.g. items from subscale one were correlated with the total score of subscales two and three. Thus items that correlated more with other subscales than it correlated with its own subscale were also weeded out from the remaining item pool. In other words, forty-seven items were removed by these correlational procedures (see Appendix D, 1 and 2).

Fifty-two items, however, were left in the three subscales. Since the remaining items in both subscales one and three were each less than six items, the minimum number of items required in each subscale, these items were also removed from the remaining pool of items (see Appendix E, 1 and 2).

Consequently, forty-six items remained and all of these were items belonging only to subscale two (see table 11, p.168). In other words, the remaining items were those dealing with teachers' efforts in the classroom. These remaining items (see items on pp.171-173) however, covered important aspects of teaching behaviour for which this project was looking, i.e. actual teacher behaviour related to the classroom. These behaviours were:-

1. teachers' classroom behaviour (24 items),
2. teachers' personality (10 items) and
3. teachers' attitude (12 items).

Table 11

Scale Item Characteristics of Pupils' Perception Questionnaire

(N - 162)

Subscale two	Item No.	Nature of Item	Pearson Correla- tion with Total Scales' Score	Students' Responses Relative Frequency Percent				
				S.A.	A.	N.S.	D.	S.D.
11								
Category	40	+	0.53	85.19	9.87	2.47	-	2.47
two	50	+	0.41	66.67	28.40	1.23	1.23	2.47
	66	+	0.60	75.31	12.35	6.17	2.47	3.70
	67	+	0.47	72.84	16.05	3.70	4.94	2.47
	71	+	0.45	34.57	44.44	6.17	7.41	7.41
	74	-	0.24	13.58	4.94	3.70	35.80	41.98
	77	+	0.21	65.43	27.16	-	4.94	2.47
	78	+	0.28	40.74	17.28	17.28	8.03	3.09
	79	+	0.21	69.14	15.93	2.47	1.23	1.23
	80	-	0.20	14.81	24.70	11.73	26.54	22.22
	84	+	0.20	72.84	18.52	3.09	4.32	1.23
	87	-	0.20	1.23	2.74	2.47	11.11	82.72
	91	+	0.33	76.55	14.81	7.41	1.23	-
	97	+	0.42	64.20	25.93	6.71	1.85	1.85
	100	-	0.37	6.17	12.35	19.75	37.03	24.70
	104	-	0.35	3.47	2.47	38.27	32.10	23.46
	106	+	0.42	82.10	9.26	4.94	3.09	0.61
	109	+	0.25	65.43	20.99	7.41	1.23	4.94
	114	-	0.30	45.68	23.46	14.81	12.35	3.70
	115	-	0.30	3.09	1.85	2.47	17.28	75.31

Table 11 continued

Scale Item Characteristics of Pupils' Perception Questionnaire

(N - 162).

Subscale two	Item No.	Nature of Item	Pearson Correlation with Total Subscales' Score	Students' Responses Relative Frequency Percent				
				S.A.	A.	N.S.	D.	S.D.
11								
Category two	118	+	0.26	43.21	35.80	11.11	4.94	4.94
	119	-	0.30	9.87	13.58	8.64	28.40	39.51
	121	+	0.23	35.80	19.75	16.05	12.35	16.05
	123	-	0.26	1.23	16.05	11.11	24.70	46.91
Category three	2	+	0.35	45.68	30.86	11.11	8.64	3.70
	3	+	0.23	76.54	1.23	12.35	2.47	7.41
	4	-	0.36	10.49	3.09	1.23	29.63	55.56
	10	+	0.36	24.07	38.89	20.99	11.73	4.32
	11	-	0.21	2.47	1.23	7.41	18.52	70.37
	12	-	0.25	2.47	-	1.23	9.26	87.04
	38	-	0.27	1.23	3.09	3.09	19.75	72.84
	49	-	0.27	5.56	6.79	2.47	22.22	62.96
	53	-	0.30	6.79	14.20	17.90	32.71	28.40
	122	-	0.30	1.23	-	6.79	16.67	75.31
Category four	18	+	0.23	76.54	8.64	4.94	2.47	7.41
	19	+	0.31	53.08	27.16	7.41	4.94	7.41
	22	+	0.29	55.56	22.22	8.64	8.64	4.94
	26	-	0.36	9.26	9.26	13.58	19.75	48.15

Table 11 continued

Scale Item Characteristics of Pupils' Perception Questionnaire

(N - 162).

Subscale two	Item No.	Nature of Item	Pearson Correla- tion with Total Subscales' Score	Students' Responses Relative Frequency Percent				
				S.A.	A.	N.S.	D.	S.D.
11								
Category four	27	-	0.20	2.47	2.47	-	-	95.06
	28	+	0.29	79.01	16.05	3.09	1.85	-
	32	-	0.23	2.47	-	2.47	4.94	91.12
	33	-	0.21	6.17	11.11	7.41	28.40	46.91
	39	-	0.23	4.94	1.23	17.28	18.52	58.02
	43	-	0.51	-	1.23	3.09	10.49	85.19
	46	-	0.31	2.47	2.47	3.70	8.64	82.72
	69	-	0.30	3.70	9.87	7.41	24.70	54.32

Key

S.A. : strongly agree.

A. : agree.

N.S. : not sure.

D. : disagree.

S.D. : strongly disagree.

5.66 The Remaining Forty-Six Items selected for the final Form of the Pupils' Perception Questionnaire.

Teachers' Classroom behaviour:

40. Teacher who summarizes and reviews the main ideas of the subject matter at the end of each lesson.
50. Teacher who uses reasonable audio-visual aids to clarify the subject matter.
66. Teacher who uses simple and clear words when explaining the lesson.
67. Teacher who asks questions at the end of each session.
71. Teacher who asks questions during the session to hold pupils' attention.
74. Teacher who sets long and difficult exams.
77. Teacher who gives pupils a chance or a clue before answering any raised question rather than providing them with ready answers.
78. Teacher who invites and values various points of view.
79. Teacher who asks various questions other than those mentioned in the textbook.
80. Teacher who moves from one subject to another before making sure that everybody has understood the previous one.
84. Teacher who presents the main ideas of the subject matter in an organized and integrated fashion.
87. Teacher who limits his questions to those expected in the secondary school certificate examination.
91. Teacher who clearly explains appropriate steps to be taken before asking pupils to do any experiment.

97. Teacher who asks questions during any practical work to maintain pupils' alertness.
100. Teacher who does not use examination results to find out where pupils need help.
104. Teacher who does not encourage learning by doing.
106. Teacher who gives pupils a chance to do the experiments by themselves.
109. Teacher who discusses the kind of evidence that lies behind the truth of any experiment.
114. Teacher who asks pupils to interpret their observation of any experimental work and to apply them to new situations.
115. Teacher who does not go over the exams after they are graded and does not discuss the results with pupils.
118. Teacher who adopts different techniques when teaching different aspects of their subject.
119. Teacher who spends most of the time in only stating facts and principles.
121. Teacher who does not leave any incomplete experiment.
123. Teacher who changes most of the practical work into an oral/theoretical lesson.

Teachers' Personality.

2. Teacher who permits pupils to show reasonable signs of humour.
3. Teacher who shows a reasonable sense of humour.
4. Teacher who permits pupils' discussions to wander too far off the subject.
10. Teacher whom pupils can depend on to hold class activities as scheduled.

- 11. Teacher who allows cheating during examinations and/or answering questions.
- 12. Teacher who orders pupils around all the time for no valid reasons.
- 38. Teacher who for most of the time comes late to the classroom.
- 49. Teacher who does not attend all his classes.
- 53. Teacher who wastes a great deal of class time on irrelevant things.
- 122. Teacher who fears pupils' questions.

Teachers' Attitude.

- 18. Teacher who trusts and respects his pupils.
- 19. Teacher who does not let his personal problems interfere with the treatment of his pupils.
- 22. Teacher who is fair in handling and grading assignments and examinations.
- 26. Teacher who deducts some marks from deserved grades as a sort of punishment.
- 27. Teacher who treats pupils of other nationalities differently.
- 28. Teacher who does not make fun of pupils for giving wrong answers.
- 32. Teacher who punishes the whole class when one or few of the pupils do something wrong.
- 33. Teacher who does not make his pupils feel that he is proud of them.
- 39. Teacher who behaves impartially towards students regardless of their ability level.
- 46. Teacher who allows pupils' popularity outside the classroom to affect his treatment of them.
- 69. Teacher who deliberately does not give exams on the prearranged day.
- 43. Teacher who treats pupils according to their popularity in previous years.

5.70 Estimation of the Reliability of the Finalised Form of the Pupils' Perception Questionnaire.

Many educators propose different techniques for the assessment of the reliability of any constructed achievement or psychological test (see: Ferguson, 1947; Tate, 1965; Anastasi, 1961, and 1968; McNemar, 1969; Ary et.al., 1972; Tuckman, 1978; and Ferguson, 1981).^{1,2,3,4,5,6,7,8.}

These techniques are:-

- a. The test-retest procedure whereby the same form of a test is administered on two occasions to the same sample, and the two scores of any individual taking the tests are correlated;
- b. The parallel-form test by which two parallel forms of a test are administered to the same testees, either at the same time or on two different occasions. The scores of the items on the two forms, for any testee are then correlated and
- c. The split-half procedure in which the same test is administered once but the scores of the same individual on the odd-even or the first and second halves are correlated.

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1. Ferguson, G.A. 1947. op.cit.
 2. Tate, W.M. 1965. op.cit.
 3. Anastasi, Anne, 1961. "Psychological Testing" Second Edition, The Macmillan Company, New York.
 4. Anastasi, A. 1968. op.cit.
 5. McNemar, Quinn, 1969. "Psychological Statistics" Fourth Edition, John Wiley and Sons Inc.
 6. Ary, D.; Jacobs, L.C.; and Razavieh, A. 1972. op.cit.
 7. Tuckman, W.B. 1978. op.cit.
 8. Ferguson, G.A. 1981. op.cit.

The difficulty that encounters the researcher in applying the parallel-forms technique lies in the difficulty in constructing two parallel forms which are truly identical in form, length, level of difficulty, time, ...and the like (Tate, 1965; Anastasi, 1961; and Ary, et.al., 1972).^{1,2,3.}

Moreover, the repetition of the same test is conditioned by the length of the duration that separates the two occasions which the test is administered. Thus, if the duration is too short, then the testees may recall their first responses of the test on the second occasion (Ferguson, 1947; McNemar, 1969; and Ferguson, 1981).^{4,5,6.} On the other hand, if the duration between the administration of the two tests is too long, then other factors such as physical and mental conditions of the testees may affect the reliability coefficient of the test (Ary, et.al. 1972).⁷

5.71 The Split-half Technique

In this project, the split-half technique for measuring the internal consistency of the remaining forty-six items of the Pupils' Perception Questionnaire (see pp.171-173), was adopted for the following reasons:-

1. Since the time was so limited for the completion of this project and since pupils who participated in this part of the study might not

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1. Tate, W.M. 1965. op.cit.
 2. Anastasi, A. 1961. op.cit.
 3. Ary, D.; Jacobs, L.C.; and Razavieh, A. 1972. op.cit.
 4. Ferguson, G.A. 1947. op.cit.
 5. McNemar, Q., 1969. op.cit.
 6. Ferguson, G.A. 1981. op.cit.
 7. Ary, D.; Jacobs, L.C.; and Razavieh, A. 1972. op.cit.

always be available,¹ the idea of administering the questionnaire to the same group of subjects on two occasions was set aside.

2. Even if the first problem was solved and pupils were free to take the questionnaire on two separate occasions, another problem could be encountered. Thus if the questionnaire was given on two occasions with too short an interval "memory of previous responses might interfere, resulting in a spuriously high correlation coefficient."² On the other hand, if the interval between the two occasions was too long, a lower correlation coefficient might rise which would not be due to the inconsistency in the scale itself but due to a genuine change in pupils' attitudes that might have happened during that period.
3. Since the number of the remaining (forty-six) items was large enough to allow for the split-half technique to be used and because the split-half technique avoided the previously mentioned difficulties encountered in both a test-retest and a parallel-form technique, the split-half method was adopted in this study.

When applying the split-half technique, either the total scores of the subjects on the first half of the items are correlated with their total on the second half, or, the total score of the testees on the odd items are correlated with the total scores of the testees on the even items.

In this study the second procedure was the one adopted. This

-
1. All secondary-school pupils were asked by the Kuwaiti Government to participate in the Celebrations of Kuwait National Day (in February), accordingly much time was spent on training outside schools. Therefore, pupils had to cover so much of the text-books materials in a short time before the final examination period started (in June).
 2. Thomas, C.K. 1978. op.cit. (p.8).

was because some factors, such as differences in the nature and difficulty levels of items and the accumulative effects of warming up, practice, fatigue, boredom, ...etc. (Anastasi, 1976),¹ could have affected the results of the pupils' responses to the questionnaire. Moreover, the items of the present scale were arranged in an appropriate order of difficulty and items dealing with a single problem were divided eventually into the two halves, i.e. the upper and lower halves later correlated as "X" and "Y".

The scale was administered to 129 (female and male) pupils from five secondary schools who participated in the main study. These pupils were from the same grade level (i.e. the fourth) but from classes other than those who participated in the main study. The application of the scale within these schools was carried out during the second two weeks of December 1980. Pupils were given the same directions as stated in page 166. However, the only difference was that pupils were now given forty-six statements instead of the original ninety-nine items. Pupils' responses were then collected and subjected to analysis (see Table 12). The reliability of the perception questionnaire was computed by substituting in the following formula:-

$$r = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{[N \sum X^2 - (\sum X)^2][N \sum Y^2 - (\sum Y)^2]}} \quad (2)$$

where:-

N = number of pairs of scores,

$\sum XY$ = sum of the products of the paired scores,

1. Anastasi, A. 1976. op.cit.

2. Bruning, L. James and Kintz, J.B. 1968. "Computational Handbook of Statistics". Scott, Foresman and Company, Glenview, Illinois 60025 (p.153).

$\sum X$ = sum of the scores on one variable (i.e. odd items),

$\sum Y$ = sum of scores on the other variables (i.e. even items),

$\sum X^2$ = sum of squared scores on the "X" variable and

$\sum Y^2$ = sum of squared scores on the "Y" variable.

Table 12

Statistical Summary of the Data Used for the Calculation
of the Reliability Coefficient Using the Split-half method.

N	129
$\sum XY$	1184907
$\sum X$	12323
$\sum Y$	12256
$\sum X^2$	1206207
$\sum Y^2$	1172640
\bar{X}_1	95.5
\bar{Y}_1	95.5
S. d. _X	8.8
S. d. _Y	8.0
r	0.91

The computed reliability coefficient was found to be 0.91. To correct for the effect of shortening of the original test, by half in the split-half procedure, on the value of the reliability coefficient the Spearman-Brown formula was applied as follows:-

$$r_{11} = \frac{2 \bar{r}_{11}}{1 + \bar{r}_{11}}$$

where:-

r_{11} = is the estimated reliability coefficient of the whole test, and

\bar{r}_{11} = is the obtained reliability coefficient of the test.

The estimated reliability coefficient of the whole test was found to be 0.95.

5.72 The Kuder-Richardson Reliability Coefficient.

The Kuder-Richardson procedure is another method of utilizing the results obtained during a single administration of a test in calculating its reliability. This procedure is based on an examination of performance of the testees on each item and on the consistency of subjects' responses to all the items in the scale.

Anastasi (1976) considers that "the difference between Kuder-Richardson and split-half reliability coefficients may serve as a rough index of the heterogeneity of a test."² In other words, "unless the test items are highly homogeneous, the Kuder-Richardson coefficient will be lower than the split-half reliability coefficient".³ The Kuder-Richardson coefficient was, therefore, used in this study as another measure of inter-item consistency.

1. Anastasi, A. 1961. op.cit. (p.122).
2. Anastasi, A. 1976. op.cit. (p.118).
3. Anastasi, A. 1961. op.cit. (p.85).

The data collected from the same pupils for the computation of the split-half reliability coefficient were used for the computation of the Kuder-Richardson reliability coefficient (see Table 13).

Table 13.

Statistical Summary of the Data Used for the Measurement of
the Kuder-Richardson Coefficient of the Pupils' Perception

Questionnaire

Number of pupils	129
Number of Items in the Scale	46
Maximum score expected of the total items	230
Mean of the scale scores	190.5
Sum of scores on the scale	24579
Sum of squared scores on the items	4755447
Standard deviation of the Scale	14.58
Variance of the Scale	212.6

The Kuder-Richardson reliability coefficient was measured by substituting the appropriate values into the K.R.-21 formula as follows:-

$$r_{xx} = \frac{n}{n-1} \left[1 - \frac{\bar{X} (n - \bar{X})}{nS_x^2} \right] \quad (1)$$

where:

n = number of items in the scale;

S_x^2 = variance of total scores on the test (defined as $\frac{\sum (X - \bar{X})^2}{N}$); and

\bar{X} = mean test score.

The computed Kuder-Richardson coefficient for the test items was found to be 0.87.

5.73 Item-Category and Total Sub-scale Correlation.

The data, resulting from the responses of the 129 pupils mentioned above, were also used to measure the correlation coefficient between each of the forty-six items and the category to which each item belonged (i.e. teachers' teaching behaviour, personality, or teachers' attitude). A correlation coefficient was also measured for each of the test items and the total sub-scale (i.e. teacher's efforts in the classroom). The correlation coefficient for the items on the test was measured by computing the Pearson Product Moment Correlation Coefficient by following the same procedure mentioned above (see p.177). The results of the computational procedure are represented in Table 14.

N.B.

In this present study, items characterizing the "good" science teacher are considered as positive items (see Table 11). The scoring of these items range from five to one, i.e. 5 (S.A.), 4 (A.), 3 (N.S.), 2 (D.) and 1 (S.D.). Items characterizing the "bad" science teacher, on the other hand, are considered as negative items. The scoring of these items, however, range from one to five, i.e. 1 (S.A.), 2 (A.), 3 (N.S.), 4 (D.) and 5 (S.D.).

Table 14.

Scale Item Characteristics of the Final Form of thePupils' Perception Questionnaire

(N - 129)

Item - Category and Total Sub-Scale Correlations

Sub-Scale	Item No.		Nature of Item	Pearson Correlation with Total Subscales' Score		Students' Responses Relative Frequency Percent				
	11	P.S. M.S.		T.S.S.	T.C.S.	S.A.	A.	N.S.	D.	S.D.
Category	40	16	+	0.53	0.54	82.1	13.2	2.3	0.8	1.6
I	50	20	+	0.54	0.56	62.0	27.9	5.4	1.6	3.1
	66	22	+	0.50	0.50	58.2	30.2	2.3	5.4	3.9
	67	23	+	0.46	0.40	47.4	34.0	6.2	7.0	5.4
	71	25	+	0.52	0.47	42.6	35.7	8.5	8.5	4.7
	74	26	-	0.37	0.26	19.4	27.9	13.2	20.9	18.6
	77	27	+	0.58	0.55	48.1	34.1	10.1	5.4	2.3
	78	28	+	0.45	0.41	52.7	39.5	4.7	2.3	0.8
	79	29	+	0.51	0.49	45.7	27.9	10.9	7.0	8.5
	80	30	-	0.51	0.56	68.2	12.4	6.2	5.4	7.8
	84	31	+	0.58	0.58	58.9	24.8	6.2	5.4	4.7
	87	32	-	0.23	0.29	16.3	31.0	13.2	24.8	14.7
	91	33	+	0.56	0.54	55.8	33.3	7.0	3.1	0.8
	97	34	+	0.46	0.36	43.4	37.2	7.8	6.2	5.4
	100	35	-	0.30	0.25	48.8	26.4	7.8	8.5	8.5
	104	36	-	0.42	0.41	18.6	37.2	29.5	8.5	6.2
	106	38	+	0.43	0.42	50.4	36.4	7.8	3.1	2.3
	109	39	+	0.50	0.50	45.7	39.5	10.1	3.1	1.6

Table 14 continued

Scale Item Characteristics of the Final Form of the
Pupils' Perception Questionnaire

(N - 129)

Item - Category and Total Sub-Scale Correlations

Sub-Scale	Item No.		Nature of Item	Pearson Correlation with Total Subscales' Score		Students' Responses Relative Frequency Percent				
	P.S.	M.S.		T.S.S.	T.C.S.	S.A.	A.	N.S.	D.	S.D.
11										
Category I	114	40	+	0.51	0.45	33.3	39.5	10.9	7.0	9.3
	115	41	-	0.59	0.57	52.7	17.9	5.4	9.3	4.7
	118	42	+	0.39	0.33	27.9	23.3	17.8	20.9	10.1
	119	43	-	0.43	0.43	29.5	39.5	14.7	15.5	0.8
	121	44	+	0.51	0.46	42.6	27.1	8.5	7.8	14.0
	123	46	-	0.35	0.36	38.0	27.1	13.2	17.0	4.7
Category II	2	1	+	0.31	0.26	46.5	44.2	3.1	5.4	0.8
	3	2	+	0.33	0.30	45.7	43.4	7.0	3.9	-
	4	3	+	0.36	0.26	20.3	35.7	12.4	14.7	7.0
	10	4	+	0.44	0.25	20.2	26.4	26.4	14.7	17.8
	11	5	-	0.54	0.35	46.5	28.7	15.5	2.3	7.0
	12	6	-	0.34	0.32	45.7	35.7	10.9	5.4	2.3
	38	14	-	0.53	0.31	53.5	32.6	8.5	2.3	3.1
	49	19	-	0.55	0.38	62.8	23.3	8.5	2.3	3.1
	53	21	-	0.52	0.56	63.5	14.0	4.7	5.4	12.4
	122	45	-	0.44	0.51	56.6	20.9	12.4	5.4	4.7

Table 14 continued

Scale Item Characteristics of the Final Form of the
Pupils' Perception Questionnaire

(N - 129)

Item - Category and Total Sub-Scale Correlations

Sub-Scale	Item No.		Nature of Item	Pearson Correlation with Total Subscales' Score		Students' Responses Relative Frequency Percent				
	P.S.	M.S.		T.S.S.	T.C.S.	S.A.	A.	N.S.	D.	S.D.
11										
Category III	18	7	+	0.43	0.60	81.4	10.9	2.3	2.3	3.1
	19	8	+	0.41	0.40	70.5	14.7	7.0	3.1	4.7
	22	9	+	0.44	0.48	82.9	13.2	3.1	0.8	-
	26	10	-	0.29	0.34	51.9	23.3	10.9	2.3	11.6
	27	11	-	0.44	0.42	83.7	3.9	8.5	0.8	3.1
	28	37	+	0.24	0.37	49.6	24.0	10.9	5.4	10.1
	32	12	-	0.29	0.34	72.9	14.7	4.7	5.4	2.3
	33	13	-	0.32	0.31	20.2	38	15.5	4.7	11.6
	39	15	+	0.44	0.35	47.2	16.3	14.0	9.3	13.2
	43	17	-	0.36	0.35	27.1	44.2	10.9	11.6	6.2
	46	18	-	0.38	0.43	53.5	30.2	9.3	2.3	4.7
	69	24	-	0.25	0.28	32.6	31.0	11.6	12.4	12.4

where:

T.S.S. = Total sub-scale.

T.C.S. = Total Category scale.

P.S. = Pilot Study (initial stage)

M.S. = Main Study (final version)

CHAPTER VIProcedures Undertaken During the Main StudySynopsis

The first part of this Chapter covers:

- 1) Selection of Samples For the Main Study
 - a) School sample
 - b) Teacher sample
 - c) Pupil sample

The second part covers:

- 1) The Research Plan for the Main Study.
 - a) STOS training procedure
 - b) Visits paid to school
 - c) Administration of the Three Achievement Tests
 - d) The Completion of the Pupils' Perception Questionnaire

6.00 Selection of Samples for the Main Study

6.01 School Samples in the Main Study

Out of the sixty Kuwaiti secondary schools (that is thirty-one male secondary schools with a total of 3148 pupils, and twenty-nine female secondary schools with a total of 2003 pupils)¹, twelve secondary schools were randomly selected (see Map of Kuwait p.xxix) for the main stage of this study (six female secondary schools and six male secondary schools). These randomly selected schools:

1. were spread over a wide range of the Kuwaiti countryside,
2. were contiguous, to some extent, to one another so that a field schedule might be made advantageously, with travel from one school to another kept to a minimum,
3. were located in geographical areas that had almost the same socioeconomic level,
4. were a mixture of Kuwaiti pupils as well as other pupils from Africa and Asia,
5. had classes of the same size,
6. had approximately twenty-five pupils in each class, and
7. had qualified male and female principals.

6.02 Teacher Sample in the Main Study

To minimize differences between the intended observed teachers

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1. In Kuwait during the academic school year 1980-1981, there were sixty eight government secondary schools (i.e. 34 male and 34 female schools). Eight of these schools were not considered during the selection of the study sample, either because they did not have fourth-grade levels or because they were trying out a new system (semester system rather than the one year system being used in all Kuwaiti schools nowadays).

(i.e., such differences between teachers were limited to teachers' behaviour in the classroom)¹ the researcher looked for career teachers. Therefore, secondary school science supervisors from the Ministry of Education were asked to recommend some career teachers. Career teachers were defined as those who had good knowledge of the field of science under study (i.e. the fourth-grade biology, chemistry and physics) and who were at least in their fifth year of teaching the fourth grade in Kuwaiti secondary schools.

Upon the recommendations of the secondary school supervisors, thirty-six (eighteen male and eighteen female) teachers were randomly selected out of the sixty four recommended teachers from the secondary schools. The randomly-selected teachers were chosen from schools located in different parts of Kuwait.

The selected teachers were informed by the Ministry of Education about the main purpose of the study (that is, how science was being taught to pupils in Kuwaiti secondary schools and what were the pupils' perceptions of their science teachers), and about the proposed visits the researcher intended to pay to their classes. Three teachers were selected from each school, namely one biologist, one chemist and one physicist. These teachers taught the same class. Thus, one class from each school was selected to represent the sample in this project.

6.03 Pupil Sample in the Main Study

A total of 308 pupils participated in this study from the twelve randomly selected secondary schools (six male and six female schools).

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1. Since the newly constructed perception questionnaire's items were concerned with teacher's behaviour in the classroom, therefore, this direction (especially teacher's adopted styles of teaching) was felt important to be the basis that differentiated between the intended observed teachers in this study.

In Kuwait, classes within the same grade level in the same school contain pupils of approximately similar abilities. This arises because pupils in each grade are assigned to their classes at the beginning of each academic school year on the basis of their results during the previous academic year.¹ Therefore, any class in any grade level should represent the whole grade level in that school.

6.10 The Research Plan for the Main Study

Two steps were taken before starting the study of teachers and pupils undergoing observation.

1. Before using the science teaching observation schedule (STOS) for the analysis of science teaching in the selected Kuwaiti high schools the present researcher undertook training procedures to become reliable and consistent in the use of the schedule (see Appendix F, 5,6,7). Eighteen hours were spent on observing the training video tapes provided by the Schools Council. High reliabilities in the three subject areas (see Appendix F, table 1) were reached after this period of training. These reliabilities were established using the reliability trials video-tapes (see Appendix F, tables 2, 3, and 4).

- 2(a) After schools were selected, a visit was paid to each school.

Principals were met first to discuss the purpose of the study with them, and to get their permission for the observer (the present researcher) to meet the teachers who were to become involved in the main study. All female and male principals showed considerable interest in the study. Moreover, their

1. If a certain school had five classes in the present academic school year then on the basis of pupils' results in the previous academic school year, the first best five students would be divided evenly in the five classes followed by the second best students, then the third best pupils and so on.

interest in the welfare of students was shown by their willingness to permit the study to be conducted in their schools, even though it was bound to be somewhat inconvenient.

2(b) Also, all teachers were met by the observer before starting the study. This was done, because it was felt that good rapport with the teachers was essential for the success of the study.

Furthermore, an awareness of the purpose of the study and an assurance to the teachers that the gathered information concerning him/her would be kept confidential should have facilitated the study. Teachers were also given the choice as to whether or not they wished to take part in the study. This ensured that they were not forced, either by the Ministry of Education or by the school principal, into taking part. This action helped to make teachers cooperate with the researcher and carry on their teaching as though she was not present.

Indeed all the randomly-selected teachers, except one, showed their willingness to participate in the study. Therefore, the class which was taught by this particular teacher was substituted by another class.¹

All teachers who took part in this study were very helpful, cooperative, and contributed much to the study by permitting the researcher to move around during the recording of teacher-pupil or pupil-pupil classroom interactions. Moreover, these teachers showed special interest in knowing pupils' perception of their behaviour in the classroom,² as well as the results of the study.

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1. The remaining two teachers also taught the newly chosen class in addition to the third new teacher, who showed his interest in taking part in the study, participated with the other thirty-three teachers from other schools participating in this project.
 2. When the participant teachers were asked, during the first visit that was paid to them by the researcher, if they would be willing to undertake some changes in their behaviour (if they were given a full report about their pupils' perceptions of their behaviour in the classroom) to match their pupils' wishes, all of them showed willingness to accommodate the changes within the bounds of their abilities. This indicates the importance of feed back to the teachers to improve their behaviour in the classroom.

Each of the participant teachers provided the researcher with a time table of his class and agreement was reached on the timing of four visits (two practical and two theoretical lessons) during the period January - April. Moreover, the selection of the four occasions was left to the researcher to decide upon according to her time table (of the visits that she had to pay to other schools and to the topics she wished to observe, at a particular school).

2(c) A first visit was paid to each teacher during his/her instruction of the selected class (although these visits were not included within the collected data for the main study), so that both the teacher and the pupils would get used to the presence of the observer in the classroom. These visits were felt essential for the success of the study, especially in the boys' schools, since it was the first time in Kuwait that a female researcher had been allowed to get inside Government boys' schools and to sit with the pupils in the same class.

6.11 Research Procedures Used in the Main Study

Having secured a representative sample of pupils and teachers and having constructed reliable achievement tests and a Pupils' Perception Questionnaire as well as selecting an appropriate systematic classroom observation instrument (i.e., the Science Teaching Observation Schedule, discussed in Chapter IV, with a training reliability of 100%, 99%, and 98% respectively for physics, chemistry and biology, see Appendix F, tables 1,2,3, and 4), visits were paid to selected schools to collect the data necessary for the main study.

6.12 Procedures Used During Classroom Observations

Every one of the thirty six teachers and their classes (in the twelve randomly-selected schools) were visited four times at regular intervals.

The first visit was paid to each class during January 1981; the second visit was undertaken during the following February and March;¹ the third visit occurred during the March-April period; and finally, the fourth visit took place during the April-May period for all three subject areas (biology, chemistry, and physics). Hence each of the thirty-six teachers was visited on four occasions and each visit lasted for forty-five minutes (which was the duration of the lesson in Kuwaiti schools). During these visits, classroom activities were recorded by the observer using the Science Teaching Observation Schedule (see Chapter IV, p. 110).

In Kuwait, teachers have to follow a specific time table in teaching science topics to pupils who are at the same grade level; the same subject matter was, therefore, observed in most schools while it was being taught by different teachers at different schools around the same time.

6.13 Administration of the Three Achievement Tests*

The selection of an appropriate instrument for the measurement of teachers' effectiveness on pupils' outcomes is always one of the main problems encountered by any researcher dealing with classroom situations. In many educational studies, however, pupils' achievement was considered, by many educators as one of the most appropriate criteria for assessing teacher effectiveness (see: Saadeh, 1970; Power and Sadler, 1976; Stones

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1. During the second two weeks of February, all Kuwaiti Schools were closed for the Spring vacation.

* In this study, each of the achievement tests, in the three areas, was administered to pupils on two occasions as a pre-post achievement test, to assess the measurement of pupils gain in knowledge during the January-May period.

and Morris, 1972; Flanders, 1970; and Evans, 1962).^{1,2,3,4,5}

In this study, pupils' achievement was taken as the basic and most important product variable for measuring the effect of the observed process variables associated with those science teachers who taught in the observed Kuwaiti high schools.

Pupils' achievement was defined, in this research, as the gain in both knowledge and understanding required from studying biology, chemistry and physics courses (mentioned in tables of specifications - table 7,a,b, and c, pp. 149-151) during the period between January-April 1981.

6.14 Administration of the Achievement Scales as Pre-Tests

Since each randomly-selected class in this project was considered as a representative sample of the whole school, classes from different schools had to be evaluated on the basis of their existing knowledge of the subject matter they were about to study and in which they were subsequently to be examined. Therefore, a pre-test (steps taken for the construction of the new achievement tests were explained in Chapter V) was essential to collect the necessary data concerning pupils' initial level of achievement, i.e., knowledge and understanding in the three subject areas.

Pupils in the twelve selected secondary schools, were administered the three achievement pre-tests in the presence of the observer only. Pupils were given the same instructions for the three pre-tests, but with

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1. Saadeh, I.Q. 1970, op.cit.
 2. Powers, C. and Sadler, R. 1976, op.cit.
 3. Stones, E. and Morris, S. 1972, op.cit.
 4. Flanders, N.A. 1970, op.cit.
 5. Evans, K.M. 1962, op.cit.

different examples.

Instructions were as follows:

1. There are eighteen multiple-choice questions, and you have 25 minutes to complete the test.
2. For each item, select the response that best completes the statement or answers the question, and then put a tick in the opposite box, as for example (in the chemistry achievement test):

1. Lime water is a clear saturated solution of calcium

- ☐ a) oxide
- ☐ b) carbonate
- ☐ c) bicarbonate
- ☐ d) hydroxide

3. Since your score will be the number of items answered correctly, be sure to attempt all the items.

The pre-test, for each subject area, was given to the pupils (at the twelve secondary schools) on separate occasions. However, some pupils were given the pre-test at the end of December, 1980, while others were asked to complete the tests in the first week of January, 1981. This was because in certain schools pupils were going to study the intended observed subject topics during the first week of January. Therefore, these schools were given the tests in December, 1980, while those who were going to study the same topics in the second week of January, were asked to complete the achievement test one week before starting the topics.

6.15 Administration of the Achievement Scales as Post-Tests

The achievement post-tests for the three subject areas were administered to Pupils (during a two-weeks period) after the completion of the three observed courses. Some schools were given the post-tests at the end of April, 1981, while others took the tests during the first week

of May, 1981.

The observed 284 (131 female and 153 male) pupils were informed that the purpose behind the completion of these tests was to obtain the gain they achieved from studying the specified subject topics. Since pupils were asked to write down their names on the answer sheet paper, pupils were therefore, assured that their attainment results would be kept strictly confidential.

For the completion of each achievement post-test, pupils were given the following instructions:

1. In the following pages you have eighteen multiple-choice questions, and you have forty minutes¹ to complete the test.
2. For each item select the response that best completes the statement or answers the question, and then put a tick in the opposite box, as for example (in the chemistry achievement test):
 1. In the modern periodic table, the elements are arranged in order of their
 - ☐ a) relative atomic masses
 - ☐ b) atomic numbers
 - ☐ c) atomicity
 - ☐ d) reactivity.
3. Since your score will be the number of items answered correctly, be sure to attempt all the items.

-
1. In the pre-test, pupils were only given 25 minutes to complete the test, instead of the 40 minutes given to them on the post-test. The difference in the duration between the two occasions was due to the fact that:
 - a) pupils had, almost, no knowledge of most of the subject matter, if not all of them, included in the test;
 - b) the duration of 25 minutes was chosen on the basis of an initial trial of the achievement-test items using a sample of 10 fourth-grade pupils (rather than the pupils participating in the study).

6.20 The Completion of the Pupils' Perception Questionnaire

The specially developed perception questionnaire for this study was administered to the 284 pupils, in the randomly-selected twelve schools, on two occasions. The first one was in January, 1981 and the second occasion was in April 1981.

In January, pupils were asked to rate the characteristics of a "good" science teacher (as they thought of him/her) on the basis of items contained in the questionnaire. The same instructions, which were given to pupils in the pilot study (see p. 166), were also given to pupils in the main sample. This questionnaire was also given to the same pupils in April. Pupils were then asked to rate their actual¹ science teachers (i.e. biology, physics and chemistry) in relation to the questionnaire items as follows:

The following statements characterise your science teachers, please place a tick in one of the five blocks (columns) provided with each statement, to show your degree of agreement or disagreement with them (concerning each teacher separately). As for example:

biology
1. My chemistry teacher always
physics
puts his white coat on.²

S.A.	A.	N.S.	D.	S.D.
✓	---	✓	---	---
---	---	---	---	---
---	---	---	---	✓

In this study, the pupils completed the same questionnaire twice; firstly for their perception of a "good" science teacher in general and

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1. The actual teachers were the observed⁴ 36 teachers; who taught biology, chemistry and physics to the participant pupils in this study.
 2. Where S.A. = Strongly Agree
A. = Agree
N.S. = Not Sure
D. = Disagree
S.D. = Strongly Disagree

secondly, for an evaluation of their "actual" science teachers. These two measures were undertaken because the researcher believed that it was necessary, in the first place, to know what constituted a "good" teacher in the pupils' eyes and to be able to compare their views with those of the observed science teachers themselves and science supervisors,¹ (who were asked to respond to the same perception questionnaire). On the other hand, the second administration of the perception questionnaire to the participant pupils (for a measure of their perception of their actual science teachers),² allowed an investigation into the degree of similarity between pupils' views of their own teachers and those of supervisors of the same observed science teachers.³ Furthermore, pupils' evaluation of their "actual" teachers were correlated later on in further statistical analyses with pupils' intellectual achievement in the observed areas.

The Pupils' Perception Questionnaire on the first occasion (i.e. to measure the perception of the "good" science teacher in general) was administered to pupils by the researcher with the help of a secondary school social adviser. On the second occasion, however, the same Perception Questionnaire was administered to the participant pupils by the observer only, in the absence of all other teachers. This precaution was taken to ensure that teachers would not see the completed questionnaire

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1. Science supervisors are members from the Ministry of Education in Kuwait, who participated in the development of the Science Curriculum for schools in Kuwait. These supervisors are also the ones who pay visits to schools during each academic year to evaluate teachers.
 2. These supervisors were the ones who observed the thirty-six science teachers (during the academic year 1980-1981) and who participated in this study.
 3. Supervisors were also asked to evaluate the observed science teachers on the basis of the newly-developed questionnaire items.

sheets (since pupils were asked to write their names). Also it was hoped that such a procedure would give sufficient confidence to pupils to allow them to complete the questionnaire as carefully and honestly as possible.

CHAPTER VIIData Analyses And ResultsSynopsisThe First Part of This Chapter Covers:

- I. Description, Results, and Analyses of Science Teaching Data.
 - a) Presentation of the classroom observation data,
 - b) Relative frequency of the occurrence of the STOS teaching behaviour between both the three science subject areas and the two sexes.
 - c) Teacher-dominated/pupil-initiated transactions.
 - d) A typology of science teaching styles.
 - e) Main characteristics of the two groups of science teachers in Kuwaiti high schools.

The Second Part Covers:

- I. Analyses of Pupils' Achievement in Biology, Chemistry and Physics.
 - a) Measuring pupils' gain in knowledge and understanding during the observational period in biology, chemistry, and physics.
 - b) Measuring the significance of the difference between the achievement of girls and boys in biology, chemistry and physics.
 - c) Measuring the significance of the difference between the achievement of 'group one' and 'group two' pupils in biology, chemistry, and physics.

The Third Part Covers:Section 1

- I. Analyses of Pupils', Teachers', and Supervisors' Responses as to what Constitutes a 'Good' Science Teacher.
 - a) Items that were rated by pupils supervisors, and teachers, as the most and least important of the characteristics of a 'good' science teacher.
 - b) Items that were rated by male and female pupils as the most and least important of the characteristics of a 'good' science teacher.

- c) Items that were rated by male and female teachers as the most and least important of the characteristics of a 'good' science teacher.
- II. Rank Order Correlation Coefficient Analyses Between Groups for Each of the Three Types of Teacher Characteristics.
 - a) On the basis of type-one characteristics, i.e. teachers' classroom behaviour.
 - b) On the basis of type-two characteristics, i.e., teachers' personality.
 - c) On the basis of type-three characteristics, i.e., teachers' attitude.
- III. Measuring the Significance of Differences between Pupils', Teachers', and Supervisors' Responses to what Constitutes a 'Good' Science Teacher.
 - a) Items that pupils rated as most or least important qualities of a 'good' science teacher but which did not coincide with the supervisors' and teachers' ratings.
 - b) Items representing the disagreement between the ratings of male and female pupils as to the characteristics of a 'good' science teacher.
 - c) Items representing the disagreement between the ratings of male and female teachers as to the characteristics of a 'good' science teacher.

Section 2

- I. The Degree of Agreement Between the Perception of Pupils' and Science Supervisors' as to the Characteristics of the Observed Biology, Chemistry, and Physics Teachers.

The Fourth Part Covers

- I. Assessing the Effect that the Sex of Pupils/Teachers has on Pupils' Perceptions of the Characteristics of their Biology, Chemistry and Physics Teachers.

The Fifth Part Covers:

- I. Prediction of Pupils' Achievement in Biology, Chemistry, and Physics from both Pupils-Teachers Classroom Variables and the Perceived Teacher's Characteristics.

- a) Justification for the selection of the dependent and the independent variables.
- 1) Relationships between the predicted variable and each of the eight classroom predictors.
 - i) The correlation coefficients measuring the relationships between biology achievement, of girls and boys, and the eight independent variables.
 - ii) The correlation coefficients measuring the relationships between Chemistry achievement, of girls and boys, and the eight independent variables.
 - iii) The correlation coefficients measuring the relationships between physics achievement, of girls and boys, and the eight independent variables.
- 2) The relative contribution of the various measures of independent variables to the variance of pupils' achievement.
 - i) Justification for the use of the stepwise-multiple regression analysis.
 - ii) Questions posed for the prediction of the achievement of boys and girls in Kuwaiti high schools.
 - iii) Statement of hypotheses.
 - iv) The inclusion of the predictor variables in the multiple regression equation by the SPSS subprogram.
 - a) Significant predictor variables associated with girls' and boys' biology achievement.
 - b) Significant predictor variables associated with girls' and boys' chemistry achievement.
 - c) Significant predictor variables associated with girls' and boys' physics achievement.

Part 17.00 Description, Results, and Analysis of Science Teaching Data7.10 Introduction

It was during this stage of the research that a good deal of useful information was learned from the collected quantitative data which became available from direct classroom observation of the teaching processes. In Kuwait, science teachers were seldom systematically observed. Therefore a description of science-teaching processes would be worthwhile, not only for the purpose of this present research, but would also be of general benefit to science educators in Kuwait in encouraging the observation of science teaching in that country.

Furthermore, a typology of science-teaching methods used in Kuwaiti high schools was also established, so that further analyses could be made on these types later on in this study.

7.11 Presentation of The Classroom Observation Data

In this project, by using the Science Teaching Observation Schedule (see Chapter IV), thirty-six teachers (6 males and 6 females within each science area) were observed for a total of 108 hours with each teacher thereby being observed for a total of three hours during four equal periods of 45 minutes each. A histogram was drawn for each of the twenty-three categories within each science subject area (see figures 3-25), from the process data obtained from these observations. These histograms represent the variance among teachers in the use of each of the twenty-three categories. Furthermore, teachers of each subject area were compared with each other (see table 16) according to the frequency of use of each of the five minor areas (i.e., categories 1a, 1b, 1c, 1d, and 1e), of the STOS by using the Mann-Whitney-U-Test. The Mann-Whitney-U-Test was adopted in this study because it is considered as one of the most powerful (Tate, 1965)¹ and

1. Tate, W.H. 1965, op.cit.

commonly used (Ferguson, 1981)¹ non-parametric test (Tuckman, 1978)² for comparing the differences among independent small samples. The Mann-Whitney-U-Test is then a technique used in this study for testing the presence of a significant difference between the distribution of the two populations from which the two samples were drawn. The significance of the difference between the two compared samples was calculated as follows:

$$U_1 = N_1 N_2 + \frac{N_1(N_1 + 1)}{2} - R_1 \quad (3)$$

or

$$\bar{U}_2 = N_1 N_2 + \frac{N_2(N_2 + 1)}{2} - R_2$$

where:

N_1 = number of teachers in the first sample;

N_2 = number of teachers in the second sample;

R_1 = sum of the ranks assigned to sample whose size is N_1 ; and

R_2 = sum of the ranks assigned to sample whose size is N_2 .

As for example, from the data available in table 15 below, the difference among the two independent groups (i.e., group I and group II which emerged from other analyses carried out in this chapter), representing the main two methods of science teaching in Kuwaiti high schools (see pp.257 -260)

1. Ferguson, G.A. 1981, op.cit.
2. Tuckman, W.B. 1978, op.cit.
3. Siegel, S. 1956, op.cit. (p.120).

was calculated as follow:

$$U^- = (18)(18) + \frac{18(19)}{2} - 295 \quad (\text{for group one})$$

$$U^- = 200$$

or

$$U^- = (18)(18) + \frac{18(19)}{2} - 371 \quad (\text{for group two})$$

$$U^- = 124$$

$$\text{then } U_1 = N_1 N_2 - U^-$$

for group one

$$U_1 = 324 - 200 = 124 \quad (\text{not significant})$$

for group two

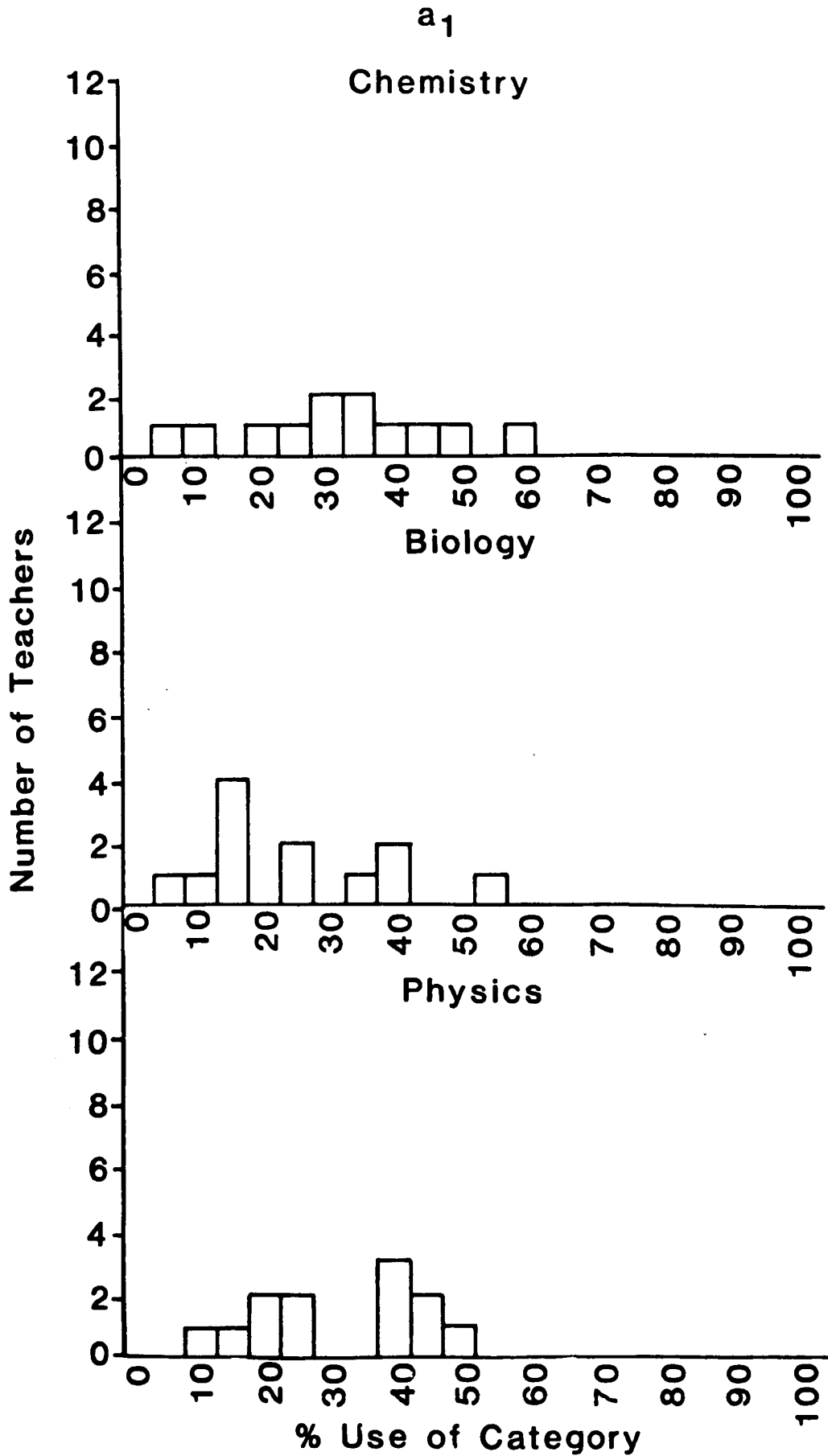
$$U_2 = 324 - 124 = 200 \quad (\text{not significant})$$

Table 15

Statistical Summary of the Data Used for the Computation of the
Mann-Whitney-U-Test for Category "a₁"

Number of Group One Teachers	Frequency of Group One	Rank of Frequencies	Number of Group Two Teachers	Frequency of Group Two	Rank of Group Two
1	3	2.0	1	3	1.0
2	6	4.5	2	5	2.0
3	6	4.5	3	7	7.0
4	7	7.0	4	10	11.0
5	7	7.0	5	12	12.5
6	8	9.5	6	14	15.0
7	8	9.5	7	14	15.0
8	12	12.5	8	16	19.5
9	14	15.0	9	19	21.5
10	15	17.5	10	20	23.0
11	15	17.5	11	22	24.5
12	16	19.5	12	24	28.0
13	19	21.5	13	24	28.0
14	22	24.5	14	25	30.5
15	23	26.0	15	25	30.5
16	24	28.0	16	26	32.0
17	30	34.0	17	28	33.0
18	32	35	18	36	36.0
$N_1 = 18$		$R_1 = 295$	$N_2 = 18$		$R_2 = 371$

Using a two-tailed test, with $N_1 = 18$, $N_2 = 18$, if the value of U equals 99 or less, the difference between the frequency of use of any category made by the two groups of teachers will be significant at 0.05.

Fig-3**Recalling facts and principles**

7.12 Relative Frequency of the occurrence of the STOS Teaching Behaviour
Between Both the Three Science Subject Areas and the Two Sexes

TEACHER TALK

1a - Teacher Asks Questions (or Invites Comments) (^a₁ - ^a₇) Which are
Answered by:

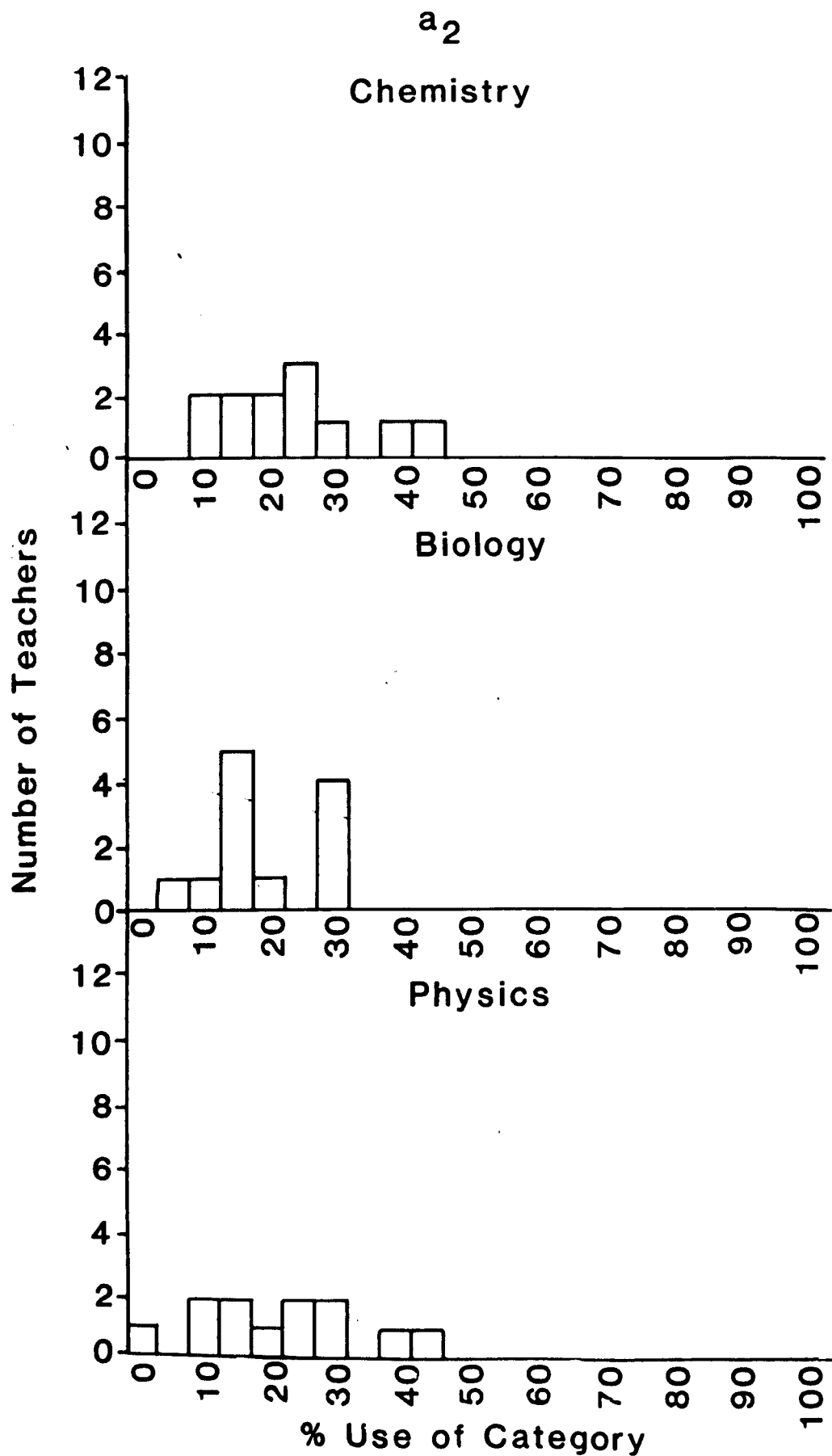
a₁ - Recalling facts and principles

A large variation was found between the frequency of use of a₁ category made by different teachers (see figure 3). For example, a range of 5% - 60% was found for the percentages of, time sampling units made use of for this category by chemistry teachers. The data also showed that no teacher failed to use this category.

As a whole, the mean percentages of use of "a₁" type behaviour for chemistry, physics and biology were 31%, 29% and 22% of time-sampling units respectively. These percentages, however, did not show any significant differences between the degree of use made of this category by the three types of science teachers (i.e., chemistry/physics, $U = 69$, N.S.; physics/biology, $U = 48.5$, N.S.; and biology/chemistry, $U = 51.5$, N.S.). Moreover, when male teachers were compared with female teachers, in each of the three science areas, on the basis of this specific teaching behaviour, it was found that female chemistry and biology teachers asked significantly more often these types of questions than did their male colleagues ($U = 7.0$, $p < 0.05$; $U = 7.0$, $p < 0.5$ respectively). No significant difference, however, was noticed between the male and female physics teachers regarding the frequency of use of this teaching behaviour.

Fig-4

Application of facts and principles to problem solving



a_2 - Applying facts and principles to problem solving

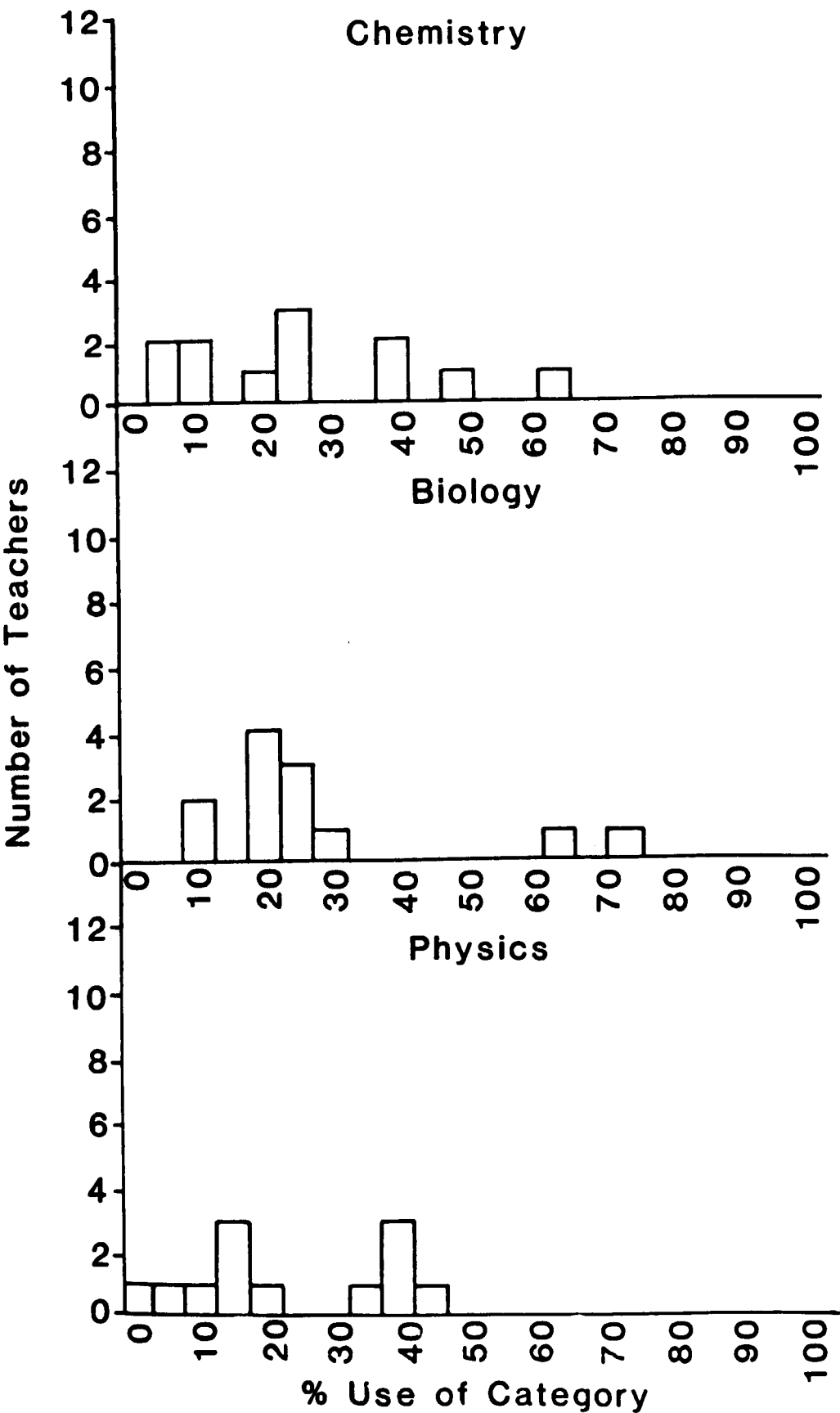
This category, where a definite answer is required as a solution to a problem, was one of the most significant categories that differentiated between the different groups of teachers emerging from later statistical analyses (discussed later in this chapter). The mean incidences of use made of this category, by the teachers of the three subject areas were 21%, 20% and 17% for chemistry, physics and biology respectively of time-sampling units (see figure 4). Moreover, a range of between 0% and 45% of the time-sampling units was computed as demonstrating " a_2 " category of behaviour, which indicated a large variation of use of this particular teaching behaviour by different teachers. It was also found that one particular physics teacher failed to use this type of behaviour.

Furthermore, no significant differences were recorded, as to the frequency of use of this teaching behaviour, between teachers of the different science areas (biology/chemistry, $U = 59$, N.S.; chemistry/physics, $U = 68.5$, N.S.; and physics/biology, $U=61$, N.S.). The mean percentage of use of " a_2 " made by the observed female teachers, was found to be significantly greater than that of the observed male colleagues in biology ($U = 6$, $p < 0.05$). On the other hand, no significant differences were found between the observed female and male teachers belonging to either chemistry ($U = 16.5$, N.S.) or physics ($U = 15$, N.S.) areas in relation to the degree of use made of " a_2 " questions.

Fig-5

Making hypotheses or speculations

a_3



a_3 - Making hypotheses or speculations

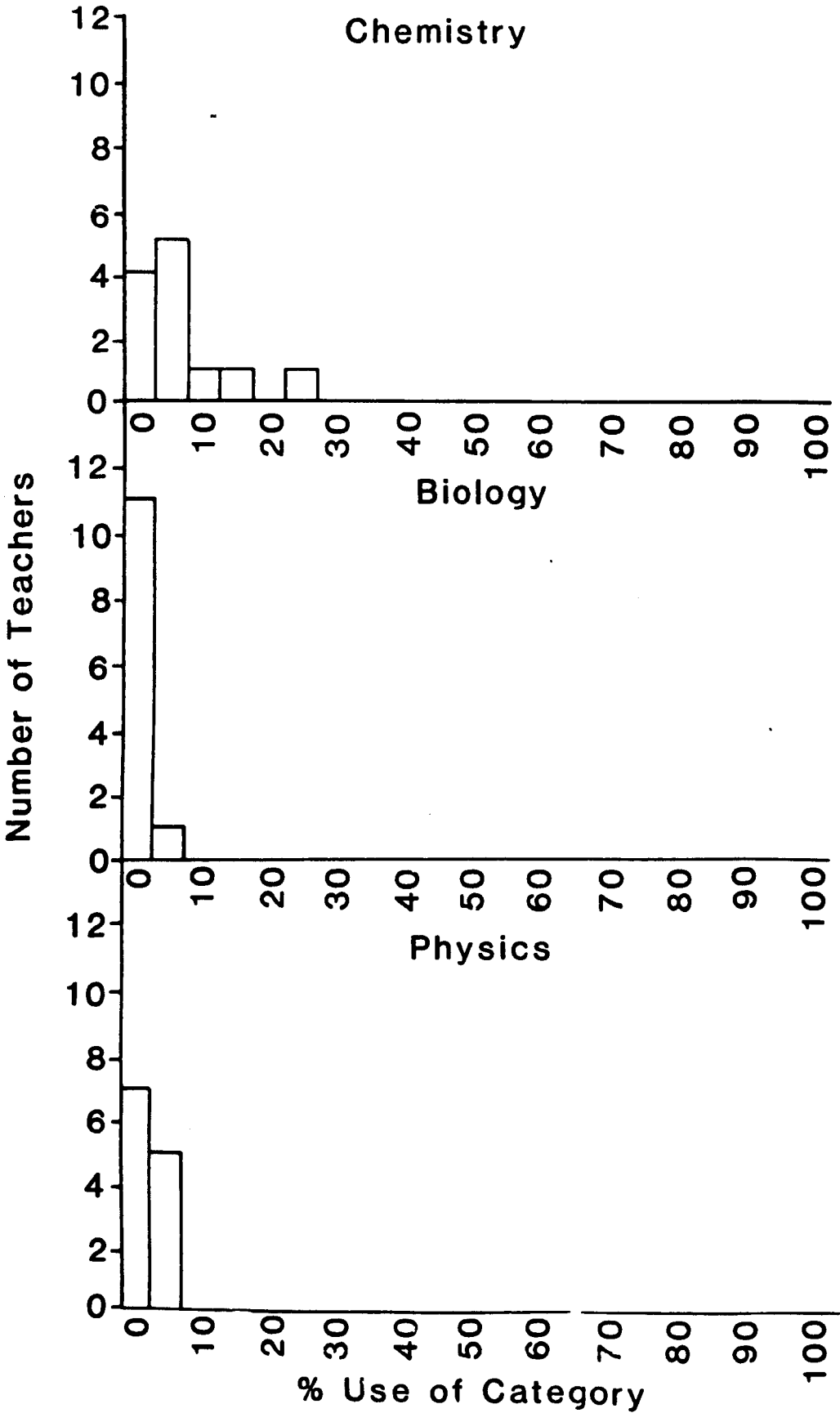
This category was also one of the most significant categories that differentiated between the two main styles of science teaching emerging from this study (see table 17b, p. 257). The mean percentages of use of this kind of question made by the chemistry, physics and biology teachers were 24%, 22% and 27% respectively, of time-sampling units. Hence no significant differences in this style of behaviour were found between either the observed chemistry and biology ($U = 71$, N.S.) teachers; chemistry and physics ($U = 62$, N.S.) teachers. Moreover, in all three areas no significant differences were found between the frequencies of use of this behaviour made by female teachers and that of the observed male teachers (i.e. biology, $U = 12$, N.S.; chemistry, $U = 16$, N.S.; and physics, $U = 17$, N.S.).

Furthermore, the use of this category (i.e., " a_3 ") had the greatest variation between individual teachers (see figure 5). Thus, while one physics teacher failed completely to make use of this teaching behaviour, such behaviour was made use of by a biology teacher to the extent of about 75% of the time-sampling units.

Fig-6

Designing of experimental procedure

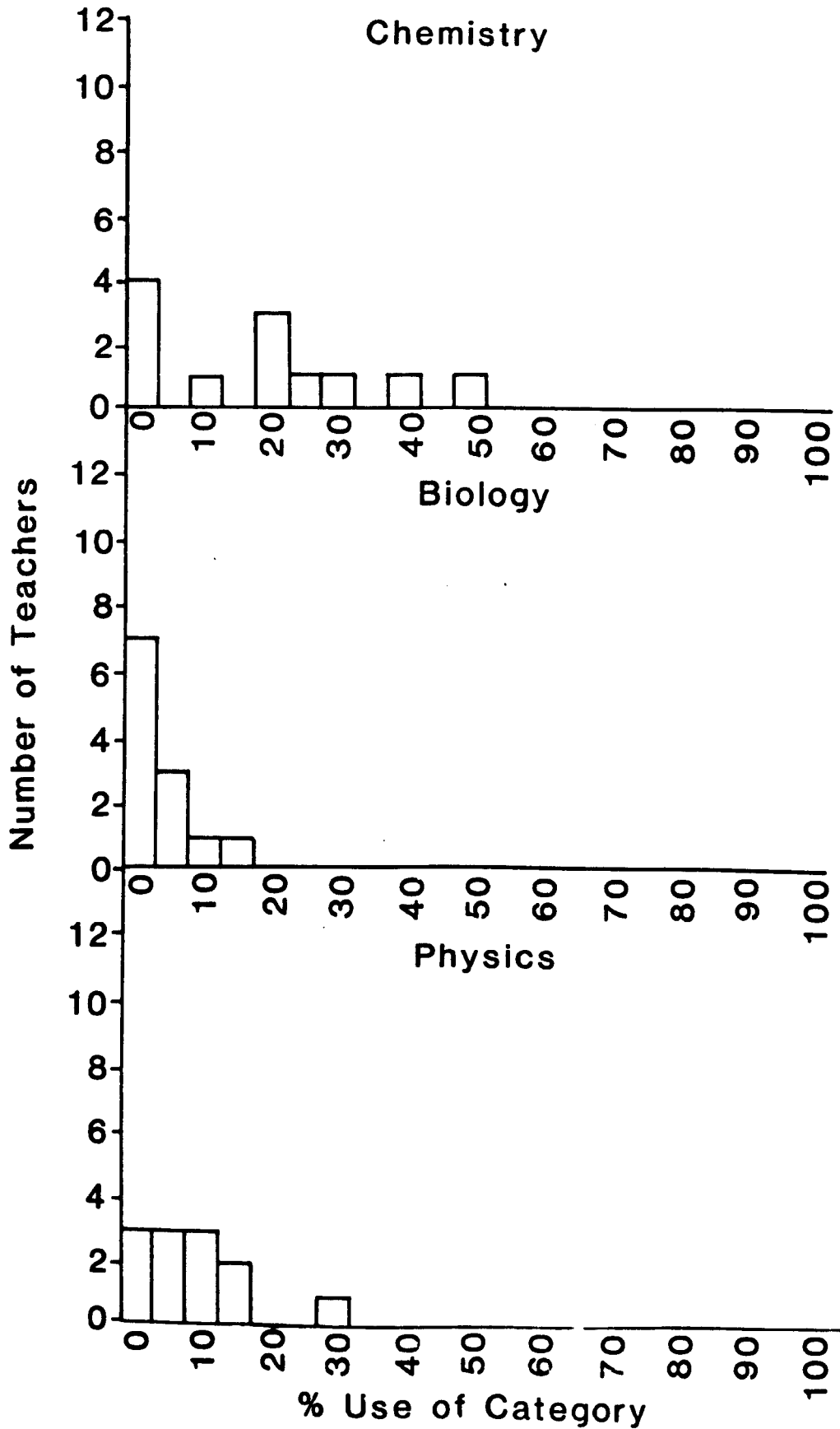
a 4



a_4 - Designing of experimental procedure

Pupils in the observed Kuwaiti high schools were rarely asked by their science teachers to design experiments. This could be seen by the relatively low mean percentages of use of this category, namely 0.4%, 5% and 1% of time-sampling units for biology, chemistry and physics respectively. The recorded frequencies, as to the use made of this behaviour by the observed teachers, however, showed that chemistry teachers made significantly more frequent use of this teaching behaviour than their biology colleagues ($U = 30.5$, $p < 0.05$). On the other hand, no significant differences were found either between chemistry and physics ($U = 38.5$, N.S.) teachers or between physics and biology ($U = 50.5$, N.S.) teachers as to the frequency of use of this behaviour.

From classroom observations it was also recognized that twenty-two science teachers (that is almost 60%) out of the thirty-six observed teachers in Kuwaiti high schools did not ask their pupils to design any experiment (see figure 6). From the data of the other fourteen teachers who used the " a_4 " category, however, the maximum use was no more than 25% of the time-sampling units. This maximum use was recorded for one chemistry teacher. Moreover, no significant differences were found between the frequencies of use of " a_4 " made by either the observed biology ($U = 15$, N.S.), physics ($U = 15.5$, N.S.) or chemistry ($U = 13$, N.S.) female teachers and that of their male colleagues who taught the same science topics.

Fig-7**Direct observation****a₅**

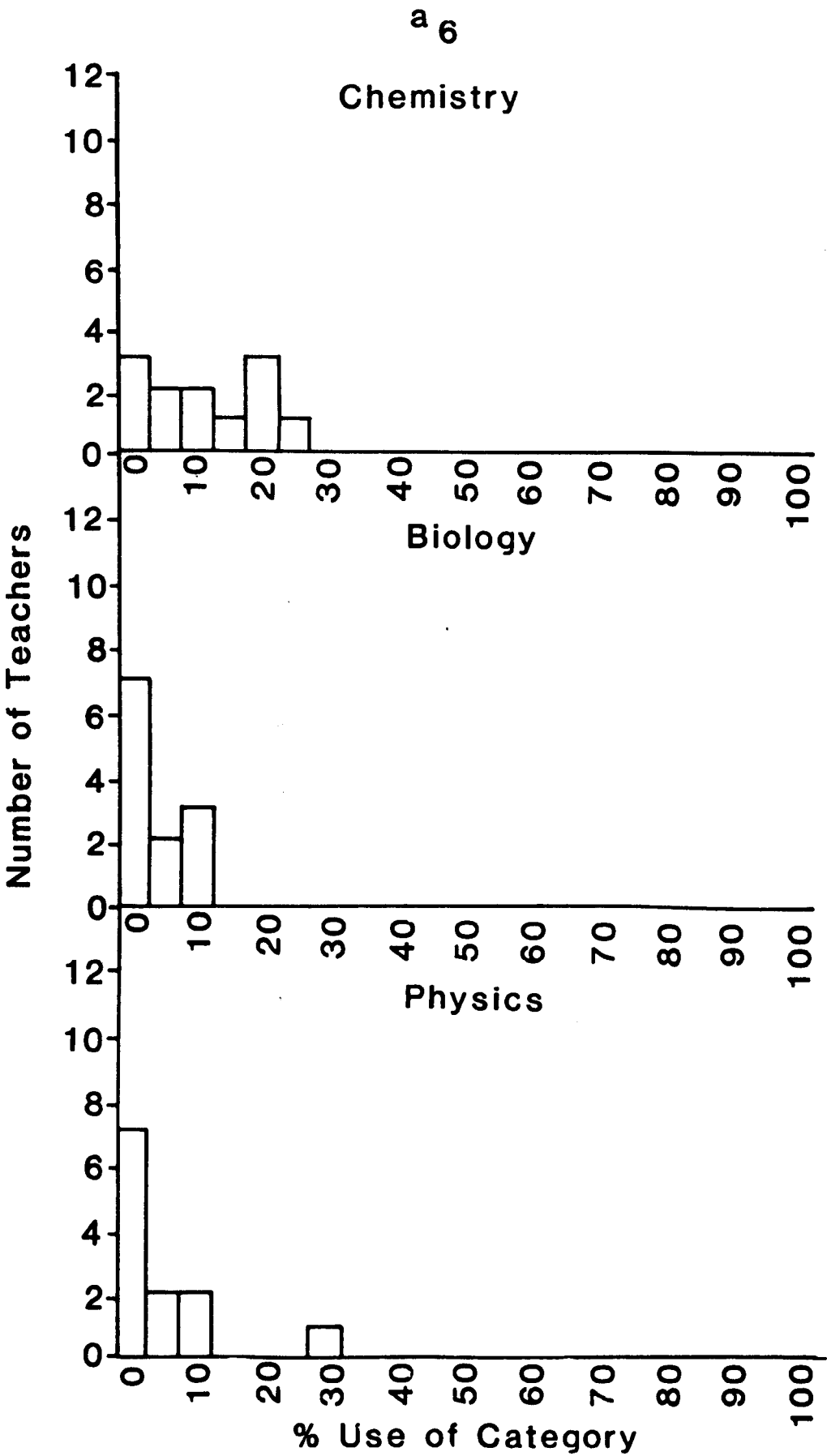
a_5 - Direct observation

The mean percentages of time-sampling units for the use of "direct-observation questions" made by teachers in the three subject areas were observed to be 2%, 17% and 7%, for biology, chemistry and physics respectively. The recorded frequencies of use, in relation to " a_5 " type questions, however, showed that chemistry teachers made significantly more use of this behaviour than their biology colleagues ($U = 34$, $p < 0.05$). On the other hand, no significant differences were found between either chemistry and physics ($U = 51$, N.S.) teachers or between physics and biology ($U = 40.5$, N.S.) teachers in the frequency of use made of this behaviour. When the observed female science teachers were compared with their male colleagues, in the three science areas, no significant differences in the degree of use of such questions were recorded (biology, $U = 17$, N.S.; physics, $U = 17.5$, N.S.; and chemistry, $U = 16.5$, N.S.).

When individual teachers were compared on the basis of their use of this type of question (see figure 7), it was found that fourteen teachers out of the thirty-six observed teachers, (i.e., 39%) failed to ask their pupils such questions, and that the highest percentage of use, (namely, 47% of the time-sampling units), was made by one chemistry teacher.

Fig-8

Interpretation of observed or recorded data

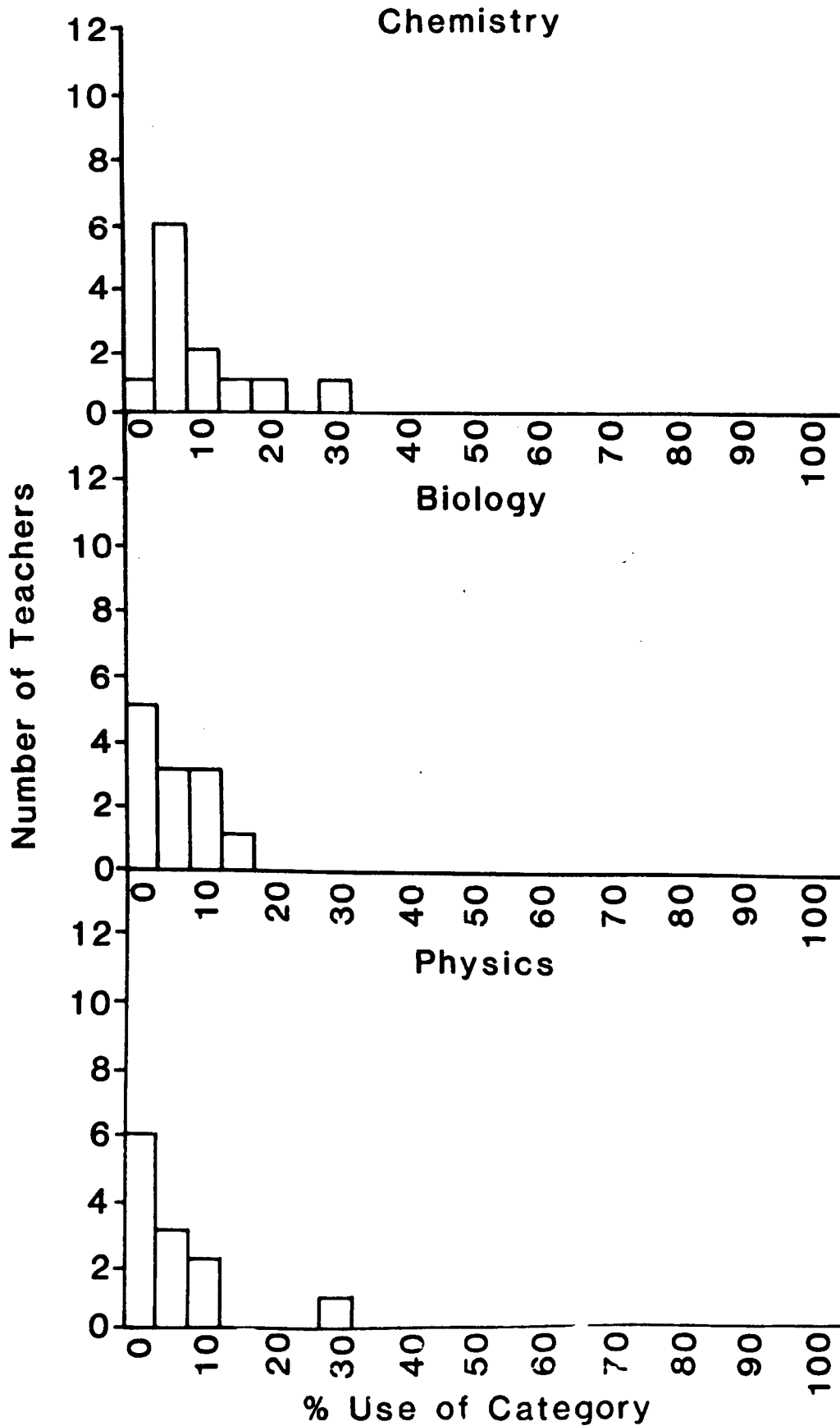


a_6 - Interpretation of observed or recorded data

The collected data indicated that the " a_6 " category was one of the least likely occurring behaviours within all three subject areas. Seventeen teachers out of the thirty-six observed teachers (i.e. 47%) failed to use this kind of question (see figure 8). The mean percentages of use of " a_6 " category made by the observed science teachers were 3%, 10% and 4% of the time-sampling units, for biology, chemistry and physics teachers respectively. The frequencies of use, made by the teachers of the three sciences, indicated that chemistry teachers, in Kuwaiti high schools, used questions which had to be answered by interpretation of observed and recorded data far more often than biology teachers ($U = 35$, $p < 0.05$). However, no such significant differences were recorded either between chemistry and physics ($U = 42$, N.S.) or between physics and biology ($U = 70$, N.S.) teachers. Moreover, when the observed female science teachers of all the three subject areas were compared with their male colleagues as to the extent they made use of " a_6 " type teaching behaviour, no significant differences were recorded between male and female teachers in either biology ($U = 17$, N.S.), chemistry ($U = 16.5$, N.S.), or physics ($U = 16.5$, N.S.) lessons.

Making inferences from observations or data

a₇

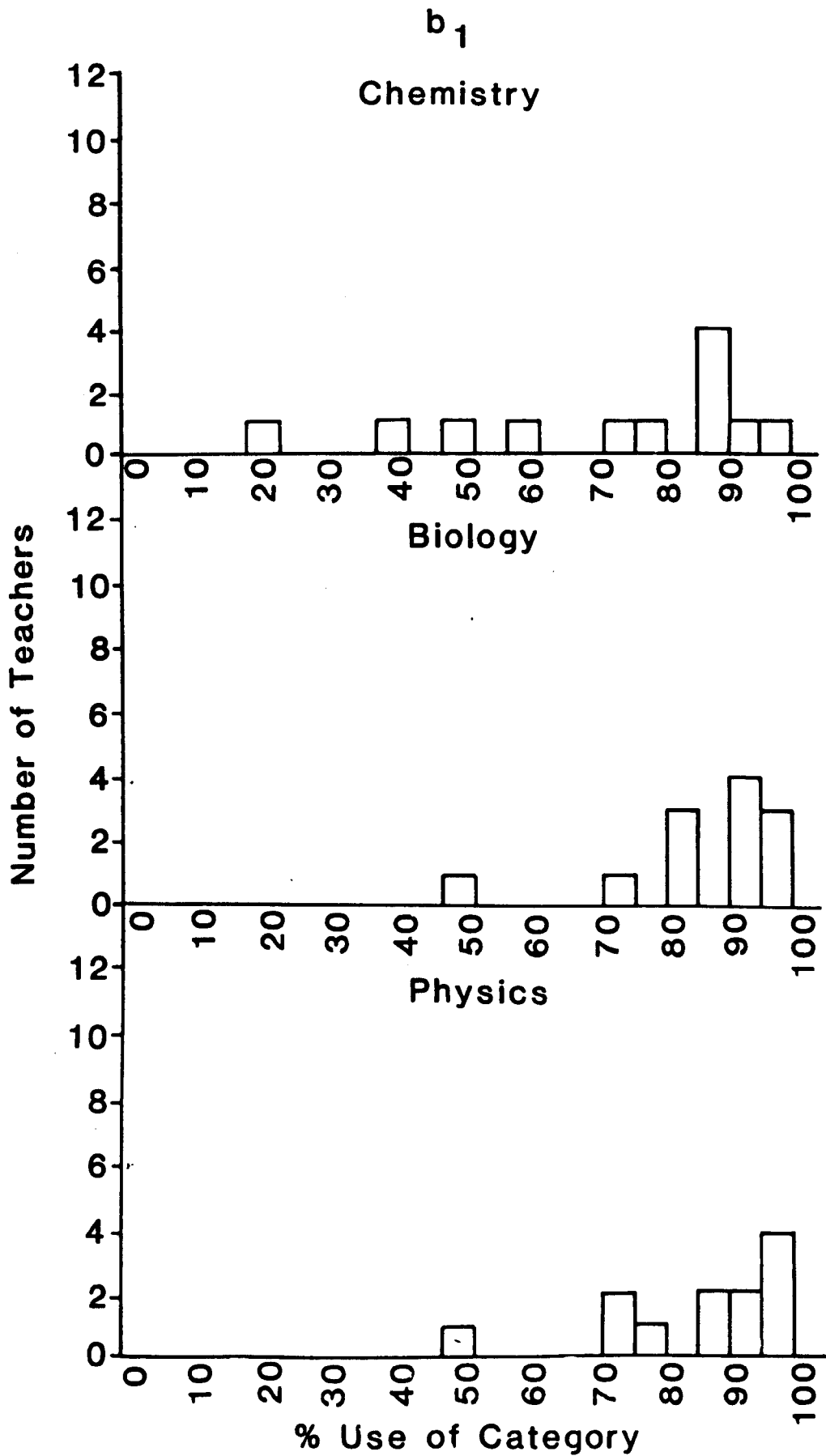


a_7 - Making inferences from observations of recorded data

The observed data covering the " a_7 " category of teaching behaviour indicated mean occurrences of this type of question in 4%, 9% and 5% of the time-sampling units for biology, chemistry and physics respectively. The same data, however, indicated that chemistry teachers made significantly more use of this category than their physics colleagues ($U = 35.5$, $p < 0.05$). Moreover, no significant differences were found, in relation to the use of this teaching behaviour, either between biology and chemistry teachers ($U = 42$, N.S.) or between physics and biology teachers ($U = 63.5$, N.S.). When male teachers within the three disciplines were compared with their female colleagues (on the basis of their use of " a_7 " type questions), it was found that all the observed teachers (i.e., males and females) made almost the same degree of use of such questions (i.e., biology, $U = 17$, N.S.; physics, $U = 17.5$, N.S.; and chemistry, $U = 14$, N.S.). It was also noticed that twelve teachers, namely, one in chemistry, five in biology and six in physics out of a total of thirty-six observed teachers, failed to use this category at all (see figure 9).

Fig-10

Teacher makes statements of facts and principles



1b - Teacher Makes Statements ($b_1 - b_4$) of:

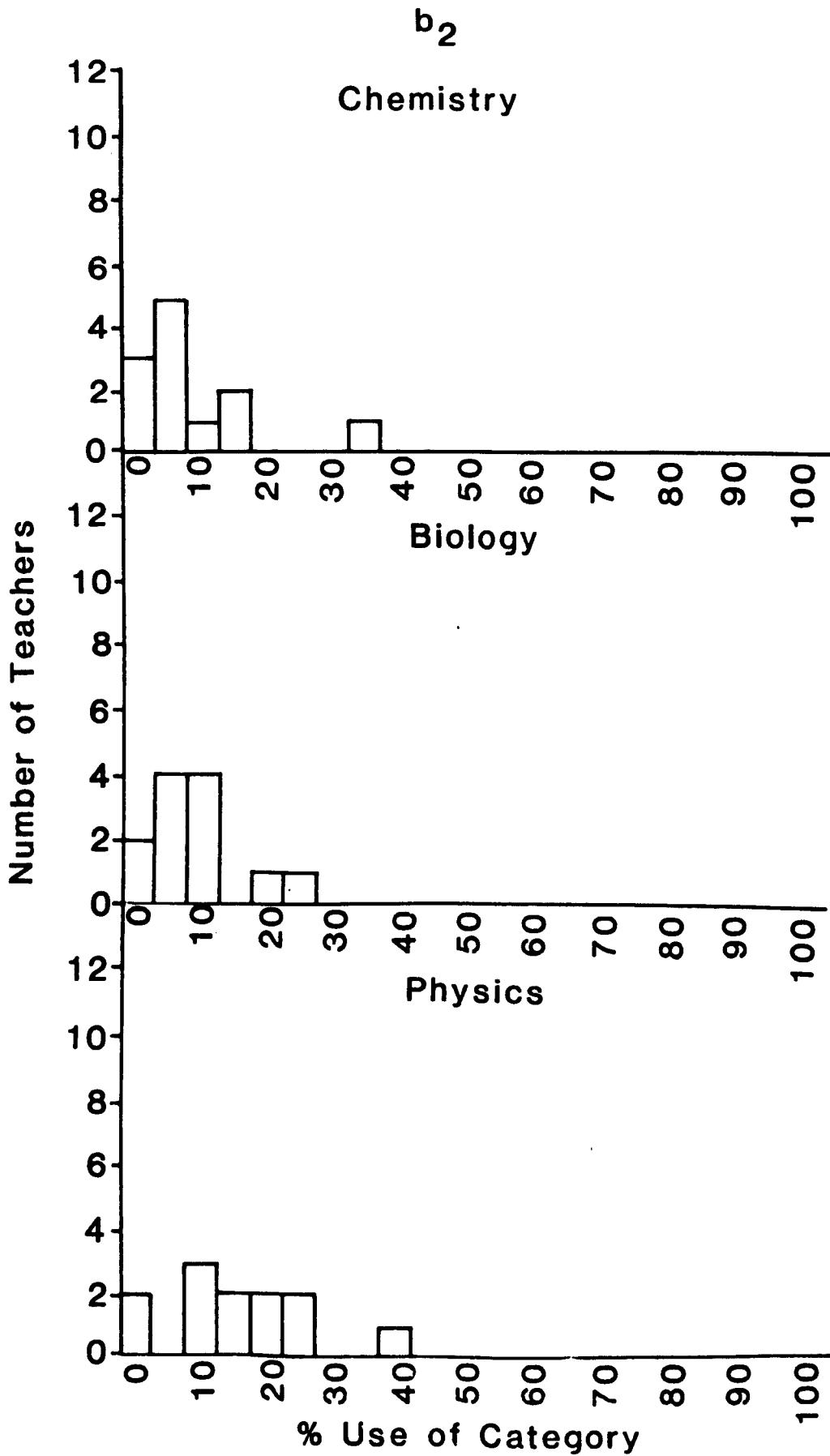
b_1 - Facts and principles

"Statements of facts and principles" category was one of the most significant categories that differentiated between the two groups of teachers which emerged, as a result of their adopted styles of teaching, from subsequent statistical analysis (see table 17b and figure 26). These kinds of statements were used very often by teachers from all three disciplines. This result arose from the mean percentages of use, obtained for each set of discipline teachers, which were 88%, 71% and 87% of the time-sampling units for biology, chemistry and physics, respectively. The mean frequencies of use in relation to " b_1 " type teaching behaviour showed no significant differences between the teachers of the three science areas (i.e., biology/chemistry, $U = 40.5$, N.S.; chemistry/physics, $U = 40.5$, N.S.; and physics/biology, $U = 70.5$, N.S.). Moreover, no significant differences were recorded between male and female teachers in the three science areas (i.e., physics, $U = 15.5$, N.S.; biology, $U = 9$, N.S.; and chemistry, $U = 17.5$, N.S.).

Considerable variations between individual chemistry teachers were noticeable (see figure 10), but such variations, were not apparent with biology and physics teachers. In other words, the frequency of use of " b_1 " statements, made by the observed chemistry teachers, ranged from less than 20% up to 100% of the time-sampling units. However, the lowest frequency of " b_1 " statements was made by a biology and by a physics teacher ranging from 45% to 50% of the time-sampling units.

Fig-11

Teacher makes statements of problems



b_2 - Of problems

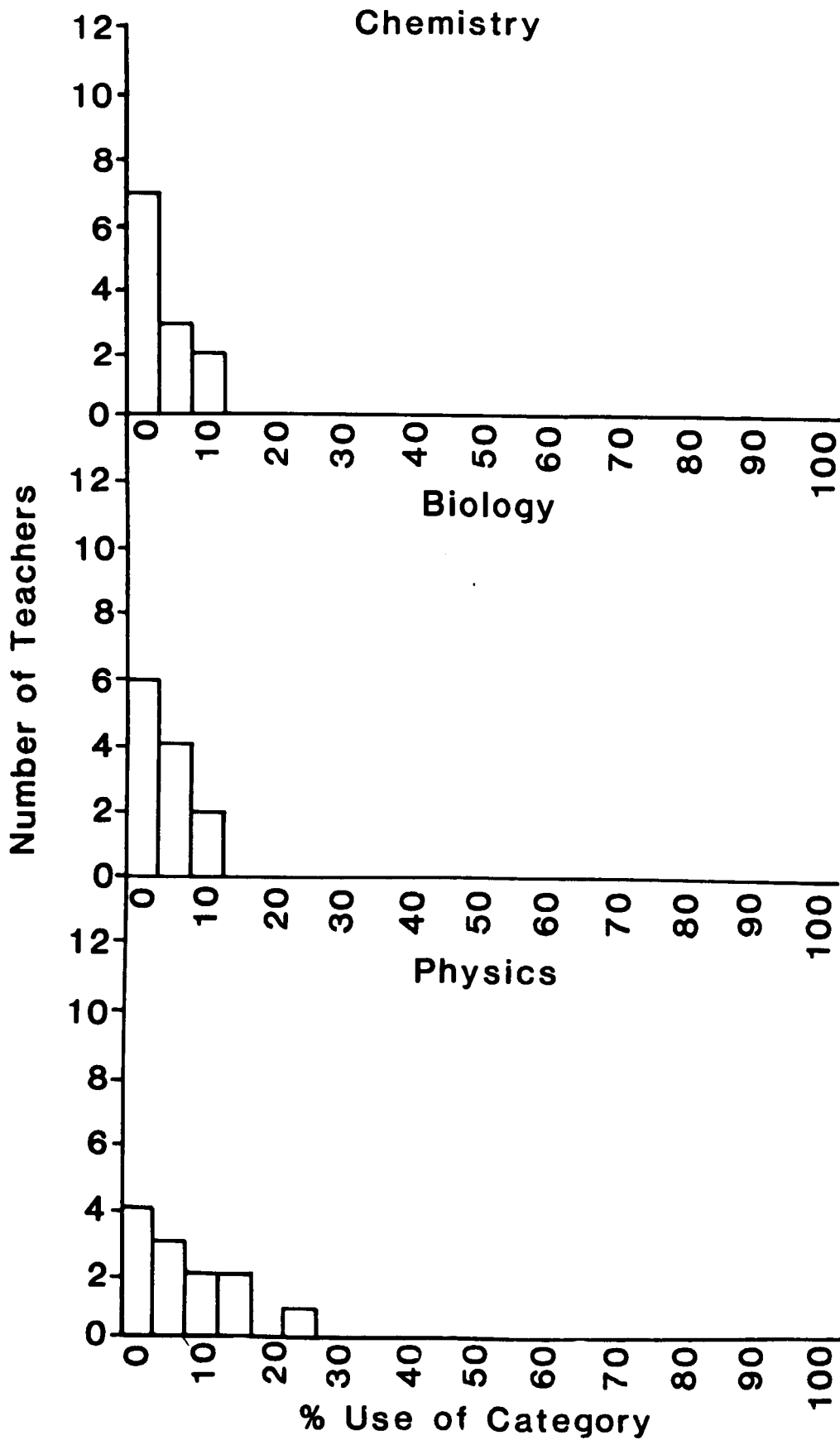
Again the " b_2 " category was one of the most significant categories differentiating between the two main cognitive styles of science teaching arising from subsequent analyses (see table 17b, figure 26). The mean percentages of use of " b_2 " type statements were 8%, 7%, and 14% of the time-sampling units for biology, chemistry and physics teachers respectively. No significant differences, however, were found between the teachers of the three separate science areas in relation to the mean frequency of use they made of this teaching behaviour (i.e., biology/chemistry, $U = 65$, N.S.; chemistry/physics, $U = 42$, N.S.; and physics/biology, $U = 43$, N.S.). Moreover, male and female teachers within each science discipline, when compared with each other, were also found to make similar use of the " b_2 " type statements (i.e., physics, $U = 16.5$, N.S.; biology, $U = 13$, N.S.; and chemistry, $U = 12$, N.S.).

During the observation periods, it was found that seven teachers (i.e. 19%) failed to use such statements, namely, three in chemistry, two in biology, and two in physics (see figure 11) classes.

Fig-12

Teacher makes statements of hypothesis or speculation

b_3



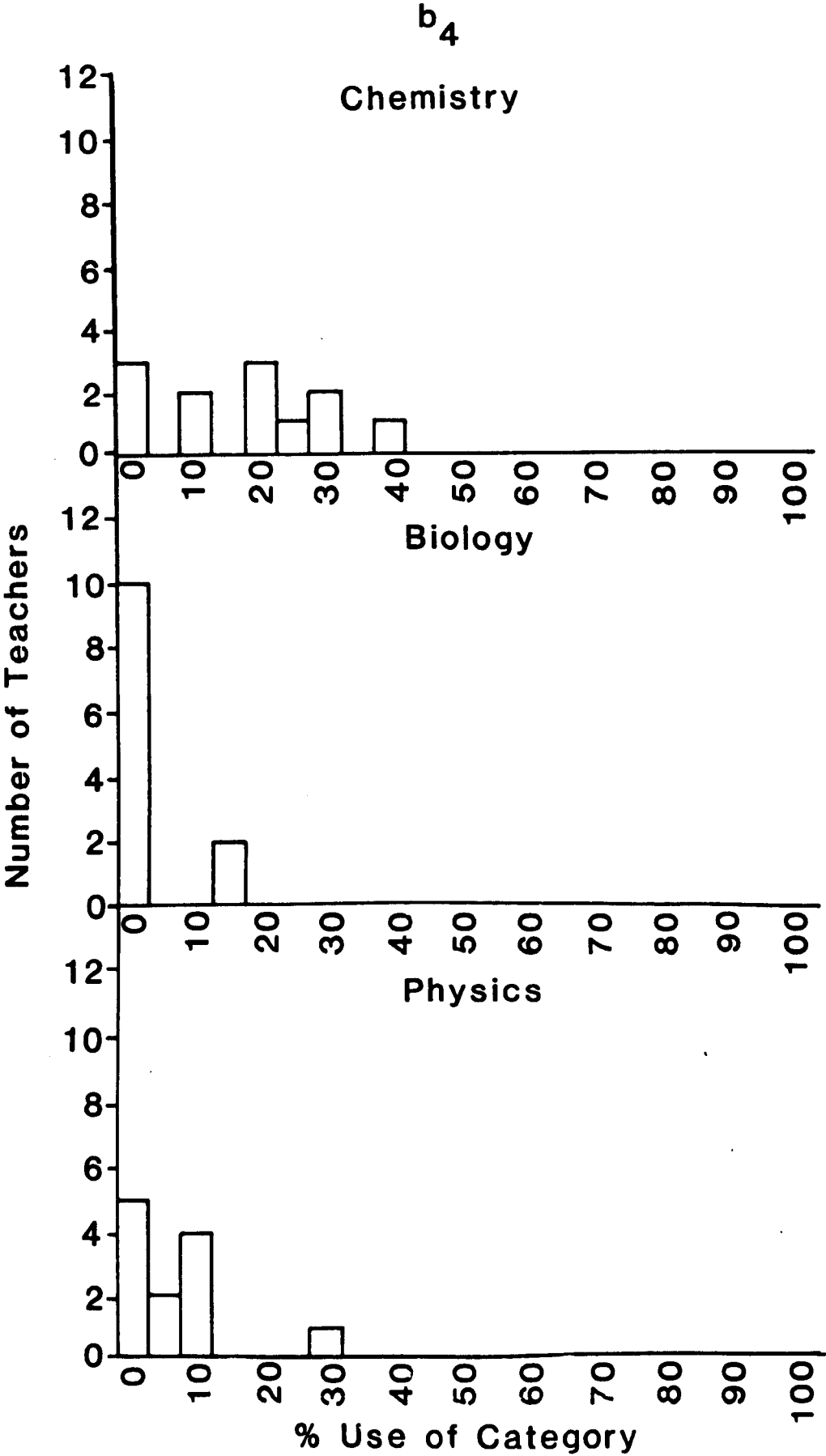
b_3 - Of hypothesis or speculations

Teachers from all three science disciplines made little use of statements of hypothesis and speculations. The mean frequency of use of " b_3 " teaching behaviour did not exceed 7% of time-sampling units. In other words, the mean frequency of use of " b_3 " category was 3%, 2% and 7% of the time-sampling units for biology, chemistry and physics respectively. The mean frequency of use of " b_3 " type statements, made by the observed science teachers, did not show any significant differences either between biology and chemistry teachers ($U = 64$, N.S.); chemistry and physics teachers ($U = 43$, N.S.); or between physics and biology teachers ($U = 48.5$, N.S.). Similarly, when male and female teachers, within each science discipline, were compared with each other the results of the analyses showed that male and female teachers of each discipline made almost the same frequency of use of " b_3 " type statements (i.e., physics, $U = 15.5$, N.S.; biology, $U = 15.5$, N.S.; and chemistry, $U = 16.5$, N.S.).

In this present study, however, it was found that seventeen teachers (i.e. 47%) including seven chemistry, six biology, and four physics failed to make any statements related to hypotheses or speculations (see figure 12).

Fig-13

Teacher makes statements of experimental procedure



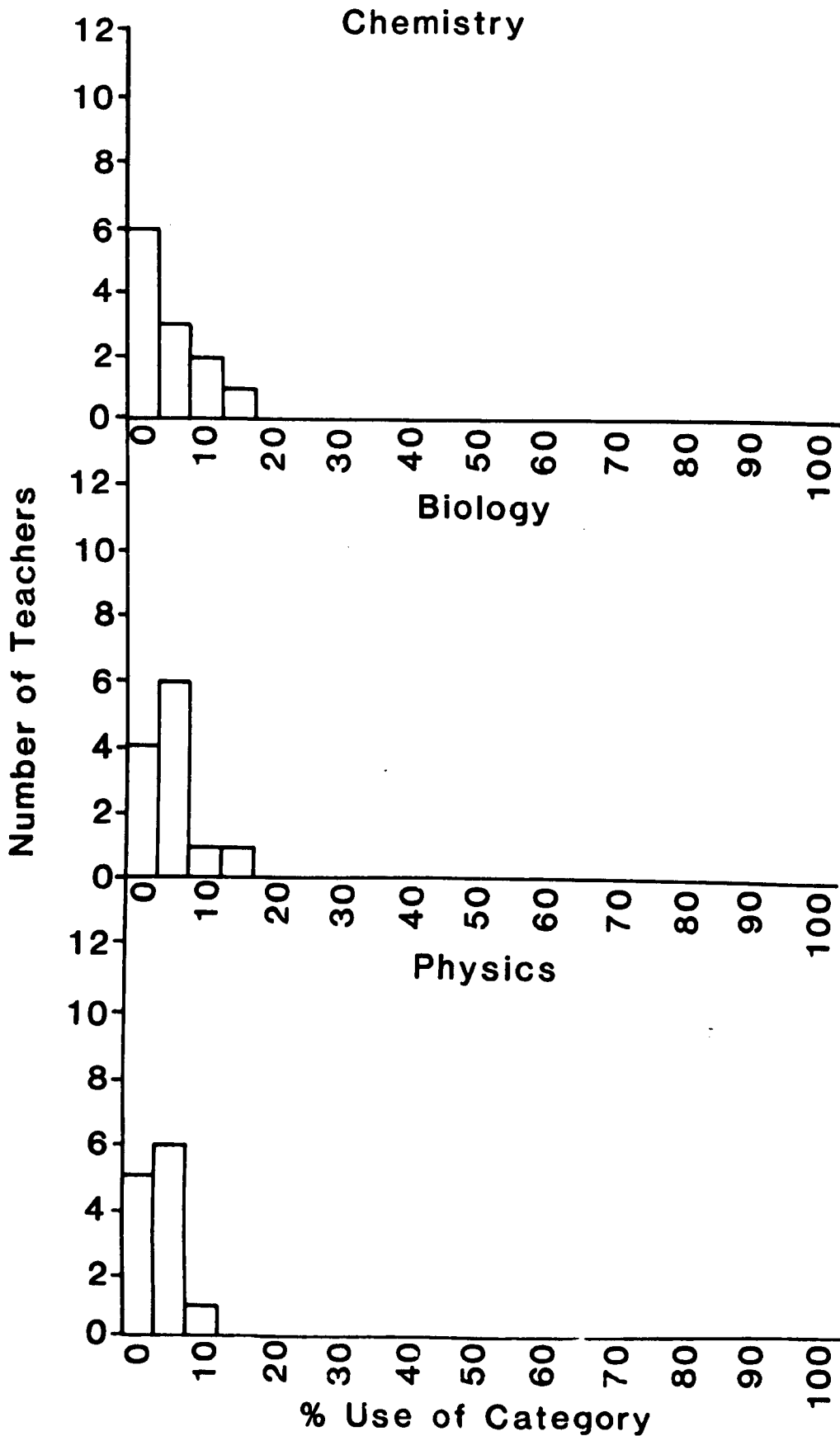
b_4 - Of experimental procedure

This category was also one of those of which teachers made little use. This conclusion resulted from the mean percentages of use made of this particular teaching behaviour, which were 2%, 16% and 5% of time-sampling units for biology, chemistry and physics respectively. The frequency of use of the " b_4 " type statements, however, showed that chemistry teachers made significantly more use of this behaviour than did their biology colleagues ($U = 25$, $p < 0.05$). No such variations, however, were recorded either between chemistry and biology teachers ($U = 47$, N.S.). Moreover, female chemistry teachers were found to make significantly more use of this teaching behaviour than did their male colleagues ($U = 7$, $p < 0.05$). On the other hand, male and female teachers in biology ($U = 18$, N.S.) and physics ($U = 17$, N.S.) lessons made almost the same frequency of use of this type of statement.

Variations between teachers within the three disciplines was remarkable (see figure 13). Although eighteen teachers failed to use this category (ten of them were biology teachers) other teachers made use of it more than 25% of time-sampling units. It was also noticed that chemistry teachers, who had made the highest use of " a_4 " type questions (see figure 6), also made the highest use of " b_4 " type statements.

Teacher directs pupils to sources of information
Acquiring or confirming facts or principles

c_1



1_c - Teacher Direct Pupils to Sources of Information

One of the conditions for the use of this minor category of STOS was that directive statements should not be classified and recorded unless pupils were actually seen to act appropriately to teachers' directions. Therefore, few occasions of both teachers' directions and pupils' appropriate actions were recorded under these categories (i.e., $c_1 - c_4$). Many directions to sources of information were given by the observed teachers as homework activities, such as, reading extra materials, conducting an experiment, or solving a problem. These activities were, however, not recorded as the observer was not certain whether or not pupils put these teachers' directions into operation.

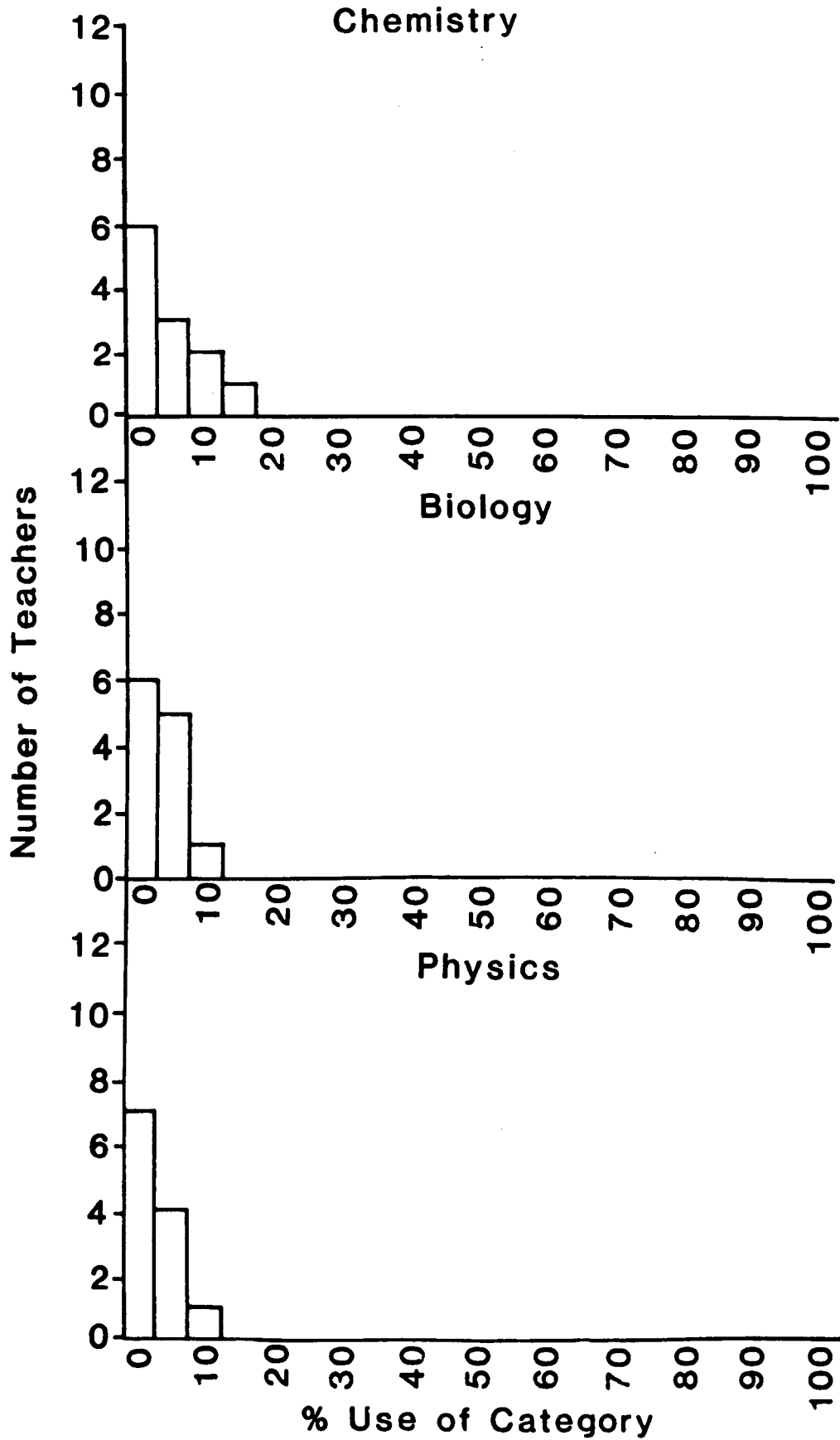
c_1 - Acquiring or confirming facts or principles

The mean percentages of use of " c_1 " type directions were about 3%, 3% and 2% of time-sampling units for biology, chemistry and physics respectively. The frequencies of use of such directions to sources of information showed no significant differences between teachers within the three disciplines (i.e., physics/biology, $U = 71.5$, N.S.; biology/chemistry, $U = 72$, N.S.; and chemistry/physics, $U = 70.5$, N.S.). Moreover, variations between male and female teachers, in each of the observed science discipline, did not show any significant differences (i.e., physics, $U = 14$, N.S.; biology, $U = 13.5$, N.S.; and chemistry, $U = 13.5$, N.S.).

It was also noticed from the observation data that fifteen teachers, namely, six chemistry, four biology, and five physics failed to direct their pupils to sources of information acquiring or confirming facts and principles (see figure 14). Moreover, the use of " c_1 " type directions, made by any observed science teacher did not exceed 15% of the time-sampling units.

**Teacher directs pupils to sources of information
Identifying or solving problems**

c_2



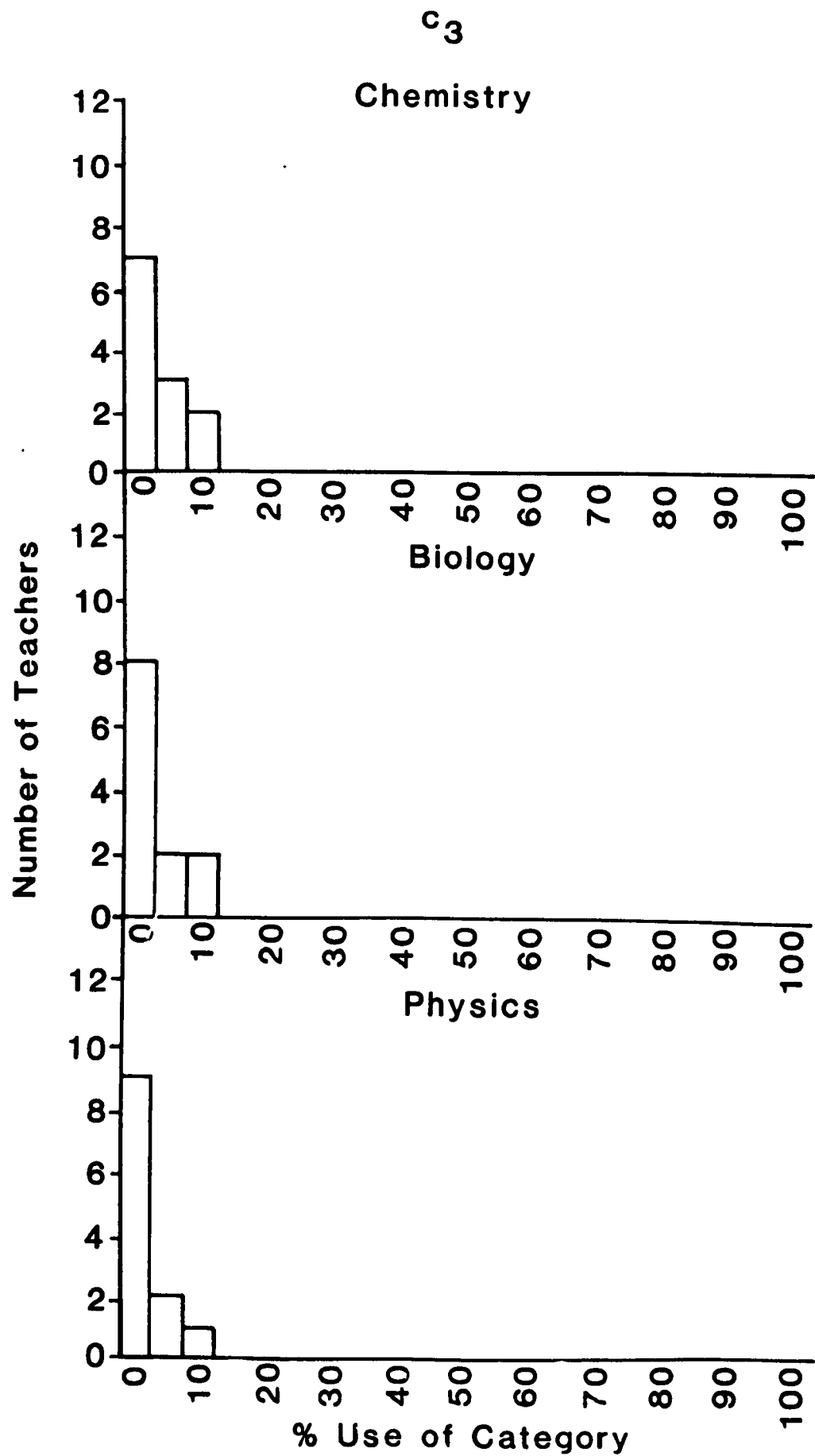
c₂ - Identifying or solving problems

The mean frequencies of use of directions, made by the thirty-six science teachers for the purpose of identifying and solving problems, were 2%, 3% and 1% of time-sampling units for biology, chemistry and physics respectively. On the basis of the recorded data, no significant differences were found either between physics and biology teachers ($U = 65.5$, N.S.); biology and chemistry teachers ($U = 63.5$, N.S.); or between chemistry and physics teachers ($U = 59$, N.S.). No significant differences in the mean frequencies of use were found either between male and female chemistry teachers ($U = 10.5$, N.S.); male and female biology teachers ($U = 8$, N.S.); or between male and female physics teachers ($U = 14$, N.S.).

Furthermore, from the collected data it was noticed that 53% of the observed teachers, namely, seven chemistry, six biology and seven physics, failed to use any "c₂" type directions during the observation periods (see figure 15). The mean frequency of use of this teaching behaviour was also found to range from 0% up to 15% of time-sampling units for chemistry and biology teachers, and from 0% up to 10% for physics teachers.

Fig-16

Teacher directs pupils to sources of information
Making inferences,formulating or testing hypotheses



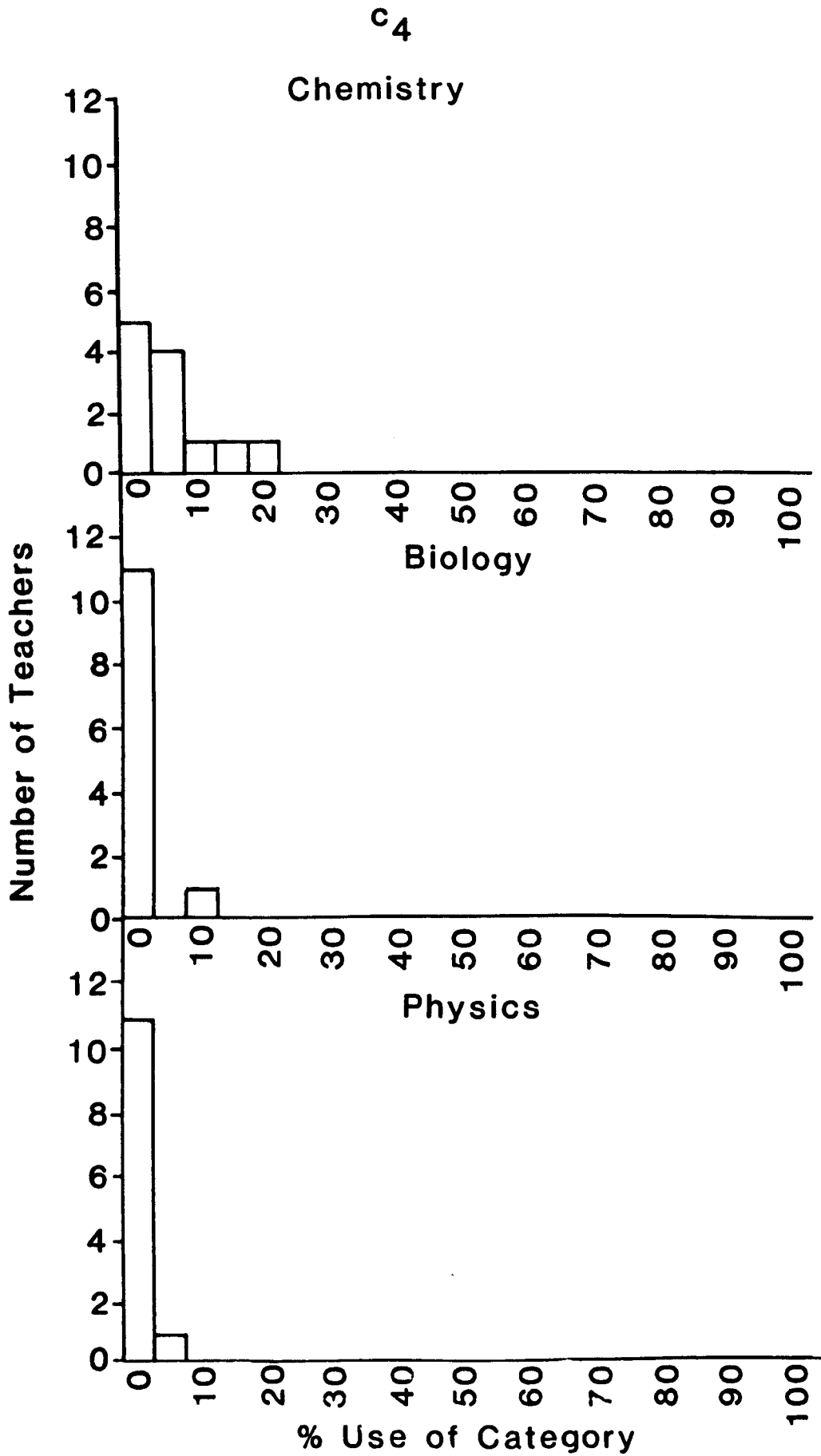
c₃ - Making inferences, formulating or testing hypotheses

The mean frequencies of use of "c₃" type directions were about 2%, 2% and 1% of time-sampling units for biology, chemistry and physics respectively. The frequencies of use made of this particular teaching behaviour, however, showed no significant differences either between physics and biology teachers (U = 66, N.S.); biology and chemistry teachers (U = 65, N.S.); or between chemistry and physics teachers (U = 58.5, N.S.). When male teachers, within each science area, were compared with their female colleagues no significant differences were recorded (i.e. physics, U = 14.5, N.S.; biology, U = 16, N.S.; and chemistry, U = 12, N.S.).

From the recorded data, in relation to the "c₃" type directions to sources of information, it was found that only one-third of the observed teachers within all three disciplines, namely, five chemistry, four biology, and three physics, made any use of it (see figure 16). Moreover, the mean frequency of use of this particular teaching behaviour was also found to range from 0% up to 10% of time-sampling units in all observed science areas. This indicated that this teaching behaviour was one of the least used in Kuwaiti high schools. Thus few science teachers directed pupils to sources of information for the purpose of making inferences, formulating or testing hypotheses.

Fig-17

Teacher directs pupils to sources of information
Seeking guidance on experimental procedure

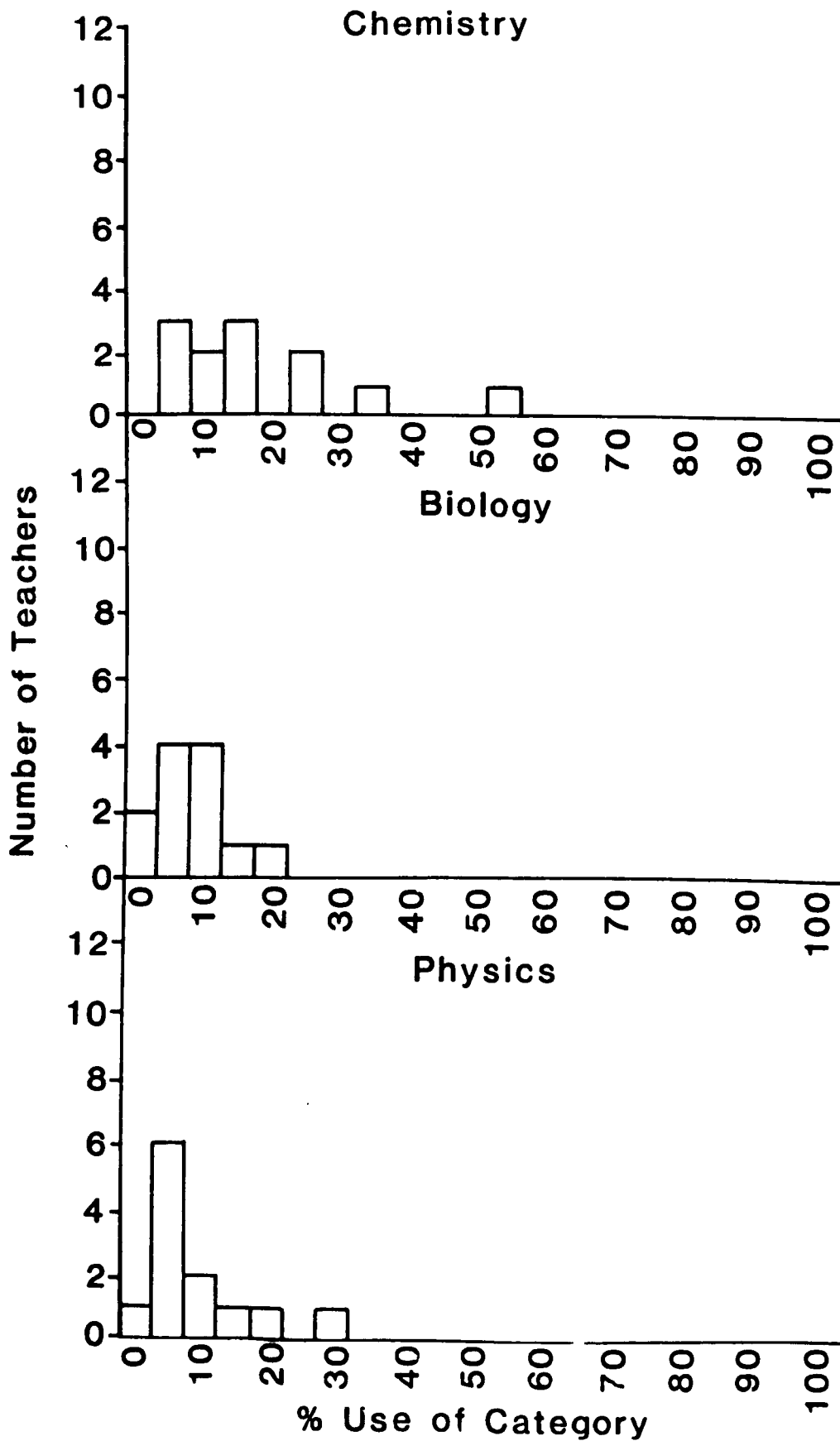


c_4 - Seeking guidance on experimental procedure

Chemistry teachers who asked their pupils to design experiments, and who made more use of " b_4 " type statements (see figure 13) than biology teachers, also provided more directions to pupils to sources of information seeking guidance on experimental procedure, than teachers within the other two disciplines. In other words, chemistry teachers made significantly more use of " c_4 " type directions than either the observed biology ($U = 37$, $p < 0.05$) or physics ($U = 33$, $p < 0.05$) teachers. The mean frequencies of use of " c_4 " type directions made by the three sets of teachers were 1%, 4% and 0.1% of time-sampling units for biology, chemistry and physics respectively. When male and female teachers, however, within each science area, were compared with each other, no significant differences were found (i.e., physics, $U = 15$, N.S.; chemistry $U = 15$, N.S.; and biology, $U = 15$, N.S.).

Nevertheless, in this project, 42% of chemistry, 92% of biology and 92% of physics teachers failed to use " c_4 " type directions. The mean frequencies of use of this particular teaching behaviour (see figure 17) was also found to range between 0% to 20% of time-sampling units for chemistry; 0% to 10% for biology; and 0% to 5% for physics teachers.

Pupils seek information or consult for the purpose of acquiring or confirming facts or principles

 d_1


TALK AND ACTIVITY INITIATED AND/OR MAINTAINED BY PUPILS

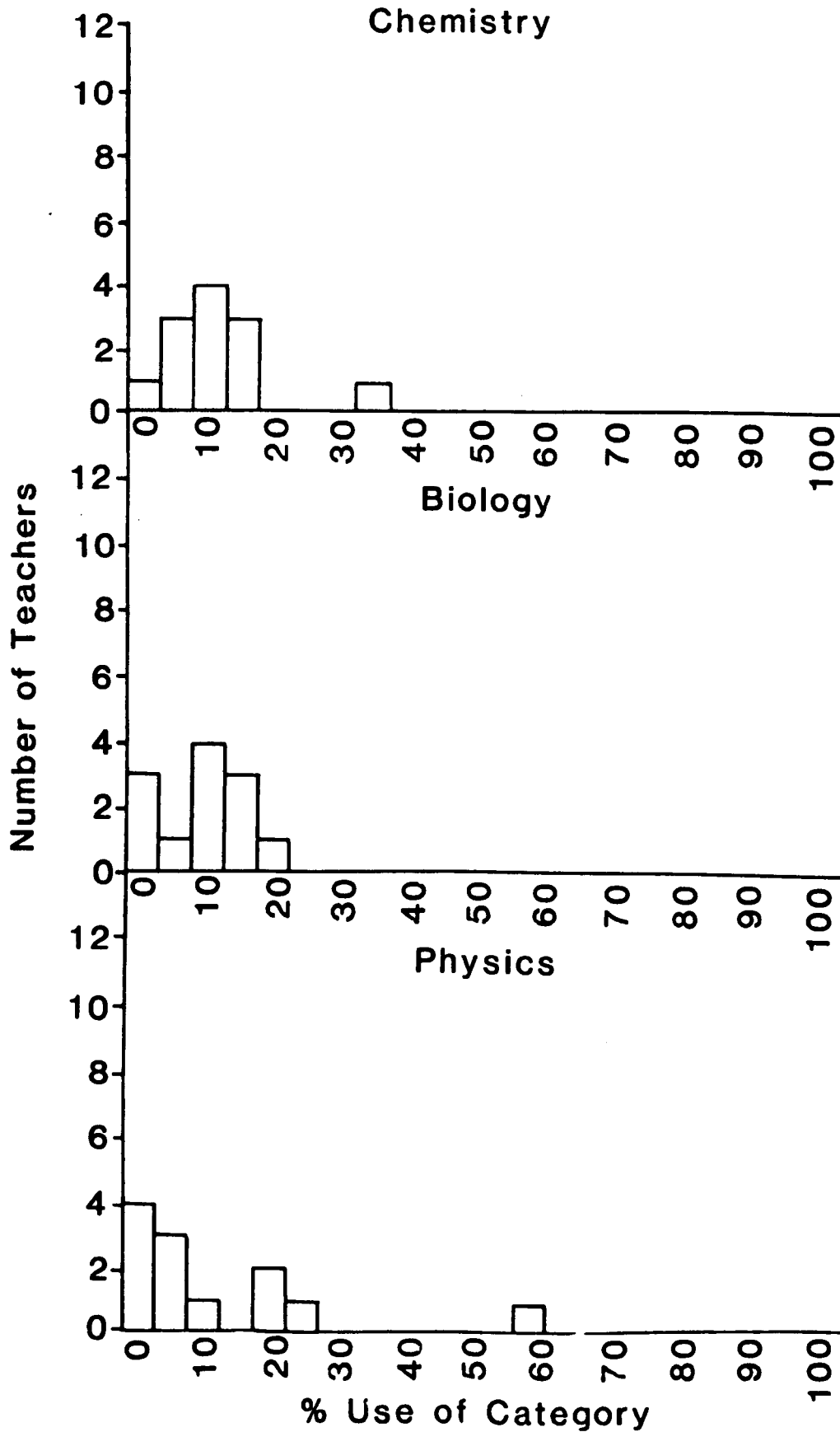
1d - Pupils Seek Information or Consult for the Purposes of:

d₁ - Acquiring or confirming facts or principles

The mean frequencies of use of "d₁" type consultations made by pupils were 6%, 17% and 9% of time-sampling units in biology, chemistry and physics lessons respectively. Pupils in chemistry lessons were found to spend significantly more time in consulting sources of information for the purpose of acquiring facts and principles, than they did in biology lessons ($U = 32$, $p < 0.05$). No such differences, however, were recorded either between physics and biology ($U = 69.5$, N.S.); or between chemistry and physics ($U = 38.5$, N.S.) lessons. Female pupils were also found to consult with each other, when studying biology, chemistry and physics topics to a similar extent as the observed male pupils (i.e., biology, $U = 8.5$, N.S.; chemistry, $U = 13.5$, N.S.; and physics, $U = 17.5$, N.S.).

It was also found that pupils in chemistry lessons consulted with each other within a range of 5% to 55% of time-sampling units, whereas, in two biology and in one physics lesson (see figure 18) pupils failed to do so.

Pupils seek information or consult for the purpose of
identifying and solving problems

 d_2


d_2 - Identifying and solving problems

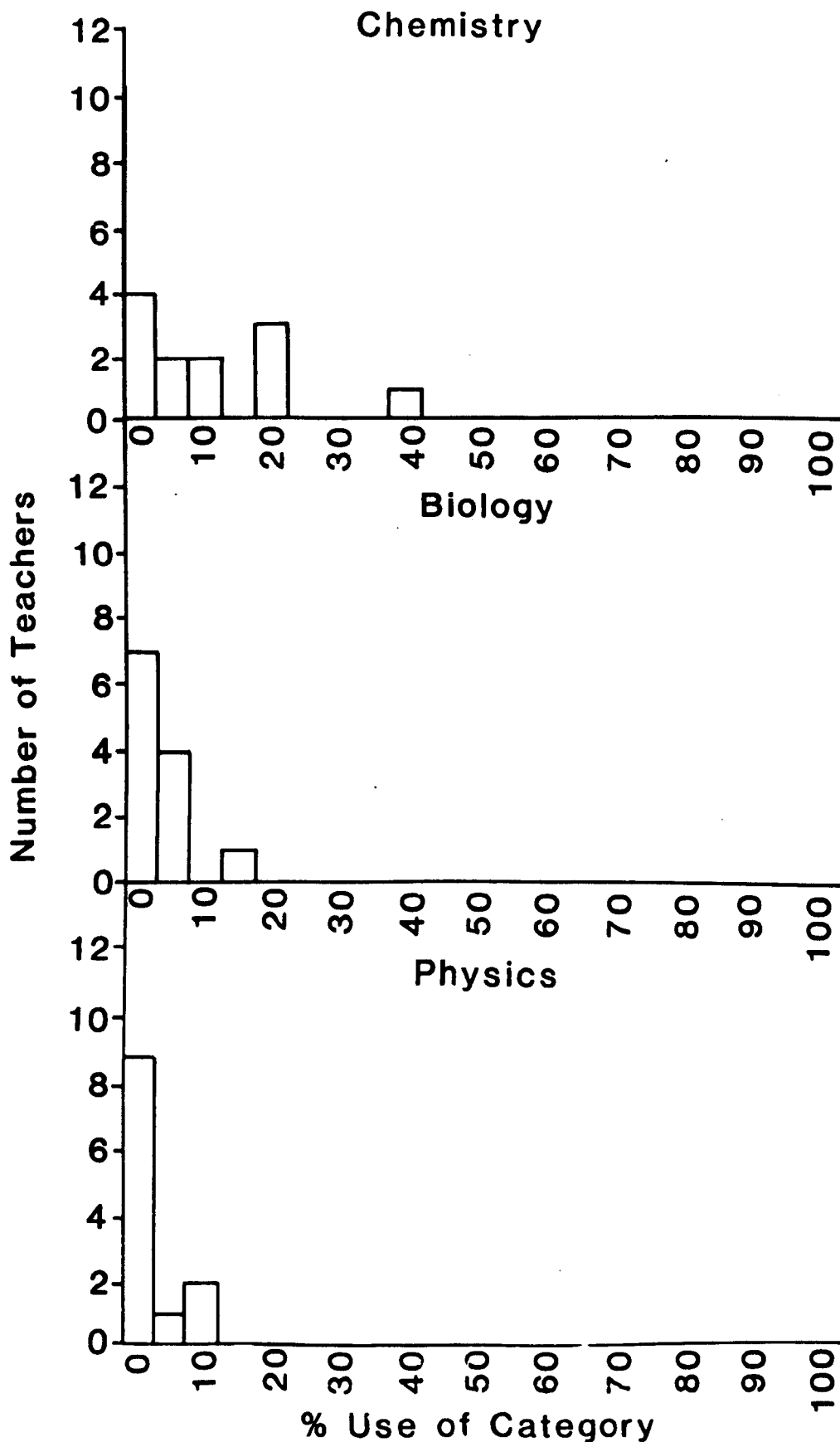
Differences between the three subject areas were noted from the mean percentages of use of " d_2 " type activities, which were 8%, 10% and 11% of time-sampling units for biology, chemistry and physics respectively. These variations, however, were not statistically significant (i.e., physics/biology; $U = 69.5$, N.S.; physics/chemistry, $U = 59.5$, N.S.; and chemistry/biology, $U = 66$, N.S.). Female pupils in chemistry lessons, made significantly more use of solving and identifying problems than did male pupils ($U = 6$, $p < 0.05$). On the other hand, no significant differences were recorded between the two sexes either in biology ($U = 14$, N.S.) or physics ($U = 17$, N.S.) lessons.

Moreover, from the recorded data, for pupils seeking information or consulting for the purpose of identifying and solving problems, it was found that in 22% of the observed lessons, namely, one chemistry, three biology and in four physics lessons, pupils failed to make any use of such behaviour. Nevertheless, the highest frequencies of use made by pupils in Kuwaiti high schools of the " d_2 " type category were found to be 35% of time-sampling units in one chemistry, 20% in one biology, and 60% in one physics lesson (see figure 19).

Fig-20

Pupils seek information or consult for the purpose of making inferences,formulating and testing hypotheses

d_3



d_3 - Making inferences, formulating and testing hypotheses

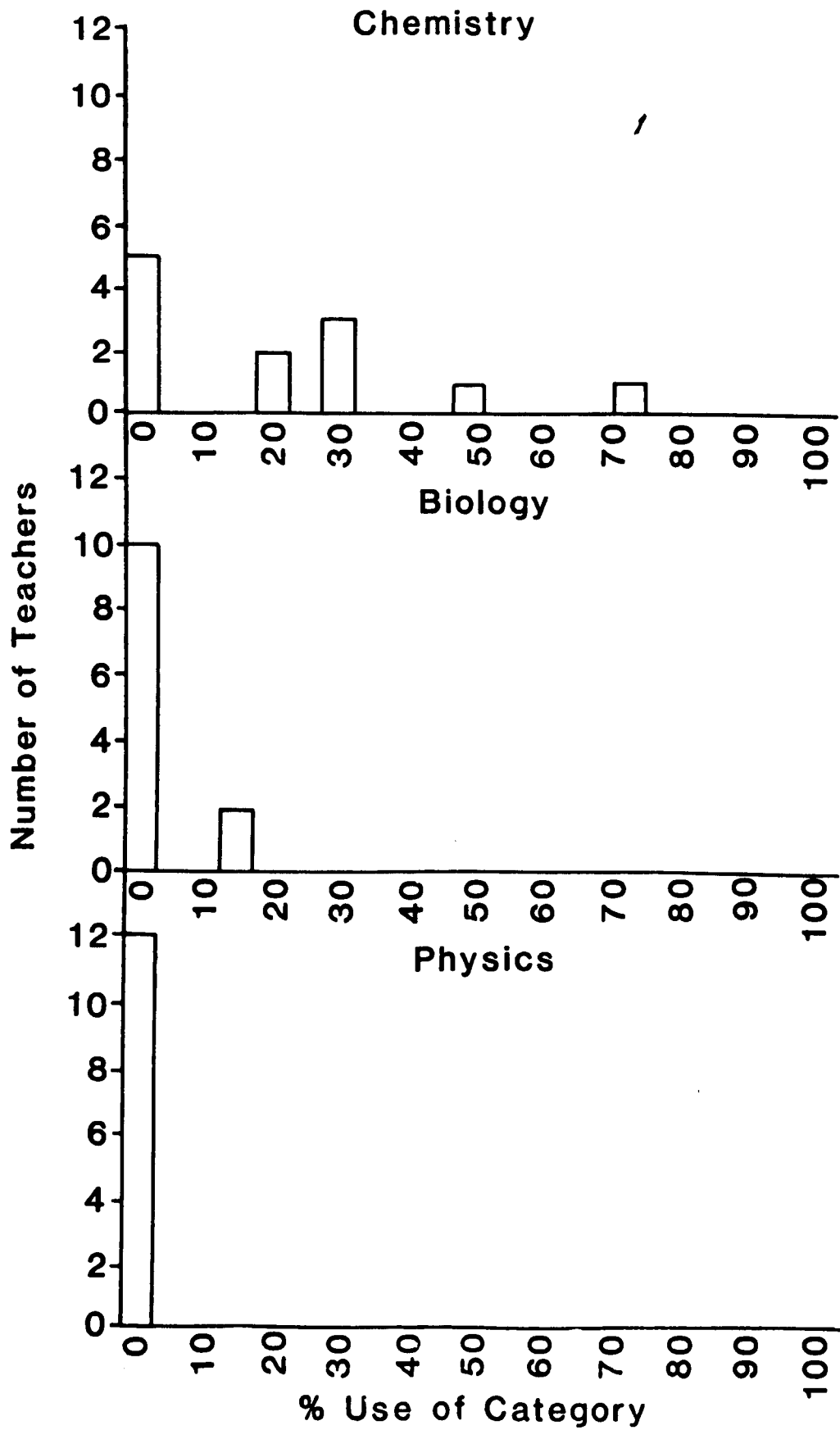
Although teachers of the three disciplines had made similar use of " c_3 " type directions (as reported earlier, see p.232), it was found that pupils in chemistry lessons, made significantly more use of " d_3 " type activities than they did when studying physics ($U = 36$, $p < 0.05$). The mean frequencies of the use of this pupil behaviour were 2%, 10% and 1% of time-sampling units for biology, chemistry and physics pupils respectively. Moreover, no significant differences were found between male and female pupils, when studying the same subject areas, as to the frequencies of use they made of the " d_3 " type behaviour (i.e. physics, $U = 20$, N.S.; biology, $U = 11$, N.S.; and chemistry, $U = 18$, N.S.).

Furthermore, the data collected showed that the observed pupils in Kuwaiti high schools did not make any use of this behaviour in four chemistry, seven biology and nine physics lessons. Moreover, the highest frequencies of use made of this activity was found to be 70% of time-sampling units in one chemistry, 15% in one biology and 10% in two physics lessons (see figure 20).

Fig-21

Pupils seek information or consult for the purpose of seeking guidance on experimental procedure

d₄



d_4 - Seeking guidance on experimental procedure

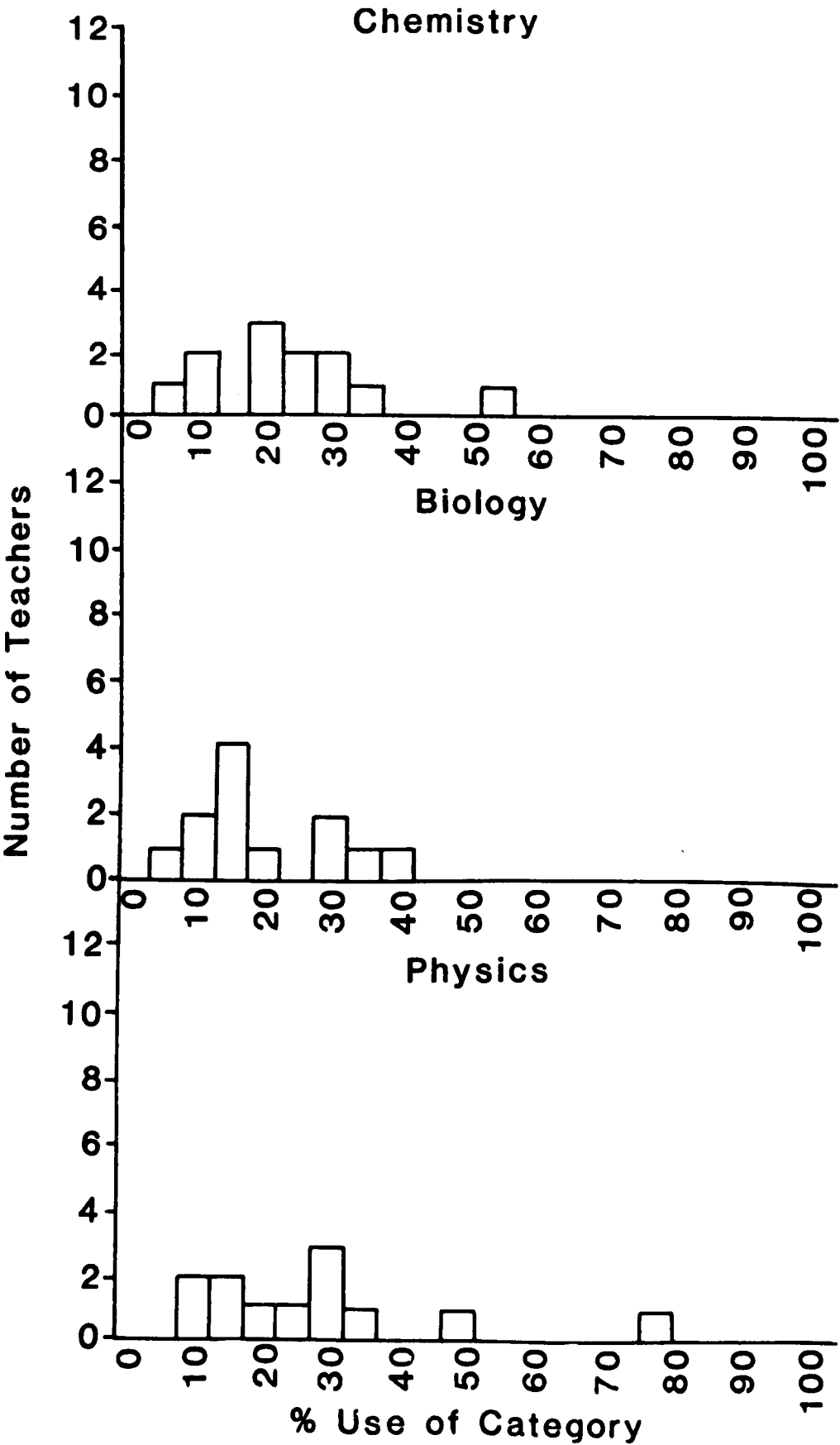
As this category involved experimental procedures it would be suggested that teachers' behaviours in relation to such categories as a_4 , a_5 , b_4 , and c_4 (see pp. 212, 214, 226 and 234) might have been associated with their pupils' " d_4 " type activities. As noted previously, chemistry teachers made significantly more frequent use of many of these teaching behaviours than did the observed biology teachers, although chemistry teachers also made more use of these categories than did physics teachers, any differences were not statistically significant. Pupils behaviour in chemistry lessons might have been affected to a considerable extent by their chemistry teachers' attitudes. This followed from the mean percentages of use of the " d_4 " category which occurred at rates of 2%, 20% and 0.0% of time-sampling units for biology, chemistry and physics lessons respectively. These values, however, showed that pupils, in Kuwaiti high schools, were significantly more active in seeking guidance from each other when working on experiments in chemistry lessons than they were when studying either biology ($U = 21$, $p < 0.05$) or physics ($U = 24$, $p < 0.05$) subjects. Male and female pupils were also found to make similar use of the above-mentioned activity when studying either physics ($U = 18$, N.S.); biology ($U = 17.5$, N.S.) or chemistry ($U = 17$, N.S.) subjects.

It was also noticed, from the collected data, that within 83% of biology lessons and within all of the observed physics lessons, pupils did not make use of this category, whereas in 42% of the chemistry lessons pupils failed to consult with each other when working on experimental procedures (see figure 21).

Fig-22

Pupils refer to teachers for the purpose of acquiring or confirming facts or principles

e_1



1e - Pupils Refer to Teachers For the Purpose of:

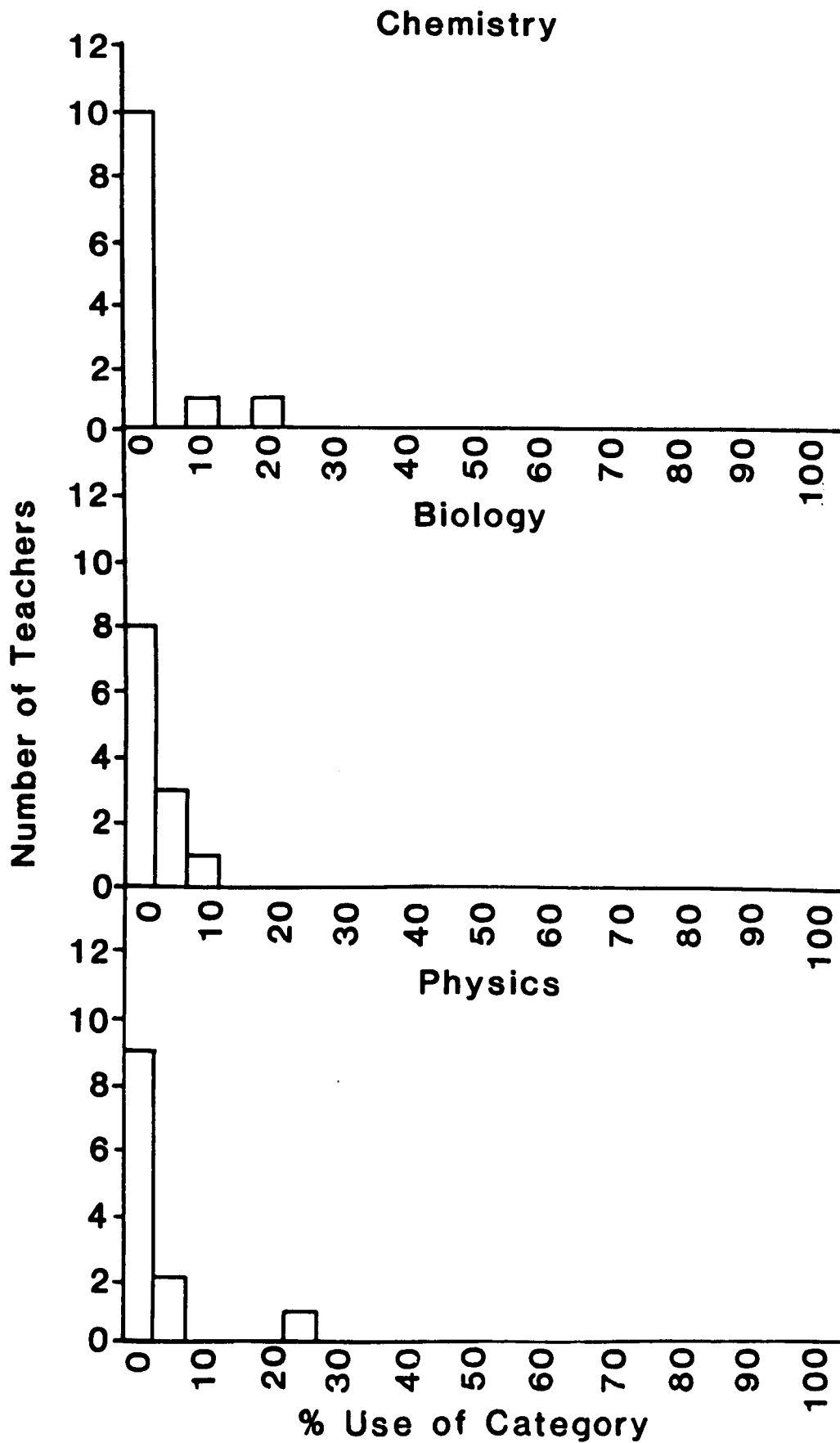
e₁ - Acquiring or confirming facts or principles

The mean percentages of use of the "e₁" category of pupil behaviour were about 17%, 21% and 27% of time-sampling units for biology, chemistry and physics respectively. The data resulting from the classroom observations, however, showed that pupils in Kuwaiti high schools referred to their science teachers in acquiring or confirming facts and principles to a similar extent in all three subjects (i.e., physics/biology, $U = 50.5$, N.S.; biology/chemistry, $U = 57$, N.S.; and chemistry/physics, $U = 57.5$, N.S.). Moreover, male pupils were found to make significantly more use of this specific behaviour than did the observed female pupils in both biology ($u = 6.5$, $p < 0.05$) and chemistry ($U = 5.5$, $p < 0.05$) lessons but not in physics ($U = 9.5$, N.S.) lessons.

In addition, pupils did not fail to make use of the above-mentioned category in any of the observed lessons. Nevertheless, pupils' references to their science teachers were found to range from 5% to 55% of time-sampling units in chemistry, 5% to 40% in biology and from 5% to 80% in physics lessons (see figure 22).

Fig-23

Pupils refer to teachers for the purpose of seeking guidance when identifying or solving problems

 e_2 

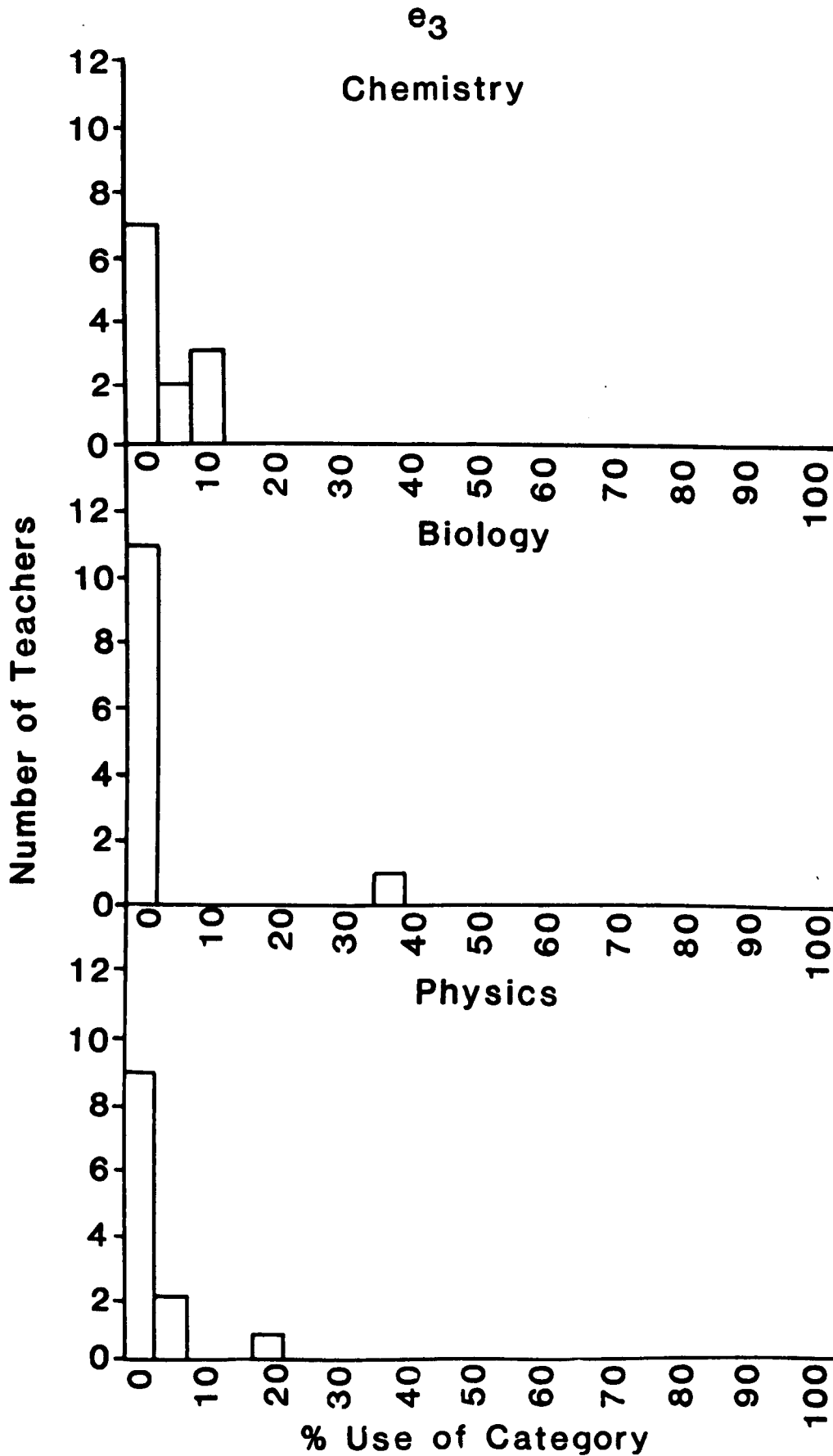
e_2 - Seeking guidance when identifying or solving problems

The mean percentages of use of the " e_2 " category were about 1%, 2% and 3% of time-sampling units for biology, chemistry and physics respectively. The frequencies of use made of this pupil activity did not show any significant difference between pupils studying the three separate science areas (i.e., physics/biology, $U = 67$, N.S.; biology/chemistry, $U = 64$, N.S.; and chemistry/physics, $U = 67$, N.S.). Moreover, when male and female pupils within the three science areas were compared with each other, no significant difference between the two sexes was recorded in either physics ($U = 14.5$, N.S.), biology ($U = 18$, N.S.), or chemistry ($U = 17.5$, N.S.).

Furthermore, it was also observed that in 83% of the chemistry, 67% of the biology, and in 75% of the physics lessons, pupils did not seek their teachers' help when working on problem-solving activities in other words, in 10 chemistry, 8 biology, and in 9 physics classes pupils did not seek guidance from their science teachers in relation to " e_2 " activity (see figure 23).

Fig-24

Pupils refer to teachers for the purpose of seeking guidance when making inferences,formulating or testing hypothesis



e_3 - Seeking guidance when making inferences, formulating or testing hypotheses

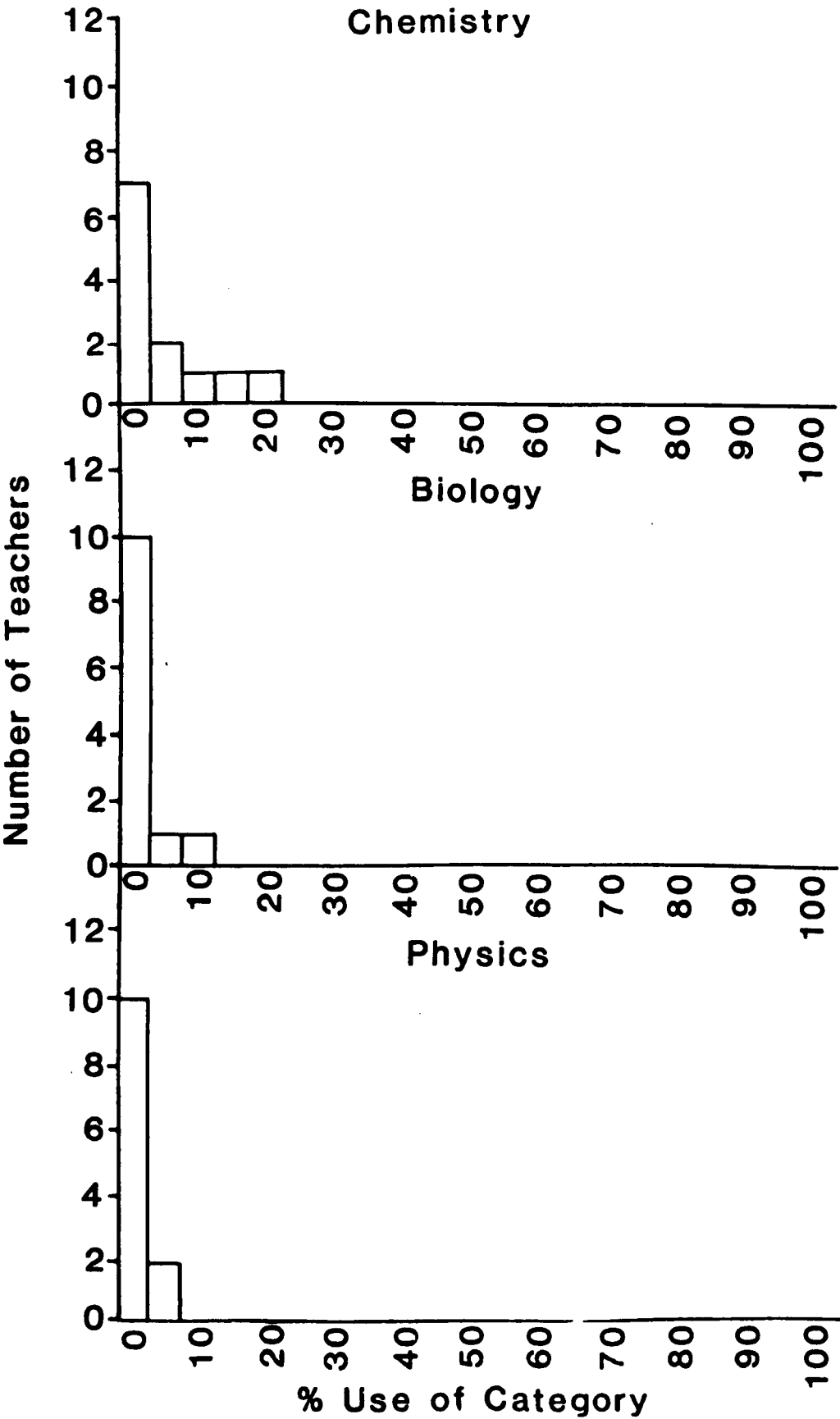
The mean percentages of use of the " e_3 " category made by the observed pupils were 3%, 2%, and 2% of time-sampling units for biology, chemistry and physics respectively. On the basis of the " e_3 " type behaviour data, no significant differences were found as to how frequently the observed pupils made use of this type of pupil behaviour in the three science areas (i.e., physics/biology, $U = 61.5$, N.S.; biology/chemistry, $U = 50.5$, N.S.; and chemistry/physics, $U = 61$, N.S.). Similarly, no significant differences were found between the frequencies of use made by the two sexes of pupils seeking teacher help in the above activities either in physics ($U = 14$, N.S.), biology ($U = 9$, N.S.) or in chemistry ($U = 14.5$, N.S.) lessons.

In most of the observed lessons, namely, seven chemistry, eleven biology and nine physics classes, pupils failed to refer to their teachers when making inferences formulating or testing hypotheses (see figure 24). The highest use, however, which was made by the observed pupils of the above-mentioned category was 10% in two chemistry, 40% in one biology and 20% in one physics lesson.

Fig-25

Pupils refer to teachers for the purpose of seeking guidance on experimental procedure

e₄



e_4 - Seeking guidance on experimental procedure

Category " e_4 ", which was another of the most significant categories that differentiated between the two groups of teachers which emerged in subsequent statistics (see Chapter VII, pp. 257 and figure 26), was found to be one of the least used by pupils in Kuwaiti high schools. It had mean percentages of use of 1%, 4% and 0.3% of time-sampling units for biology, chemistry and physics respectively. The frequency of use, in relation to " e_4 " activity, however, showed that pupils in Kuwaiti schools made significantly more use of this activity when studying chemistry than they did when studying physics ($U = 36$, $p < 0.05$). On the other hand, no such differences were recorded either between chemistry and biology ($U = 51.5$, N.S.) lessons or between physics and biology lessons ($U = 60$, N.S.). Female pupils were found to seek " e_4 " type help from their science teachers to the same extent as male pupils (i.e., physics, $U = 18$, N.S.; biology, $U = 14$, N.S.; and chemistry, $U = 14$, N.S.). In relation to " e_4 " activity, it was also noticed that in 58% of the chemistry, 83% of the biology and in 83% of the physics classes, the observed pupils in Kuwaiti high schools did not consult their teachers when working on experimental procedures (see figure 25).

7.20 Teacher-Dominated/Pupil-Initiated Transactions

The ratio of teacher-initiated activity to that of pupils', was computed for chemistry, physics and biology. The same ratio was also computed for the observed male and female samples (separately) for each subject area.

This was done by:

- 1) Calculating the frequency of use of each of the 23 STOS categories, made by the observed 36 science teachers and their 284 pupils, during the observation periods (i.e., January to April, 1981) and
- 2) dividing the total frequency of teacher-dominated activities (i.e., categories, 1a, 1b and 1c) by the total use of the STOS twenty-three categories (i.e., 1a, 1b, 1c, 1d and 1e) as shown in table 16.

It can be seen from the data, represented in table 16, relating to the frequencies of use of each of the five categories (i.e., 1a, 1b, 1b, 1d, and 1e) recorded for the observed Kuwaiti classrooms, that science teachers in general dominate the transactions of their classroom activities.

Teachers' domination was found to be represented by 82%, 72% and 80% of the total activities in biology, chemistry and physics lessons respectively. Hence these percentages mean that pupils in the observed Kuwaiti high schools were given the opportunity by their biology, chemistry and physics teachers to either consult with each other or to question their teachers in only 18%, 28% and 20% of classroom activities.

Teachers, within the three science disciplines, were compared with each other on the basis of the frequency of use they made of each of the minor categories (i.e., 1a, 1b and 1c). No significant differences were recorded in relation to "1a" category either between biology and physics teachers ($U = 62.5$, N.S.) nor between physics and chemistry teachers ($U = 40.5$, N.S.). Chemistry teachers, however, were found to question their pupils more than did the observed biology teachers ($U = 29$, $p < 0.05$).

In the case of "1b" category, no significant differences were recorded between any of the three science areas as to the frequency of their use of this particular teaching behaviour (i.e., chemistry/biology, $U = 72$, N.S.; biology/physics, $U = 43$, N.S.; and physics/chemistry, $U = 48.5$, N.S.).

Relating to the "1c" type teaching behaviour, it was found that chemistry teachers directed their pupils more than did either the observed biology ($U = 9$, $p < 0.01$) or physics ($U = 32$, $p < 0.05$) teachers. Physics teachers, however, were also found to direct their pupils significantly more often than their biology colleagues ($U = 25$, $p < 0.05$).

In the case of "1d" categories, pupils in chemistry lessons were found to be more active and to consult with each other when studying chemistry related subjects significantly more often than they did when studying biology ($U = 18.5$, $p < 0.01$) or physics ($U = 24.5$, $p < 0.05$) topics.

Finally no significant differences were recorded between observed pupils in the extent to which they referred to their teachers, "1e" type activities, when working in the different subject areas (i.e., chemistry/biology, $U = 49$, N.S.; biology/physics, $U = 52$, N.S.; and physics/chemistry, $U = 67$, N.S.).

Similarly, male and female teachers within the three science disciplines seemed to adopt the same teaching strategies with their pupils, i.e., the ratio of teacher-domination to pupil-initiated transactions was found to range, in the observed female schools, from 71% up to 84% (see table 16, p. 253). A ratio of similar magnitude of 73% up to 80% was found in the corresponding male schools. When male and female classes within each science discipline were compared with each other, the only recorded significant difference between the two sexes was related to "1a" type teaching behaviour. In other words, female chemistry teachers asked female pupils more questions than did their male colleagues ($U = 6$, $p < 0.05$) when teaching the same subject matter to their male pupils.

Table 16: The Ratio of Teacher-Dominated to Pupil-Initiated Transactions In Chemistry, Biology and Physics

Classrooms

S.T.O.S.. Categories	Biology						Chemistry						Physics					
	Mixed		Male		Female		Mixed		Male		Female		Mixed		Male		Female	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
<u>Teacher-Dominated</u>																		
T.Questions (1a) a ₁ - a ₇	548	34.1	233	29.3	315	38.8	843	37.5	377	34.3	466	40.6	634	34.0	288	31.6	346	37.0
T.Statements (1b) b ₁ - b ₄	721	44.9	380	47.9	341	42.0	691	30.7	378	34.1	313	27.3	805	43.6	404	44.3	401	42.8
T.Directions (1c) c ₁ - c ₄	50	3.1	21	2.6	29	3.6	89	4.0	49	4.6	40	3.5	33	1.8	19	2.1	14	1.5
Totals = $\frac{TD}{TD + PI} \times 100$	$\frac{1319}{1606}$	82%	$\frac{634}{794}$	80%	$\frac{685}{812}$	84%	$\frac{1623}{2249}$	72%	$\frac{804}{1101}$	73%	$\frac{819}{1148}$	71%	$\frac{1472}{1848}$	80%	$\frac{711}{912}$	78%	$\frac{761}{936}$	81%
<u>Pupils-Initiated</u>																		
P.Consultations (1d) d ₁ - d ₄	127	7.9	50	6.3	77	9.5	411	18.2	172	15.6	239	20.8	150	8.1	58	6.4	92	9.8
P.Reference (1e) e ₁ - e ₄	160	10.0	110	13.9	50	6.1	215	9.6	125	11.4	90	7.8	226	12.2	143	15.6	83	8.9
Totals = $\frac{PI}{TD + PI} \times 100$	$\frac{287}{1606}$	18%	$\frac{160}{794}$	20%	$\frac{127}{812}$	16%	$\frac{626}{2249}$	28%	$\frac{297}{1101}$	27%	$\frac{329}{1148}$	29%	$\frac{376}{1848}$	20%	$\frac{201}{912}$	22%	$\frac{175}{936}$	19%

Where TD = Teacher Dominated. PI = Pupil Initiated.

7.3 A Typology of Science Teaching Styles

Cluster analysis, was undertaken to sort out the thirty-six observed science teachers into groups on the basis of data from the STOS' 23 categories. It was hoped to establish different patterns of cognitive styles used by science teachers in Kuwaiti high schools. This sorting procedure set out to minimize the differences between teachers, on the basis of their adopted style of teaching within each group, and at the same time maximize the variation among teachers between the emerging groups.

The cluster analysis procedure involved the following main steps:

- 1) Correlation coefficients were computed regarding teachers' frequencies of use within each of the 23 categories (two at a time) by using the following formula:

$$r = \frac{N \sum XY - (\sum Y)(\sum X)}{\sqrt{[N \sum X^2 - (\sum X)^2][N \sum Y^2 - (\sum Y)^2]}} \quad (1)$$

where:

N = number of pairs of scores (categories);

$\sum XY$ = sum of products of paired scores;

$\sum X$ = sum of scores on one variable;

$\sum Y$ = sum of scores on the other variable;

$\sum X^2$ = sum of squared scores on the "X" variable, and

$\sum Y^2$ = sum of squared scores on the "Y" variable.

1. Bruning, L.J. and Kintz, L.B. 1968, op.cit., (p.153).

Teachers who correlated highly with each other, on the basis of the Pearson-Product Moment Correlation Coefficient, were grouped together.

On the basis of the initial sorting out procedure two main groups emerged.

- 2a) A second step was followed in the sorting procedure, by which teachers were paired in turn. Teachers within each of the two groups were ranked according to their frequency of use on each category, and the sum of ranks computed for each group of teachers on each category (see Table 15).
- 2b) To determine whether there was a significant difference regarding the relative frequency of use of each category by the two groups of teachers, the Mann-Whitney-U-Test was adopted (see pp.202) for testing the presence of a significant difference between the distribution of the two population.
- 3a) Categories that were found to be significant and differentiated between the two groups, on the basis of their high or low frequency of use, were arranged for each group separately. This was done by ranking each of these categories on the basis of its median.
- 3b) For each teacher in each group, categories that were found to be significant were then ranked and correlated, by the Spearman Rank-Order Correlation Coefficient, ρ , against the median ranks of the two groups (previously reached for at step 3a), as follows:

$$\rho = 1 - \frac{6 \sum D^2}{N(N^2-1)} \quad (1)$$

where:

D = difference score between "X" (i.e. median rank) and "Y" (i.e. frequency rank) pairs; and

N = number of pairs of scores (i.e., significant categories in each group.)

An example of computing the Spearman Rank-Order Correlation Coefficient, ρ , for teacher-1, in group two is represented in table 17a as follows:

Table 17a

Signifi- cant cat- egories for group II	Median Frequ- ency	Median Rank	Frequ- ency	Frequ- ency Rank	Signifi- cant cat- egories for group I	Median Frequ- ency	Median Rank	Frequ- ency	Frequ- ency Rank
a_3	9.5	1	9	1	e_4	0.0	1	0.0	1.5
a_2	10.0	2	13	2	b_2	6.0	2	0.0	1.5
b_1	37.0	3	45	3					
$\rho =$				1.0	$\rho =$				0.5

Teachers, who correlated most highly with their group, in which they were originally placed (e.g. teacher one in group II), were left, and those who correlated highly with other group were removed to the other group. Steps from 2b and 3b, however, were repeated (in the case of this study) ten times before the final sorting out procedures was reached (see table 17b).

Table 17b

Statistical Summary of the Data Resulting From the
Final Sorting-Out Procedure

Significant Categories	Group One		Group Two	
	R_1	U	R_2	U
a_2	403.0	232.0	263.0	92.0*
a_3	424.0	253.0	242.0	71.0*
b_1	396.5	255.5	269.5	98.5*
b_2	264.0	93.0*	402.0	213.0
e_4	252.0	81.0*	414.0	243.0

where:

(*) is significant at the 0.05 level using a two-tailed test

On the basis of these cluster-analysis procedures two main groups of teachers, in Kuwaiti high schools (resulting from their adopted teaching behaviour), were produced. Eighteen of the science teachers were classified within each of the two groups. These are referred to as "group one" and "group two" science teachers in subsequent discussions.

7.31 Main Characteristics of the Two Groups of Science Teachers in Kuwaiti High Schools

7.32 "Group One" Science Teachers

A dominant feature of this group of science teachers was the relatively high incidence of teachers' questions in categories a_1 , a_2 , a_3 , a_6 ,

and a_7 , combined with relatively high frequencies of teachers' statements (b_1 and b_2). Thus there was a distinguishing pattern of teacher-dominated transactions. This pattern was particularly characteristic of this group (see figure 26). In addition there was a tendency for these teachers to make statements of facts and principles (b_1), as well as, of problems (b_2), followed by asking questions which had to be answered either by recalling facts and principles (a_1), applying facts and principles (a_2), or making hypothesis or speculation (a_3).















































These dominant features of these science teachers, however, were also combined with teachers' directions to pupils and to sources of information for identifying or solving problems (c_2). Moreover, talk and activities initiated and/or maintained by pupils taught by these teachers were associated with their teachers' attitudes. This was reflected by pupils' consultations, which were concentrated on solving problems (d_2), or by referring to teachers when identifying or solving problems (e_2), and/or making inferences, and formulating or testing hypotheses (e_3). Furthermore, pupils' activities lacked questions concerning any guidance on experimental procedure (e_4). The " e_4 " category was one of the unique features of this group. The relatively low frequency use of teachers' statements of experimental procedure (b_4), combined with low emphasis on questions concerning observing or designing of experimental procedure suggested a non-practical problem-solving image of this group.

7.33 "Group Two" Science Teachers






A dominant feature of this group (see figure 26) was the relatively low incidence of teachers' questions (1_a) excepting those demanding the recall of facts and principles (a_1) and those requiring the design of experimental procedures (a_4) and of direct observations (a_5).

Figure- 26

Main Characteristics that Differentiated Between the Two
Groups of Science Teachers in Kuwaiti High Schools

Group one	Group two	
		<u>TEACHER TALK</u>
		1a- <u>Teacher Asks Questions (or invites) Comments which are Answered by:</u>
		a ₁ - Recalling facts and principles
		a ₂ - Applying facts and principles to problem solving
		a ₃ - Making hypothesis or speculation
		a ₄ - Designing of experimental procedure
		a ₅ - Direct observation
		a ₆ - Interpretation of observed or recorded data
		a ₇ - Making inferences from observations or data
		1b- <u>Teacher Makes Statements of:</u>
		b ₁ - Fact and principle
		b ₂ - Problems
		b ₃ - Hypothesis or speculation
		b ₄ - Experimental procedure
		1c- <u>Teacher Directs Pupils to Sources of Information for the Purpose of:</u>
		c ₁ - Acquiring or confirming facts or principles
		c ₂ - Identifying or solving problems
		c ₃ - Making inferences,formulating or testing hypothesis
		c ₄ - Seeking guidance on experimental procedure
		<u>TALK AND ACTIVITY INITIATED AND/OR MAINTAINED BY PUPILS</u>
		2d- <u>Pupils Seek Information or Consult for the purpose of:</u>
		d ₁ - Acquiring or confirming facts or principles
		d ₂ - Identifying or solving problems
		d ₃ - Making inferences,formulating or testing hypothesis
		d ₄ - Seeking guidance on experimental procedure
		2e- <u>Pupil Refer to Teacher for the Purpose of:</u>
		e ₁ - Acquiring or confirming facts or principles
		e ₂ - Seeking guidance when identifying or solving problems
		e ₃ - Seeking guidance when making inferences,formulating or or testing hypothesis
		e ₄ - Seeking guidance on experimental procedure

where:

-  relatively low frequency of use, but not significant
-  relatively high frequency of use, but not significant
-  relatively high frequency of use, and is significant
-  relatively low frequency of use, and is significant
-  lack of use, and is significant

Moreover, teachers' directions were concentrated on those to sources for acquiring/confirming facts or principles (c_1),

making inferences/testing hypotheses (c_3) and guidance on experimental procedure (c_4). Teachers' statements in this group were concentrated on those of hypothesis or speculation (b_3) and of experimental procedure (b_4). This behaviour of a practical and fact-acquiring image of the science teacher was reflected in pupils' activities which were concentrated upon consulting or referring for the purpose of acquiring/confirming (d_1 and e_1), making inferences, formulating or testing hypotheses (d_3 and e_3), and seeking guidance on experimental procedure (d_4 and e_4).

CHAPTER 7Part II7.40 Analyses of Pupils' Achievement Tests7.41 Measuring pupils' Gains in Knowledge and understanding during the observational period in the three science subjects

The first part of this section is directed towards the measurement of the gain in pupils' cognitive knowledge and understanding after studying the observed topics, in biology, chemistry, and physics, during a four months period between January and April. To do so, pupils' scores were collected through the administration of the pre-test during December-January (1980-1981) and the post-test in the following May (1981). The difference between the two scores was calculated for each pupil in each of the three science areas.

As the pre-test scores on the three achievement tests differed only slightly from zero values, indicating little previous knowledge and understanding of the topics to be taught during the period January to April, as well as showing that there was little or no variance among the pre-test scores, a "residual mean gain" calculation was found to be of no advantage over the "raw-gain" calculations undertaken in this section. Thus the "raw-gain" calculations are the only ones reported in tables 18a to 18e.

To test the significance of the difference between the two values, the differences between pupils' two scores (i.e., pre-tests and post-tests) were subjected to a t-test for related groups. The t-test is seen by Bruning and Kintz (1968)¹ as one of the most commonly used techniques which is applied to test the significance of the difference between the means of two groups. The t-test is also considered as having the same power as the

1. Bruning, J.L. and Kintz, B.L. 1968, op.cit.

F-Test (Connolly, 1962).¹ This is because the t-test and the F-test are the most likely of all tests to reject the Null hypothesis when the H_0 is false (Siegel, 1956)². There are several formulae, however, for the computation of the t-test, each of which serves a different purpose. Thus, the t-test could be applied to assess the significance of the difference between, for example, a sample mean and the population mean; the means of unrelated groups; the mean of two related groups; and the difference among several means (see Bruning and Kintz, 1968; and Guilford, 1965).^{3 & 4} In this section the t-test for related groups was computed using the following formula:

$$t = \frac{\bar{X} - \bar{Y}}{\sqrt{\frac{\sum D^2 - \frac{(\sum D)^2}{N}}{N(N-1)}}} \quad (5)$$

where:

\bar{X} = the mean value of the post-test scores;

\bar{Y} = the mean value of the pre-test scores;

N = number of pupils; and

$\sum D^2$ = the sum of the difference score between each "X" and "Y" pairs squared.

The results of the t-test analyses are represented in tables 18a - 18e for each of the observed samples. From the results of these t-analyses, it is obvious that a significant gain in the intellectual achievement of the

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1. Connolly, G.T. and Slukin, W. 1962 "An Introduction to Statistics for the Social Science", Second Edition, Cleaver-Hume Press Ltd.
 2. Siegel, S. 1956, op.cit.
 3. Bruning, J.L. and Kintz, B.L. 1968, op.cit.
 4. Guilford, J.P. 1965 "Fundamental Statistics in Psychology and Education". Fourth Edition, McGraw-Hill Book Company.
 5. Bruning, L.James, Kintz, L.B. 1968, op.cit. (p.12).

Table 18a

Statistical Summary of Both Males' and Females' AchievementTest Data and Their Correlated t-test Analyses (N = 284)

Subject Areas	Achievement Test	Mean Score	Standard Deviation	d.f.s.	t value	P ≤
Biology	Pre-test (Y)	0.97	1.143	283	61.19	0.001
	Post-test (X)	11.41	2.726	283		
Chemistry	Pre-test (Y)	0.89	1.178	283	38.22	0.001
	Post-test (X)	10.06	4.123	283		
Physics	Pre-test (Y)	0.76	0.970	283	39.92	0.001
	Post-test (X)	8.35	3.180	283		

Table 18b

Statistical Summary of Male Pupils' Achievement Test Dataand Their Correlated t-test Analyses (N=153)

Subject Areas	Achievement Test	Mean Score	Standard Deviation	d.f.s.	t value	P ≤
Biology	Pre-test (Y)	0.902	1.075	152	41.78	0.001
	Post-test (X)	11.105	2.810	152		
Chemistry	Pre-test (Y)	0.909	1.221	152	27.10	0.001
	Post-test (X)	10.020	4.217	152		
Physics	Pre-test (Y)	0.771	0.942	152	27.30	0.001
	Post-test (X)	7.686	3.144	152		

observed pupils has occurred in all three studied areas, namely, biology, chemistry and physics. The t-values which represent the significance of the mean difference between the observed pupils pre- and post-achievement scores were found to be highly significant in all cases ($p < 0.001$).

Table 18c

Statistical Summary of Female Pupils' Achievement Test Data
and Their Correlated t-test Analyses (N = 131)

Subject Areas	Achievement Test	Mean Score	Standard Deviation	d.f.s.	t value	P \leq
Biology	Pre-test (Y)	1.038	1.218	130	45.75	0.001
	Post-test (X)	11.756	2.590			
Chemistry	Pre-test (Y)	0.863	1.128	130	26.98	0.001
	Post-test (X)	10.115	4.026			
Physics	Pre-test (Y)	0.741	0.997	130	30.78	0.001
	Post-test (X)	9.122	3.043			

Table 18d

Statistical Summary of "Group One" Pupils' Achievement Test
Data and Their Correlated t-test Analyses

Subject Areas	Achievement Test	Mean Score	Standard Deviation	d.f.s.	t value	P \leq
Biology	Pre-test (Y)	0.878	1.034	179	46.62	0.001
	Post-test (X)	11.028	2.737			
Chemistry	Pre-test (Y)	0.873	0.090	133	38.90	0.001
	Post-test (X)	9.90	4.23			
Physics	Pre-test (Y)	0.891	1.165	127	26.61	0.001
	Post-test (X)	8.16	3.35			

where:

"Group one" pupils are those who were taught by teachers classified as "Group one" teachers on the basis of their adopted method of teaching.

Table 18e

Statistical Summary of "Group Two" Pupils' Achievement Test
Data and Their Correlated t-test Analyses

Subject Areas	Achievement Test	Mean Score	Standard Deviation	d.f.s	t value	P ≤
Biology	Pre-test (Y)	1.115	1.302	103	40.77	0.001
	Post-test (X)	12.058	2.591			
Chemistry	Pre-test (Y)	0.608	0.870	149	24.70	0.001
	Post-test (X)	10.27	3.99			
Physics	Pre-test (Y)	0.845	1.191	155	27.45	0.001
	Post-test (X)	8.52	3.01			

Where:

"Group two" pupils are those who were taught by teachers classified as "Group two" teachers on the basis of their adopted method of teaching.

7.42 Measuring the Significance of the Difference Between The Achievement of Groups Within the Observed Kuwaiti Sample

The second part of this section is addressed to finding out if the gains in science achievement, based on the raw scores of the post-test, of

- 1) male pupils, are similar to those of the female pupils in the three observed science areas, and if the gains of
- 2) "group one" pupils (i.e., those who were taught by "Group one" teachers) are similar to those of "group two" pupils (i.e., those who were taught by "group two" teachers) in the three science areas.

In other words, did either the sex of the observed pupils or the two different styles of science teaching which were adopted by the two groups of teachers produce any differential effects on the pupils' cognitive achievement in the three observed science areas?

7.43 Statement of Hypotheses

Each of the above questions is stated in a form of a null hypothesis followed by the alternative form as follows:

1: H_0 - There are no significant differences between the achievements of the male pupils and those of the female pupils in the studied areas.

H_1 - There are significant differences between the achievements of the male pupils and those of the female pupils in the studied areas.

2: H_0 - There are no significant differences between the attainments of the "group one" pupils and those of "group two" pupils in biology, chemistry and physics.

H_1 - There are significant differences between the attainments of "group one" pupils and those of "group two" pupils in biology, chemistry and physics.

To test the above hypotheses, the data resulting from the raw scores of the observed pupils post-achievement tests, in the science topics observed, were subjected to an independent t-analysis using the following formula:

$$t = \frac{\bar{X} - \bar{Y}}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}} \quad (1)$$

where:

\bar{X}_1 = the mean value of sample one;

\bar{X}_2 = the mean value of sample two;

S_1 = the standard deviation of sample one;

S_2 = the standard deviation of sample two;

N_1 = the number of pupils in sample one; and

N_2 = the number of pupils in sample two.

The results of the *t*-analyses, which were carried out to find whether the gain in knowledge and understanding of the male ($N = 153$) and female ($N = 131$) groups differed significantly from each other in each of the three science areas, suggested that the observed female pupils achieved significantly better results in biology ($t = 2.03$, $P < 0.05$) and physics ($t = 3.886$, $P < 0.001$) than male pupils (see table 19a). On the other hand, no significant difference was found between the male ($N = 153$) and female ($N = 131$) groups in chemistry ($t = 0.20$, N.S.). Therefore, the first null hypothesis was rejected in both the cases of biology and physics. In the case of chemistry, since no significant difference was found between the achievement of the two sex groups the null hypothesis was accepted. Hence any difference between the gain in knowledge and understanding in chemistry of both male and female pupils was possibly due to chance and not to the superiority of one group over the other.

Moreover, the *t*-test which was carried out to assess the significance of the differences in the achievement between 'group one' and 'group two' pupils (see table 19b) indicated that the only significant difference was found between the achievement of these two groups in biology ($t = -3.16$, $P < 0.01$). Thus the null hypothesis which implied that the teaching method had no effect on pupils' achievement was rejected in the case of biology, at the 0.01 level of significance, and was accepted, on the other hand, in the cases of chemistry and physics.

Table 19aStatistical Summary of Male and Female Pupils' Post-testRaw Scores Used in the t-test Analyses (N = 284)

Subject Area	Sample	Number of Pupils	Mean Score	Standard Deviation	Estimated Standard Deviation	d.f.s.	t value	P ≤
Biology	Male	153	11.11	2.81	0.321	283	-2.03	0.05
	Female	131	11.76	2.59				
Chemistry	Male	153	10.02	4.22	0.490	283	-0.20	N.S.
	Female	131	10.12	4.03				
Physics	Male	153	7.69	3.15	0.368	283	-3.886	0.001
	Female	131	9.12	3.04				

Table 19bStatistical Summary of "Group One" and Group Two" PupilsPost-Test Raw Scores Used in the t-test Analyses (N=284)

Subject Area	Sample	Number	Mean Score	Standard Deviation	Estimated Standard Deviation	d.f.s.	t value	P ≤
Biology	Group One	180	11.03	2.75	0.326	283	-3.160	0.01
	Group Two	104	12.06	2.59				
Chemistry	Group One	127	9.90	3.99	0.489	283	-0.757	N.S.
	Group Two	157	10.27	4.23				
Physics	Group One	134	8.16	3.35	0.380	283	-0.947	N.S.
	Group Two	150	8.52	3.01				

7.50 Analysis of Pupils', Teachers' and Supervisors' Responses to What Constitutes a "Good" Science Teacher

This part of the study is directed towards measuring the degree of agreement between pupils, supervisors, and science teachers in Kuwait on the characteristics of a "good" science teacher.

Having finally selected the forty-six items (see Chapter 5, pp. 171-173) for the newly-constructed Perception Questionnaire, 284 pupils, 17 secondary-school science supervisors,¹ and 36 science teachers, who were observed in the main study during the period January to April, were asked to rate the qualities of a "good" science teacher (using the newly developed Perception Questionnaire). In this study, the qualities of a "good" science teacher were perceived in terms of three main aspects, namely,

- 1) teachers' classroom behaviour (24 items);
- 2) teachers' attitude (12 items) and
- 3) teachers' personality (10 items).

Each of the 337 participants i.e., pupils, supervisors, and teachers, was asked to state his/her degree of agreement or disagreement using a five-point scale, starting from strongly agree (5) to strongly disagree (1), on each of the items of the Perception Questionnaire. The following instructions were given to direct the 337 participants as to how they should respond to the Pupils' Perception Questionnaire:

-
1. The above-mentioned Secondary-School Science Supervisors are members from the Kuwaiti Ministry of Education, who visit the Kuwaiti secondary schools to supervise science teachers in biology, physics, and chemistry. Moreover, these supervisors also supervise the observed 36 science teachers (who were observed in this study) during the academic year 1980-1981.

Dear Pupil/Teacher/Supervisor

You have forty-six items describing the qualities of the "good" science teacher as seen by other science pupils, and I would like you:

First to read each of the following statements carefully:

Second to state your response on each statement by making a tick in one of the five columns you are given (nearby each statement). Therefore, if you

1. strongly agree with the statement put a tick (✓) in the first column;
2. only agree with the statement put a tick (✓) in the second column;
3. are not sure whether to agree or disagree with the statement, put a tick (✓) in the third column;
4. do not agree with the statement put a tick (✓) in the fourth column; and
5. strongly disagree with the statement put a tick (✓) in the fifth column.

As for example: The "good" science teacher is the one who:

1. Always put his white coat on.
2. Gives me a piece of chocolate whenever I give the right answer.

SA 5	A 4	NS 3	D 2	SD 1
--	--	✓	--	--
--	✓	--	--	--

One of the main areas the present researcher was interested in was to find out whether or not supervisors, teachers and pupils, in Kuwaiti secondary schools agreed with each other on what constituted the "good" science teacher. Therefore, the following research questions were of particular interest:

1. Do pupils agree with supervisors on the relative importance of the characteristics a "good" science teacher should possess?
2. Do pupils agree with their science teachers on the relative importance of the characteristics a "good" science teacher should hold?
3. Do science teachers agree with science supervisors on the relative importance of the characteristics a "good" science teacher should hold?

The ratings of the three separate groups (the ratings of male-female pupils and male-female teachers were also analysed separately), to the forty-six Perception Questionnaire items were collected and compared with each other by using the Spearman Rank-Order Correlation Coefficient (see Table 20).

It was felt necessary to determine whether the three groups, i.e., pupils, teachers, and supervisors responded with equal enthusiasm to the same perception questionnaire items. The following formula for rho, the rank-order correlation coefficient, describes the computational procedure followed in this study

$$\rho = 1 - \frac{6 \sum D^2}{N(N^2 - 1)} \quad (1)$$

where:

D = Difference in ranking given by two groups for each item; and

N = Number of pairs of scores (i.e., number of items).

The results of the Spearman Rank-Order Correlation analyses, based on the data detailed in Table 1, are represented in Table 21 a,b,c, and d.

1. Bruning, L.J. and Kintz, L.B., 1968, (p.156).

Table 20

Pupils', Teachers', and Supervisors' Rankings of Each of the Forty-Six Perception Questionnaire Items which Describe the Characteristics of a "Good" Science Teacher

Item Number	Pupils						Teachers						Super- visors	
	Mixed		Male		Female		Mixed		Male		Female		Sums of Ratings	Rank Order
	Sums of Ratings	Rank Order	Sums of Ratings	Rank Order	Sums of Ratings	Rank Order	Sums of Ratings	Rank Order	Sums of Ratings	Rank Order	Sums of Ratings	Rank Order		
2	1221	24.5	643	23.0	578	33.0	148	8.5	77	13.5	71	7.0	72	9.5
3	1221	24.5	658	29.5	563	25.5	140	4.5	75	8.0	65	2.0	74	14.0
4	1050	7.0	551	6.0	449	3.0	151	11.0	77	13.5	74	8.0	73	12.0
10	937	1.0	489	1.0	448	2.0	132	2.0	62	3.0	70	5.0	59	2.0
11	1108	9.0	597	10.5	511	9.0	173	41.0	85	39.5	88	43.0	85	45.0
12	1193	19.0	643	23.0	550	18.5	146	7.0	71	5.0	75	9.5	72	9.5
18	1363	46.0	719	44.5	644	46.0	174	44.0	84	35.0	90	45.5	85	45.0
19	1306	41.5	689	38.5	617	44.5	174	44.0	87	44.5	87	40.5	82	30.5
22	1306	41.5	689	38.5	617	44.5	167	32.5	84	35.0	83	26.5	81	36.5
26	1164	16.5	612	14.5	552	21.5	145	6.0	77	13.5	68	3.0	71	7.0
27	1335	44.5	719	44.5	616	42.5	174	44.0	87	44.5	87	40.5	81	36.5
32	1278	38.5	689	38.5	589	36.0	170	38.5	83	32.0	87	40.5	81	36.5
33	1136	12.5	612	14.5	524	12.0	156	13.5	78	18.0	78	11.0	78	25.5
38	1250	32.0	673	34.0	577	29.0	173	41.5	85	39.5	88	43.0	83	42.0
39	1022	5.0	536	4.0	486	6.0	116	1.0	56	1.0	60	1.0	40	1.0
40	1335	44.5	719	44.5	616	42.5	161	19.0	77	13.5	84	30.0	73	12.0
43	1077	8.0	566	8.0	511	9.5	162	21.5	81	25.5	81	18.0	71	7.0
46	1221	24.5	643	23.0	578	33.0	163	24.0	82	29.5	81	18.0	73	12.0
49	1250	32.0	673	34.0	577	29.0	164	26.0	85	39.5	79	13.0	83	42.0
50	1250	32.0	672	32.0	578	33.0	169	36.0	86	42.5	83	26.5	85	45.0
53	1250	32.0	674	36.0	576	27.0	176	46.0	89	46.0	87	40.5	83	42.0
66	1250	32.0	658	29.5	592	37.5	165	28.5	84	35.0	81	18.0	79	29.5
67	1193	19.0	641	18.0	552	21.5	160	17.0	77	13.5	83	26.5	75	15.5
69	966	2.0	521	3.0	445	1.0	156	13.0	74	7.0	82	22.5	68	5.0

Table 20 (continued)

Item Number	Pupils						Teachers						Super- visors	
	Mixed		Male		Female		Mixed		Male		Female		Sum of Ratings	Rank Order
	Sum of Ratings	Rank Order	Sum of Ratings	Rank Order	Sum of Ratings	Rank Order	Sum of Ratings	Rank Order	Sum of Ratings	Rank Order	Sum of Ratings	Rank Order		
71	1221	24.5	643	23.0	578	33.0	170	38.5	84	35.0	86	36.5	80	32.5
74	1022	5.0	551	6.0	471	4.5	140	4.5	70	4.0	70	5.0	77	21.5
77	1193	19.0	643	23.0	550	18.5	161	19.0	81	25.0	80	15.0	81	36.5
78	1306	41.5	704	41.5	602	39.5	158	15.0	77	13.5	81	18.0	76	18.5
79	1221	24.5	643	23.0	578	33.0	165	28.5	82	29.5	83	26.5	76	18.5
80	1306	41.5	704	41.5	602	39.5	163	24.0	81	25.5	83	22.5	78	25.5
84	1250	32.0	658	29.5	592	37.5	167	32.5	82	29.5	85	33.0	80	32.5
87	994	3.0	505	2.0	489	7.0	161	19.0	80	22.0	81	13.0	78	25.5
91	1250	32.0	643	23.0	607	41.0	155	12.0	76	9.0	76	13.0	67	14.0
97	1278	38.5	719	44.5	559	23.0	165	28.5	79	19.5	86	3.5	71	7.0
100	1193	19.0	643	23.0	550	18.5	163	24.0	81	25.5	82	22.5	82	39.5
104	1136	12.5	597	10.5	539	15.0	159	16.0	77	13.5	82	22.5	78	25.5
28	1193	19.0	643	23.5	550	18.0	139	3.0	60	2.0	79	13.0	73	25.5
106	1136	12.5	627	17.0	509	8.0	166	31.0	82	29.5	84	30.0	79	29.5
109	1221	24.5	658	29.5	563	25.5	165	28.5	79	19.5	86	36.5	75	15.5
114	1136	12.5	597	10.5	539	15.0	169	36.0	84	35.0	85	33.0	80	32.5
115	1250	32.0	689	38.5	561	24.0	169	36.0	85	39.5	84	30.0	76	18.5
118	1022	5.0	551	6.0	471	4.5	162	21.5	77	13.5	85	33.0	80	32.5
119	1136	12.5	612	14.5	524	12.0	150	10.0	80	22.0	70	5.0	78	25.5
121	1136	12.5	612	14.5	524	12.0	178	8.5	73	6.0	75	9.5	65	3.0
122	1250	32.0	673	34.0	577	29.0	172	40.0	86	42.5	86	36.5	77	21.5
123	1164	16.5	597	10.5	539	15.0	168	34.0	80	22.0	88	44.0	76	18.5

Table 21a

Spearman Rank Order Correlation Coefficient of Pupils' and Supervisors' Ratings on the Perception Questionnaire

Groups Compared	No. of Items	rho value	P ≤
i) Pupils and Supervisors	46	0.36	0.05
ii) Male Pupils and Supervisors	46	0.37	0.01
iii) Female Pupils and Supervisors	46	0.32	0.01

Table 21b

Spearman Rank Order Correlation Coefficient of Pupils' and Teachers' Ratings on the Perception Questionnaire

Groups Compared	No. of Items	rho value	P ≤
i) Pupils and Teachers	46	0.53	0.01
ii) Male Pupils and Male Teachers	46	0.52	0.001
iii) Female Pupils & Female Teachers	46	0.40	0.01

Table 21c

Spearman Rank Order Correlation Coefficient of Teachers' and Supervisors' Ratings on the Perception Questionnaire

Groups Compared	No. of Items	rho value	P ≤
i) Teachers and Supervisors	46	0.72	0.01
ii) Male Teachers and Supervisors	46	0.75	0.001
iii) Female Teachers and Supervisors	46	0.57	0.001

Table 21d

Spearman Rank Order Correlation Coefficient of Male-and-Female Pupils' Ratings and Male-and-Female Teachers' Ratings on the Perception Questionnaire

Groups Compared	No. of Items	rho value	P ≤
i) Male and Female Pupils	46	0.86	0.001
ii) Male and Female Teachers	46	0.68	0.001

7.51 Items That were Rated by Pupils, Supervisors and Teachers as the Most and Least Important Characteristics of a "good" Science Teacher

From the above rho values, it is noticed that the highest degree of agreement, on the perceived characteristics of the "good" science teacher was found between male and female pupils ($\rho = 0.86$, $p < 0.001$). This means that both male and female pupils in Kuwaiti high schools held similar views of the "good" science teacher whom they either enjoyed working with, or would like to work with during their school years.

The second highest degree of agreement, on the perceived characteristics of a "good" science teacher, was found between male and female teachers ($\rho = 0.68$, $p < 0.001$), and teachers with supervisors ($\rho = 0.72$, $p < 0.01$). Hence the observed thirty-six teachers and their supervisors from Kuwait held very similar opinions as to what aspects constituted the "good" science teacher. Finally, the least degree of agreement, that resulted from the rho analyses, on the perceived characteristics of the "good" science teacher, occurred between supervisors and pupils ($\rho = 0.36$, $p < 0.05$), in Kuwaiti Secondary Schools.

From the data represented in table 20 above, which resulted from the ratings of the observed 284 pupils, thirty-six science teachers, and seventeen science supervisors, it can be seen that there were eight characteristics of a "good" science teacher which all three groups regarded as being the most important to possess. Those most important qualities of a "good" science teacher (in terms of sums of ratings) as described by pupils, teachers, and supervisors in Kuwaiti high schools were as follows:

- 1) showing trust and respect for one's pupils (item 18);
- 2) displaying fairness in handling and grading classroom exams and assignments (item 22);
- 3) not allowing personal problems to interfere with the treatment of pupils (item 19);
- 4) not wasting classtime by late attendance (item 38);

- 5) not wasting classtime by discussing irrelevant subjects that are not linked with the course topic (item 53);
- 6) not reprehending the whole class when only one or few of the pupils have done wrong (item 32);
- 7) using relevant audio-visual aids to clarify the discussed subject matter (item 50); and lastly,
- 8) not being prejudiced in his treatment of and behaviour to a pupil on the basis of nationality (item 27).

On the other hand, the ratings of the participant pupils, science teachers and science supervisors indicated little attention paid to the following characteristics:

- 1) strict control of classroom discussion to topics only mentioned in the course text-book and not using other sources in an effort to save valuable time (item 4).
- 2) deliberately not administering exams on the day that has been decided upon (item 69);
- 3) behaving impartially towards pupils regardless of their level of ability (item 39);
- 4) not leaving any unfinished experiments (item 121); and finally,
- 5) not holding classroom activities as scheduled (item 10).

7.52 Items that were rated by Male and Female Pupils as the most and least Important Characteristics of a "Good" Science Teacher

As indicated above, this section is concerned with items that were viewed similarly by both male and female pupils in Kuwaiti high schools. Those items that showed an inverse opinion between both the three groups and between the sexes of pupils and teachers are discussed later on in this chapter. Items that were rated highly, that is, of most importance (see table 20) by both sexes were:

- 1) trust and respect shown by the teacher towards his/her pupil (item 18);

- 2) giving pupils the opportunity for learning by seeking out information on an individual level (item 104);
- 3) asking pupils to interpret their observations of any experimental work and to apply them to new situations (item 114);
- 4) not adopting different techniques over a range of different subjects (item 118);
- 5) limiting classroom questions to only those expected in the Secondary School Certificate Examination (item 87);
- 6) a strict personality who consequently does not allow cheating (item 11);
- 7) treating pupils according to their popularity at school in previous years (item 43); and finally,
- 8) not giving pupils the impression that he/she is proud of them (item 33).

7.53 Items that were rated by Male and Female Teachers as the Most/Least Important Characteristics of a "Good" Science Teacher

In addition to those items that were agreed upon by the three participant groups (i.e., pupils, teachers, and supervisors), as of the Most/Least important of the qualities of a "good" science teacher, the similarities between the opinions of male and female teachers were also analyzed. The following items were regarded by both male and female teachers as the most important qualities of a "good" science teacher:

- 1) not allowing cheating during examination or help from other pupils during class questioning (item 11);
- 2) asking questions (rather than just rationally expanding information) during a class session in order to hold the pupils' attention and interest (item 71).
- 3) treating pupils of other nationalities differently (item 27)
- 4) Asking pupils to interpret their observation at any experimental work and to apply them to new situations (item 114); and finally,
- 5) fearing pupils' questions (item 122).

Items that were given the least emphasis by both male and female teachers (see table 20), in Kuwaiti high schools, as important qualities of a "good" science teacher were:

- 1) showing reasonable signs of humour (item 3),
- 2) giving long and difficult exams (item 74),
- 3) ordering pupils around all the time for no valid reasons (item 12).

7.54 Analyses of Pupils', Teachers' and Supervisors' Ratings of the Personality, Attitude and Classroom behaviour of a "Good" Science Teacher

With the knowledge of the above rank order correlation coefficients, resulting from ratings of pupils, teachers and supervisors as to the qualities of a "good" science teacher in general, an additional pertinent question was asked, concerning the items giving most agreement and most disagreement to either personality, attitude or classroom behaviour, between the various participants. Hence it would be worth finding out which items, measuring each of the following three main aspects, namely teachers' personality, attitude or classroom behaviour, describing the characteristics of the "good" science teacher (and the different groups), male-female pupils, male-female teachers, pupils-teachers, pupils-supervisors and teachers-supervisors - agree or disagree with most.

To seek this information, the same data resulting from the responses of pupils, teachers and supervisors (represented in table 22 below) were rearranged separately on the basis of each of these three types of teacher characteristics.

A Spearman rank order correlation coefficient was carried out in tables 22, a, b, c, and d; 23a, b, c, d; and 24a, b, c, and d below.

7.55 Rank Order Correlation Coefficient Analyses Between Groups for Each of the Three Types of Teacher Characteristics

I -I On the basis of type-one Characteristics, i.e. a "good" teacher's classroom behaviour (24 items) the degree of agreement between each of two groups (i.e., male-female pupils, pupils-teachers, pupils-supervisors, teachers-supervisors, and male-female teachers) was calculated after ranking each of the twenty-four items (of the Perception Questionnaire measuring teachers' characteristics) on the basis of its relative importance (starting from the lowest to the highest ranked items) within each of the groups.

In general, the calculated degrees of agreement as to the perception of a "good" teacher's classroom behaviour between the three participant groups were indicated as follows:

- a) teachers and supervisors $\rho = 0.42$ $p < 0.05$
- b) teachers and pupils $\rho = 0.24$ N.S.
- c) supervisors and pupils $\rho = -0.21$ N.S.

Thus, from the above values of ρ , it was noted that the only significant agreement on what constituted the classroom behaviour of a "good" science teacher, was found between teachers and supervisors ($\rho = 0.42$, $p < 0.05$). The results of the rank-order correlation analyses for all possible combinations of groups, namely, male-female pupils, male-female teachers, pupils-teachers, teachers-supervisors and pupils-supervisors, in relation to "type one" items within the Perception Questionnaire are represented in tables 22a,b,c, and d below.

Table 22a

Spearman Rank Order Correlation Coefficient Between the Ratings of Pupils and Supervisors on the Classroom Behaviour of a "Good" Science Teacher

Groups Compared	No.of Items	rho-value	P \leq
i) Pupils and Supervisors	24	-0.21	N.S.
ii) Male Pupils and Supervisors	24	-0.16	N.S.
iii) Female Pupils and Supervisors	24	-0.18	N.S.

Table 22b

Spearman Rank Order Correlation Coefficient Between the Ratings of Pupils and Teachers on the Classroom Behaviour of a "good" Science Teacher

Groups Compared	No.of Items	rho-value	P \leq
i) Pupils and Teachers	24	0.24	N.S.
ii) Male Pupils & Male Teachers	24	0.27	N.S.
iii) Female Pupils & Female Teachers	24	0.12	N.S.

Table 22c

Spearman Rank Order Correlation Coefficient Between the Ratings of Teachers and Supervisors on the Classroom Behaviour of a "Good" Science Teacher

Groups Compared	No.of Items	rho-value	P \leq
i) Teachers and Supervisors	24	0.42	0.05
ii) Male Teachers & Supervisors	24	0.62	0.001
iii) Female Teachers & Supervisors	24	0.06	N.S.

Table 22d

Spearman Rank Order Correlation Coefficient Between the Ratings of Male-Female Pupils and Male-Female Teachers on the Classroom Behaviour of a "Good" Science Teacher

Groups Compared	No.of Items	rho-value	P \leq
i) Male and Female Pupils	24	0.82	0.001
ii) Male and Female Teachers	24	0.35	0.05

From the above results, it was noticed that the highest significant degree of agreement was found between male and female pupils ($\rho = 0.82$, $p < 0.001$), male teachers and supervisors ($\rho = 0.62$, $p < 0.001$), and male and female teachers ($\rho = 0.35$, $p < 0.05$). However, no significant agreement was found between pupils and teachers, ($\rho=0.24$, N.S.) or between female teachers and supervisors ($\rho = 0.06$, N.S.).

II On the basis of type-two characteristics, i.e., a "good" teacher's personality (10 items)

The degree of agreement between the three groups, namely pupils, teachers and supervisors was indicated from the rank-order correlation coefficient as follows:

a) teachers and supervisors	$\rho = 0.83$ $p < 0.01$
b) teachers and pupils	$\rho = 0.62$ $p < 0.05$
c) pupils and supervisors	$\rho = 0.55$ $p < 0.05$

Thus, on the basis of teacher-personality items, significant agreement was found within the three sets of comparisons. Although all three comparisons indicated significant agreement as to a "good" teacher's personality, the degree of agreement between supervisors and teachers was greater than that between pupils and either supervisors or science teachers. The complete summary of results of the relationships among all five groups, i.e., male-female pupils, pupils-teachers, pupils-supervisors, male-female teachers and teachers-supervisors, as indicated by the rank-order correlation coefficients for the "type two" characteristics (personality items), as measured by the Perception Questionnaire, are given in tables 23a, b, c and d as follows:

Table 23a

Spearman Rank Order Correlation Coefficient Between the Ratings of Pupils and Supervisors on the Personality of a "Good" Science Teacher

Groups Compared	No.of Items	rho-value	P \leq
i) Pupils and Supervisors	10	0.55	0.05
ii) Male Pupils and Supervisors	10	0.56	0.05
iii) Female Pupils and Supervisors	10	0.26	N.S.

Table 23b

Spearman Rank Order Correlation Coefficient Between the Ratings of Pupils and Teachers on the Personality of a "Good" Science Teacher

Groups Compared	No.of Items	rho-value	P \leq
i) Pupils and Teachers	10	0.62	0.05
ii) Male pupils and male Teachers	10	0.75	0.01
iii) Female pupils and Female Teachers	10	0.23	N.S.

Table 23c

Spearman Rank Order Correlation Coefficient Between the Ratings of Teachers and Supervisors on the Personality of a "Good" Science Teacher

Groups Compared	No.of Items	rho-value	P \leq
i) Teachers and Supervisors	10	0.83	0.01
ii) Male Teachers and Supervisors	10	0.80	0.01
iii) Female Teachers and Supervisors	10	0.81	0.01

Table 23d

Spearman Rank Order Correlation Coefficient Between the Ratings of Male-Female Pupils and Male-Female Teachers on the Personality of a "Good" Science Teacher

Groups Compared	No.of Items	rho-value	P \leq
i) Male and Female Pupils	10	0.70	0.01
ii) Male and Female Teachers	10	0.77	0.01

From the above rho values, it is noticed that female pupils agree significantly with the observed male pupils on the personality of a "good" science teacher ($\rho = 0.7, p < 0.01$), the rho analyses with female pupils, however, did not show any significant agreement either with supervisors ($\rho = 0.26, N.S.$) or with their female teachers ($\rho = 0.23, N.S.$) on their perception of the personality of a "good" teacher. On the other hand, male pupils agreed significantly with both supervisors ($\rho = 0.56, p < 0.05$) and with male teachers ($\rho = 0.75, p < 0.01$) on those items of the Perception Questionnaire characterizing the personality of the "good" science teacher.

III On the basis of "type-three" characteristics, i.e., the "good"

Teacher's attitude

The degree of agreement between the three groups, namely pupils, teachers, and supervisors was indicated from the rank-order correlation coefficients as follows:

- | | | |
|-----------------------------|----------------|-------------|
| a) teachers and supervisors | $\rho = 0.82$ | $p < 0.001$ |
| b) teachers and pupils | $\rho = 0.814$ | $p < 0.001$ |
| c) pupils and supervisors | $\rho = 0.930$ | $p < 0.001$ |

From the above rho values, one could infer that items characterizing the attitude of a "good" science teacher, were ranked with almost equal enthusiasm by pupils, teachers and supervisors. The degree of agreement between pupils and supervisors ($\rho = 0.93, p < 0.001$) was very high indeed.

The results of the rank-order correlation coefficient of the five groups (i.e., male-female pupils, male-female teachers, teachers-supervisors, pupils-supervisors, and pupils-teachers) in relation to the items associated with "type-three" characteristics are represented in tables 24a, b, c and d.

Table 24a

Spearman Rank Order Correlation Coefficient Between the Ratings of Pupils and Supervisors on the attitude of a "Good" Science Teacher

Groups Compared	No.of Items	rho-value	P \leq
i) Pupils and Supervisors	12	0.93	0.001
ii) Male Pupils and Supervisors	12	0.92	0.001
iii) Female Pupils and Supervisors	12	0.91	0.001

Table 24b

Spearman Rank Order Correlation Coefficient Between the Ratings of Pupils and Teachers on the Attitude of a "Good" Science Teacher

Groups Compared	No.of Items	rho-value	P \leq
i) Pupils and Teachers	12	0.81	0.001
ii) Male Pupils and Male Teachers	12	0.81	0.001
iii) Female Pupils and Female Teachers	12	0.71	0.001

Table 24c

Spearman Rank Order Correlation Coefficient Between the Ratings of Teachers and Supervisors on the Attitude of a "Good" Science Teacher

Groups Compared	No.of Items	rho-value	P \leq
i) Teachers and Supervisors	12	0.82	0.001
ii) Male Teachers and Supervisors	12	0.83	0.001
iii) Female Teachers and Supervisors	12	0.79	0.001

Table 24d

Spearman Rank Order Correlation Coefficient Between the Ratings of Both Male-Female Pupils and Male-Female Teachers on the attitude of a "Good" Science Teacher

Groups Compared	No.of Items	rho-value	P \leq
i) Male and Female Pupils	12	0.92	0.001
ii) Male and Female Teachers	12	0.80	0.001

From the above rho values, it was concluded that all participants in this study agreed substantially ($p < 0.001$, for all comparisons between Groups) on the twelve items, characterising the attitudes of a "good" science teacher towards pupils and his fairness towards them.

7.56 Items that Pupils rated as most or least Important Qualities of a "Good" Science Teacher but which did not coincide with the Supervisors' or Teachers' Ratings

As indicated in the heading, the final analysis is concerned with items that were significantly deemed as of least or most important to pupils but not by the teacher or supervisors (see Table 20). The significance of the disagreement among those items showing greatest frequency differences was found using the t-test for independent groups (see table 25a and b). These items are:

- 1) not allowing cheating during examination or help from other pupils during class questioning (item 11);
Pupils in Kuwaiti high schools rated this area as one of the least important items whereas teachers and supervisors viewed it as of importance;
- 2) "the summarization and review of the main ideas of a subject at the end of each lesson" (item 40). Whereas the pupils valued this as of high importance, the teachers and supervisors in Kuwaiti high schools, listed other items as of greater importance;
- 3) "asking pupils to interpret their experimental findings and apply them to new situations" (item 114). Pupils paid little attention to this while teachers and supervisors rated this highly; and finally,
- 4) "adopting different teaching techniques with different topics" (item 118). Here, pupils paid least attention to this item whereas teachers paid moderate attention and supervisors gave a rating of high importance.

Table 25a

t-test for Measuring the Significance of Difference Between
Pupils' and Supervisors' Ratings of the Characteristics of
a "Good" Science Teacher

Item No.	Pupils' Ratings		Supervisors' Ratings		t-value	P \leq
	Mean Score of the item	s.d. of the item	Mean Score of the item	s.d. of the item		
11	3.90	1.34	5.00	0.50	15.7	0.001
40	4.70	0.76	4.30	0.59	2.67	0.01
114	4.00	1.40	4.70	0.47	5.00	0.001
118	3.60	1.68	4.70	0.47	7.33	0.001

Table 25b

t-test for Measuring the Significance of Difference Between
Pupils' and Teachers' Ratings of the Characteristics of a
"Good" Science Teacher

Item No.	Pupils' Ratings		Supervisors' Ratings		t-value	P \leq
	Mean Score of the item	s.d. of the item	Mean Score of the item	s.d. of the item		
11	3.90	1.34	4.80	0.47	8.18	0.001
114	4.00	1.41	4.30	1.10	5.00	0.001

7.57 Items Representing Disagreement Between the Ratings of Male and
Female Pupils to the Characteristics of a "Good" Science Teacher

The only significant (see table 25c) item that male and female pupils in Kuwaiti high schools disagreed upon was "asking questions during any practical work to hold pupils' attention" (item 97). Male pupils ranked this point as most important whereas female pupils gave this quality only a moderate emphasis (see table 20).

Table 25c

t-test for Measuring the Significance of Difference Between Female
and Male Pupils' Ratings of the Characteristics of a "Good" Science
Teacher

Item No.	Ratings of Female Pupils		Ratings of Male Pupils		t- value	P \leq
	Mean Score of the item	s.d. of the item	Mean Score of the item	s.d. of the item		
97	4.3	1.14	4.7	0.42	3.64	0.001

7.58 Items Representing Disagreement Between the Ratings of Male and Female
Teachers to the Characteristics of a "Good" Science Teacher

The following three items showed the most significant disagreement (see table 25d) between male and female teachers in Kuwaiti high schools. These items were rated by female teachers as highly important whereas male teachers regarded them as not so very important (see table 20). These items were:

- 1) "summarizing and reviewing the main ideas of the subject matter at the end of each session" (item 40);
- 2) "discussing the kind of evidence behind the truth of any experiment" (item 109); and finally
- 3) "changing most of the required classroom practical work into oral/theoretical ones" (item 123).

Table 25d

t-test for Measuring the Significance of Difference Between Female
and Male Teachers' Ratings of the Characteristics of a "Good"

Science Teacher

Item No.	Ratings of Female Teachers		Ratings of Male Teachers		t value	P \leq
	Mean Score of the Item	s.d. of the item	Mean Score of the Item	s.d. of the item		
40	4.7	0.49	4.3	0.58	2.80	0.01
109	4.8	0.43	4.4	0.61	2.20	0.05
123	4.9	0.32	4.4	0.86	2.27	0.05

7.60 The Degree of Agreement Between the Perceptions of Pupils and Science
Supervisors as to the Characteristics of the Observed Biology, Chemistry
and Physics Teachers

This section is directed towards assessing the degree of agreement between the observed 284 pupils and the 17 science supervisors¹ on the actual classroom characteristics of the observed science teachers. The evaluated science teachers are those who carried out the teaching of the observed biology, chemistry, and physics topics (see appendix A-1,2 and 3) during the period January to April 1981). The characteristics of the observed science teachers were measured using the newly-developed Perception Questionnaire (see pp. 171-173).

It was thought that it would be of some considerable interest to find out if the observed pupils and science supervisors in Kuwaiti high schools agreed on their perception of the 36 observed science teachers. Pupils'

-
1. The participant 17 science supervisors are those members of the Kuwaiti Ministry of Education who supervise the teaching of science in all Kuwaiti high schools. Some of those supervisors are responsible for the teaching practice in their speciality (i.e., biology, chemistry, and physics) for more than one school/teacher. Hence the situation in this study where there are only 17 supervisors responsible for 36 science teachers.

ratings of their science teachers' characteristics might be quite different from those made by the supervisors from the Kuwaiti Ministry of Education (of the same teachers). Each group might perceive teachers' characteristics in a distinctive way. On the other hand, pupils and supervisors might significantly agree on such ratings.

To explore these perceptions among pupils and supervisors, the following null hypotheses are stated. The corresponding alternative hypotheses are also included:

1: H_0 - There is no significant agreement between chemistry pupils and chemistry supervisors on the ratings of the teaching characteristics of the observed twelve chemistry teachers in Kuwaiti high schools.

H_1 - There is significant agreement between chemistry pupils and chemistry supervisors on the ratings of the teaching characteristics of the observed twelve chemistry teachers in Kuwaiti high schools.

2: H_0 - There is no significant agreement between biology pupils and biology supervisors on the ratings of the teaching characteristics of the observed twelve biology teachers in Kuwaiti high schools.

H_1 - There is significant agreement between biology pupils and biology supervisors on the ratings of the teaching characteristics of the observed twelve biology teachers in Kuwaiti high schools.

3: H_0 - There is no significant agreement between physics pupils and physics supervisors on the ratings of the teaching characteristics of the observed twelve physics teachers in Kuwaiti high schools.

H_1 - There is significant agreement between physics pupils and physics supervisors on the ratings of the teaching characteristics of the observed twelve physics teachers in Kuwaiti high schools.

To test these null hypotheses, i.e., the lack of any significant agreement between both pupils and supervisors on the ratings of the teaching characteristics of the observed teachers, the 284 participant pupils and 17 science supervisors (who observed the same 36 science teachers during

the academic year 1980-1981) were asked to rate the observed science teachers using the items of the finalised form of the Perception Questionnaire, in May 1981, on a five-point scale starting from strongly agree (5) to strongly disagree (1). Both groups responded to the Perception Questionnaire as follows:

The following statements characterise your biology, chemistry, and physics teachers; please place a tick (✓) in one of the five blocks (columns) provided with each statement, to show your degree of agreement or disagreement with them (concerning each teacher separately). For example:

biology
1. My chemistry teacher always smiles
physics

S.A.	A.	N.S.	D.	S.D.
✓	--	--	--	--
--	✓	--	--	--
--	--	--	✓	--

Where: S.A. = strongly agree; A = agree; N.S. = not sure;

D = disagree; and S.D. = strongly disagree.

The data resulting from the reaction of both pupils and supervisors to each of the 46 items of the Perception Questionnaire were then collected and analysed using the Pearson product moment correlation coefficient (see table 26b). Three sets of correlation analyses, i.e., one for each scientific discipline, were carried out between the perception of both pupils and supervisors to each of the 36 observed teachers. The opinions of pupils and supervisors regarding each individual teacher were examined separately by correlating the pupils' mean ratings of each of the 46 items with those of the supervisors regarding the same item (see table 26a). In other words, each of the 36 science teachers was evaluated by his/her supervisor and by his/her own pupils. Hence the evaluation of the characteristics of one teacher would not affect the evaluation of such characteristics of another teacher.

On the basis of the results represented in table 26b, it is clear that

both biology pupils and biology supervisors significantly agreed on the evaluation of all the observed biology teachers except two (one male and one female biology teacher). In other words 83% (i.e., ten out of twelve) of the evaluated biology teachers were rated quite similarly by both pupils and supervisors. Moreover the degrees of agreement between biology pupils and biology supervisors ranged from 0.161 ($p = \text{N.S.}$) up to 0.488 ($p < 0.001$). Therefore overall the null hypothesis is rejected in favour of the alternative hypothesis, i.e., there is significant agreement between pupils and supervisors with regard to the characteristics of biology teachers, which they both observed.

Regarding the evaluation of the observed chemistry teachers by their pupils and supervisors, significant agreements were found between the opinions of the teacher's own chemistry pupils and their supervisors in ten classrooms. In other words, the perceptions of female pupils in two chemistry classes did not coincide with those of their chemistry teachers' supervisors when evaluating the behaviour of these two female chemistry teachers. Moreover, the degrees of agreement between the twelve chemistry supervisors and their chemistry pupils was found to range between 0.033 ($p = \text{N.S.}$) and 0.609 ($p < 0.001$). Hence, the null hypothesis, relating to the chemistry teachers is accepted in two cases, but rejected in ten cases. That is in, 83% (i.e., ten out of twelve) of the evaluated chemistry teachers the null hypothesis was rejected.

Lastly, from the values of the Pearson correlation coefficients represented in table 28b, it can be seen that physics pupils in eight out of twelve classes (i.e., 67% of the evaluated cases) agreed significantly with their physics teachers' supervisors as to their ratings of the observed physics teachers. The degrees of agreement between the two groups, however, were found to range between 0.006 ($p = \text{N.S.}$) and 0.444 ($p < 0.001$). In this instance, pupils in two female and two male classes differed in their overall opinions from those of their physics teachers' supervisors with regard to

these teachers' characteristics. Hence the null hypothesis is accepted on four occasions while the alternative hypothesis is accepted on eight occasions.

Table 26a

Example of the Statistical Data used for the Calculation of the Pearson Product Moment Correlation Coefficient Between the Mean Rating of Chemistry Pupils and the rating of a Chemistry Supervisor of the Characteristics of one of the Chemistry Teachers (i.e. teacher No.5)

Item No	Mean Ratings of Pupils	Ratings of Supervisor	Item No	Mean Ratings of Pupils	Ratings of Supervisor	Item No	Mean Ratings of Pupils	Ratings of Supervisor	Item No	Mean Ratings of Pupils	Ratings of Supervisor
1	3.7	5	13	2.6	5	25	2.2	5	37	2.5	4
2	3.4	5	14	4.2	5	26	3.8	5	38	3.0	4
3	3.7	4	15	3.2	5	27	2.5	4	39	2.7	5
4	2.7	5	16	2.4	1	28	2.3	2	40	2.1	1
5	2.8	5	17	2.5	5	29	1.5	2	41	2.4	4
6	3.9	4	18	3.5	5	30	3.2	5	42	2.4	5
7	3.4	5	19	4.3	5	31	2.6	4	43	2.9	3
8	3.3	3	20	2.1	1	32	3.7	2	44	2.4	4
9	3.4	5	21	3.2	5	33	2.6	2	45	2.6	5
10	3.9	5	22	2.9	2	34	2.6	2	46	3.2	4
11	3.3	5	23	2.0	2	35	2.6	5			
12	4.0	1	24	3.3	5	36	2.9	5			

where:

The mean score of an item = the sum of the pupil evaluation score for that item divided by the number of pupils in the class.

Table 26b

Correlation Between the General Perception of both Pupils and Science Supervisors of the 36 observed Science Teachers regarding their classroom characteristics as measured by the Perception Questionnaire

Teacher No.	Sex of Teacher	Biology		Chemistry		Physics	
		r	p ≤	r	p ≤	r	p ≤
1	♂	0.181	N.S.	0.520	0.001	0.273	0.05
2	♂	0.335	0.01	0.373	0.01	0.006	N.S.
3	♂	0.365	0.01	0.609	0.001	0.240	0.05
4	♂	0.407	0.01	0.290	0.05	0.285	0.05
5	♂	0.356	0.01	0.374	0.01	0.444	0.001
6	♂	0.380	0.01	0.290	0.05	0.157	N.S.
7	♀	0.161	N.S.	0.389	0.01	-0.157	N.S.
8	♀	0.488	0.001	0.261	0.05	0.109	N.S.
9	♀	0.290	0.05	0.414	0.01	0.273	0.05
10	♀	0.245	0.05	0.458	0.001	0.293	0.05
11	♀	0.381	0.01	0.187	N.S.	0.384	0.001
12	♀	0.361	0.01	0.033	N.S.	0.413	0.01

7.7 Assessing the Relationship between the sex of Pupils or Teachers and Pupils' Perceptions of the Characteristics of their Biology, Chemistry, and Physics Teachers

In this section further analyses were undertaken to assess the relationship between the sex of pupils or teachers and the perceptions of pupils as to the characteristics of teachers in the classroom (as measured by the newly-developed Perception Questionnaire - see pp. 171-173). In Kuwaiti high schools girls are always taught by female teachers and boys by male teachers.

Pupils' perception scores based on their ratings of their biology, chemistry, and physics teachers (see pp. 272-273) on items of the Pupils' Perception Questionnaire were analyzed for boys and girls separately. Using these results of pupils' perception scores answers to the following questions were sought.

1. Does the sex of pupils or teachers have a significant relationship to the way pupils perceive the general classroom characteristics of their science teachers, as measured by the Pupils Perception Questionnaire? In other words, do boys rate their teachers higher than girls in the questionnaire items?
2. Does the sex of pupils or teachers have a significant relationship to the way girls and boys perceive each of different dimensions of behaviours, namely, personality, attitude, and classroom behaviours of their biology, chemistry, and physics teachers?

Statement of Hypotheses

Each of the above questions is stated in the form of both a null hypothesis and an alternative hypothesis (see pp. 120-121) which are as follows:

- 1: H_0 The sex of pupils or teachers has no significant relationship with the way pupils perceive the general classroom characteristics, as measured by

their ratings on the Pupil Perception Questionnaire, of their biology, chemistry and physics teachers.

H_1 - The sex of pupils or teachers has a significant relationship with the way pupils perceive the general classroom characteristics, as measured by their ratings on the Pupil Perception Questionnaire, of their biology, chemistry, and physics teachers.

$2:H_0$ - The sex of pupils or teachers has no significant relationship with the way girls and boys in Kuwaiti high schools perceive each of the separate dimensions of behaviour, namely, the personality, attitude, and classroom behaviours of their biology, chemistry and physics teachers.

H_1 - The sex of pupils or teachers has a significant relationship with the way girls and boys in Kuwaiti high schools perceive each of the separate dimensions of behaviour, namely, the personality, attitude, and classroom behaviours of their biology, chemistry, and physics teachers.

To answer the above-mentioned questions and hence to test these hypotheses, the t-test for uncorrelated groups (see :p. 266) was applied, firstly, to the data which resulted from the ratings of both male and female pupils of the general classroom characteristics (i.e., all 46 Pupils Perception Questionnaire items describing the attitude, personality, and classroom behaviour) of their biology, chemistry, and physics teachers. Secondly, the t-test was applied to the data which resulted from the perceptions of boys and girls separately to the attitude, personality, and classroom behaviours of their science teachers. The data used for the first t-test analyses were collected for each of the two sexes of pupils through the summing up of their perceptions on each of the 46 Pupils' Perception Questionnaire items. The mean ratings of boys was then compared with that of the girls. The same procedure was followed when collecting the data for the second t-analyses. However, the perceived attitude of the observed male and female teachers was measured through the summing up

of girls and boys ratings on the twelve items (see p. 284) which described the attitude of their science teachers; the perceived personality of teachers, was measured by the pupils' ratings on the appropriate ten items (see p. 284) related to this dimension; and finally, the perceived classroom behaviours of the teachers was measured by summing up the ratings of pupils on the appropriate twenty-four items (see p. 284) covering this specific teaching behaviour.

The results of the computation procedures are represented in table 27(a-d).

Firstly, the t-values represented in table 27a indicated that the overall perceptions (i.e., as measured by the all 46 perception questionnaire items) of girls and boys of the characteristics of their biology and physics teachers did not differ significantly (i.e., biology, $t = 0.263$, N.S.; physics, $t = 0.682$, N.S.). On the other hand, female pupils were found to rate the general characteristics of their chemistry teachers significantly higher than did male pupils ($t = 3.291$, $p < 0.001$). The null hypotheses, which were related to these findings, were accordingly accepted in the cases of both biology and physics teachers, but was rejected in the case of chemistry teachers.

Secondly, from the t-values represented in table 27b regarding the three separate dimensions of perceived characteristics of male and female biology teachers, it is apparent that both girls and boys rated the personality, attitude and classroom behaviours similarly. That is to say, no significant differences were recorded between the perceptions of girls and those of boys as to personality ($t = 0.855$, N.S.); attitude ($t = 0.425$, N.S.); or classroom behaviours ($t = 0.740$, N.S.) of their biology (male or female) teachers. Similarly, from the t-values represented in table 29d, it is clear that both girls and boys in Kuwaiti high schools gave similar ratings to the three behavioural dimensions of their physics teachers. In other words, no significant differences were found between the perceptions

of girls and boys in Kuwaiti high schools regarding the personality ($t = 0.711$, N.S.); attitude ($t = 0.250$, N.S.); or classroom behaviours ($t = 1.469$, N.S.) of their physics (male or female) teachers.

Moreover, the t -values represented in table 27c, indicated that girls in Kuwaiti high schools perceived the classroom behaviours and attitude of their chemistry teachers in significantly better terms than the perceptions given by boys to their chemistry teachers regarding the same behavioural areas. Thus, significant differences were recorded between the perceptions of girls and boys on both the attitude ($t = 4.006$, $p < 0.001$) and classroom behaviours ($t = 4.304$, $p < 0.001$) of their chemistry teachers. On the other hand, no such significant difference was recorded between the perception of girls and boys, in Kuwaiti high schools, regarding the personality of their chemistry teachers ($t = 0.818$, N.S.). On the basis of these findings, the null hypotheses, related to the differences between the perceptions of boys and girls to the personality, attitudes, classroom behaviours of their biology and physics teachers were, therefore, accepted. Similarly, the null hypothesis related to the difference in perception of the personality of male and female chemistry teachers was accepted. Nevertheless, the null hypotheses, related to the differences between the perceptions of the boys and girls of the attitude and classroom behaviours of their chemistry teachers were rejected at the 0.001 level of confidence.

Table 27a

Statistical Summary of the Data used for the Measurement of the t-analysis (unrelated means) regarding the Differences in the Perceptions of Boys and Girls of the Classroom Characteristics of their Biology, Chemistry and Physics Teachers

Subject Matter	Sample	No.of Case	Mean	Standard Deviation	Estimated Standard Error	d.f	t value	P \leq
Biology	Boys	153	170.64	26.98	3.114	282	0.263	N.S.
	Girls	131	169.82	25.44				
Chemistry	Boys	153	154.27	40.26	4.205	282	-3.291	0.001
	Girls	131	168.11	30.47				
Physics	Boys	153	164.04	33.82	3.986	282	0.682	N.S.
	Girls	131	166.76	33.19				

Table 27b

Statistical Summary of the Data used for the Measurement of the t-analyses (unrelated means) regarding the Differences in the Perceptions of Boys and Girls of the Personality, Attitude and Classroom Behaviours of their Biology Teachers

Behavioural Area	Sample	No.of Pupils	Mean	Standard Deviation	Estimated Standard Error	d.f	t value	P \leq
Personality	Males	153	37.05	5.357	0.655	282	0.855	N.S.
	Females	131	37.61	5.630				
Attitude	Males	153	45.40	7.572	0.895	282	0.425	N.S.
	Females	131	45.02	7.476				
Classroom Behaviour	Males	153	88.42	17.028	1.959	282	0.740	N.S.
	Females	131	86.97	15.952				

Table 27c

Statistical Summary of the Data used for the Measurement of the t-analyses (unrelated means) regarding the Differences in the Perceptions of Boys and Girls of the Personality, Attitude and Classroom Behaviours of their Chemistry Teachers

Behavioural Area	Sample	No. of Pupils	Mean	Standard Deviation	Estimated Standard Error	d.f.	t value	P ≤
Personality	Males	153	42.98	8.162	1.002	282	0.818	N.S.
	Females	131	43.80	8.623				
Attitude	Males	153	35.59	6.202	0.729	282	4.006	0.001
	Females	131	38.51	6.052				
Classroom Behaviour	Males	153	78.32	20.351	2.156	282	4.304	0.001
	Females	131	87.60	15.946				

Table 27d

Statistical Summary of the Data used for the Measurement of the t-analyses (unrelated means) regarding the Differences in the Perceptions of Boys and Girls of the Personality, Attitude, and Classroom Behaviours of their Physics Teachers

Behavioural Area	Sample	No. of Pupils	Mean	Standard Deviation	Estimated Standard Error	d.f.	t value	P ≤
Personality	Males	153	37.18	6.057	0.774	282	0.711	N.S.
	Females	131	36.63	6.859				
Attitude	Males	153	44.15	8.352	1.042	282	0.250	N.S.
	Females	131	43.89	9.076				
Classroom Behaviour	Males	153	82.72	22.833	2.546	282	1.469	N.S.
	Females	131	86.46	20.066				

7.80 Predicting the Achievement of the Observed Science Pupils from the Eight Independent Variables Measuring both the Pupil-Teacher Science Classroom Interactions (five variables) and Pupils' Opinions of the Characteristics of their Observed Science Teachers (three variables)

7.81 Justification for the selection of the dependent and the independent variables

The importance of the behaviour of a teacher in any classroom, is seen by many educators, as an essential factor in the success of the teaching-learning process. A teacher's behaviour is seen by Flanders (1967)¹ as an important element that affects the climate of any classroom. Medley and Mitzel (1963)² suggest that one should identify the most important behaviours of a teacher, and score them reliably so as to measure their effect on the teaching-learning process. The identification of the most important variables, however, relating to teachers is not an easy job (Tatsuka and Tideman, 1963)³ and even after the characteristics of a teacher have been identified, usually it is not easy to state firmly whether or not these variables are valid (Kirk, 1969)⁴.

The two main sets of variables used, in this project, to measure the relationship of classroom behaviour with pupils' outcomes (pupils' achievement is measured by the newly developed achievement tests in biology, physics and chemistry) were those associated with pupil-teacher interactions and with teachers' characteristics. The data on the first set of variables, i.e., pupil-teacher classroom interactions, were collected

1. Flanders, N.A., 1967, op.cit.

2. Medley, D.M., and Mitzel, H.E., 1963, op.cit.

3. Tatsuka, M.M. and Tideman, D.V., 1963, op.cit.

4. Kirk, G., 1969, op.cit.

using the Science Teaching Observation Schedule (see ch.VI, table 2, p.110) which describes possible areas of interactions which may take place, in any science classroom, between pupils and teachers. Thus the S.T.O.S. covers two major areas; the first area is related to all the activities that are initiated and/or maintained by the teacher, i.e., teacher's talk. This area covers (i) teacher's questions, (1a); (ii) teacher's statements (1b) and (iii) teacher's directions (1c). The second major area is restricted to the activities that are initiated and/or maintained by pupils in the classroom. This area covers (i) pupils' consultations with each other (1c); and (ii) pupils' reference to their teachers (1e).

The data on the second set of variables teacher's characteristics, were collected through the administration of the Pupil Perception Questionnaire to pupils taking part in the study. This Pupil Perception Questionnaire, was developed for the present study in a pilot study preceding the main study itself (see Ch.V, pp.157-165) Pupil Perception Questionnaire, as may be recalled, examined three types of characteristics of a science teacher in the classroom, namely, (i) teacher's classroom behaviours (24 items); (ii) teacher's personality (10 items); and (iii) teacher's attitude (12 items). The items describing the three dimensions (see ch.V, p. 138) of teacher's characteristics are mentioned in chapter V, pp.171-173.

These classroom variables were chosen as the antecedent variables so as to measure the extent to which they might predict the achievement of the observed pupils in biology, chemistry, and physics. These chosen predictors were considered to be both reliable and important in their potential to predict pupil achievement. Much research (e.g., Frumkin and

Howell, 1954; Webb and Bowers, 1957; Goodenough, 1957; Washburne and Heil, 1960; Flanders, Anderson, and Amidon, 1961; Mastin 1963; Solomon, Rosenberg and Bezdek, 1964; Walberg and Anderson, 1968; Khan, 1969; Hiller, Fisher, and Kaess, 1969; Herman, Potterfield, Dayton, and Amershek, 1969; Wright and Nuthall, 1970; Rosenshine and Furst, 1971; Nash, 1976; Eggleston, Galton and Jones, 1976; and Cantrell, Stenner, and Katzenmeyer, 1977)¹⁻¹⁶

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1. Frumkin, M. Robert and Howell, H. William 1954, "Effective College Teaching: A Preliminary Causal Analysis", Journal of Educational Research, Vol. 47, pp. 683-693.
 2. Webb, B. Welse; and Bowers, D. Norman, 1957, "The Utilization of Student Learning as a Criterion of Instructor Effectiveness", Journal of Educational Research; Vol. 51, pp. 17-23,
 3. Goodenough, Eva, 1957, "The Forced Choice Technique as a Method for Discovering Effective Teacher Personality", Journal of Educational Research, Vol. 51, pp. 25-31.
 4. Washburn, C. and Heil, M. Louis, 1960, "What Characteristics of Teachers Affect Children's Growth?" The School Review, 68, pp. 420-428.
 5. Flanders, A. Ned, Anderson, Paul J., and Amidon, J. Edmund, 1961. "Measuring Dependence Proneness in the Classroom", Educational and Psychological Measurement, Vol. 41, No. 3, pp. 575-587.
 6. Mastin, E. Victor, 1963. "Teachers Enthusiasm", The Journal of Educational Research, Vol. 56, No. 7, pp. 385-386
 7. Solomon, D., Rosenberg, L. and Bezdek, E. W. 1964, "Teacher Behaviour and Student Learning", Journal of Educational Psychology, Vol. 55, No. 1, pp. 23-30.
 8. Walber, J. Herbert, and Anderson, J. Gary, 1968, "Classroom Climate and Individual Learning", Journal of Educational Psychology, Vol. 59, No. 6, pp. 414-419.
 9. Khan, S. B., 1969, "Affective Correlates of Academic Achievement", Journal of Educational Psychology, Vol. 60, No. 3, pp. 216-221.
 10. Hiller, J. H., Fisher, G. A., and Kaess, W. 1969, "A Computer Investigation of Verbal Characteristics of Effective Classroom Lecturing", American Educational Research Journal, Vol. 6, No. 4, pp. 661-677.
 11. Herman, W. L., Potterfield, J. E., Dayton, C. M., and Amershek, K. G., 1969, "The Relationship of Teacher-Centered Activities and Pupil-Centered Activities to Pupil Achievement and Interest in 18 Fifth-Grade Social Studies Classes", American Educational Research Journal, Vol. 7, No. 2, pp. 227-240.
 12. Wright, C. J., and Nuthall, G., 1970, "Relationships Between Teacher Behaviours and Pupil Achievement in Three Experimental Elementary Science Lessons", American Educational Research Journal, Vol. 7, No. 4, pp. 477-491.
 13. Rosenshine, B., and Furst, N., 1971, op. cit.
 14. Nash, Roy, 1976, "Teacher Expectations and Pupil Learning", Routledge & Kegan Paul.
 15. Eggleston, J. F., Galton, M. J., and Jones, E. M., 1976, op. cit.
 16. Cantrell, R. P., Stenner, A. J., & Katzenmeyer, W. G. 1977, "Teacher Knowledge, Attitude and Classroom Teaching Correlates of Student Achievement", Journal of Educational Psychology, Vol. 69, No. 2, pp. 172-179

supports the importance of teacher-pupil behaviour in predicting pupil outcomes (see also Ch.VIII, pp.407-424).

Pupils' achievement was selected as the predicted variable, because it is often considered by many educators (as well as by the Kuwaiti Ministry of Education) to be the most obvious criterion in the evaluation of a teacher's effectiveness in the classroom (Evans, 1962, Saadeh, 1970, Flanders, 1970, Stones and Morris, 1972; and Power and Sadler, 1976)^{1,2,3,4,5}

7.82 Relationships Between the Predicted Variable and Each of the Eight Classroom Predictors

Hence statistical analyses were undertaken to elicit the most significant relationships between pupils' achievement and each of the following predictors:

- i) teacher's personality;
- ii) teacher's attitude;
- iii) teacher's classroom behaviour;
- iv) teacher's questions;
- v) teacher's statements;
- vi) teacher's directions;
- vii) pupils' consultations; and
- viii) pupils' reference to their teachers.

The following section is aimed at looking at the relative contribution which each of the above independent variables makes to the variance of pupil achievement. Since pupils and teachers, in this study, were observed in the three different science areas, namely, biology, chemistry and physics, the analyses adopted in this section were carried out separately for each of the

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- 1. Evans, K.M., 1962, op.cit.
 - 2. Saadeh, I.Q., 1970, op.cit.
 - 3. Flanders, N.A., 1970, op.cit.
 - 4. Stones, E. and Morris, S. 1972, op.cit.
 - 5. Power, C. and Sadler, R. 1976, op.cit.

three subject areas. The analyses for each science subject area was also carried out for:

- i) male pupils only; and
- ii) female pupils only.

To find out the relative contribution of each of the above independent variables to the variance of pupil achievement, the relationships between the predicted criterion, i.e., pupils' achievement outcomes, and each of the predictor variables were calculated as a first step in the analytical procedure.

The data used for these analyses were:

- i) pupil's achievement raw score in each of the three science areas;
- ii) the perception of each of the 284 participant pupils (resulting from their reaction to items in the Pupil Perception Questionnaire) to the characteristics of his/her teacher in terms of his/her personality, attitude, and classroom behaviours; and
- iii) the observed codings for the activities of both pupils and teachers, in each of the 36 science classes, on teacher's questions, statements, directions and pupils' consultation and reference to their science teachers.

In other words, the achievement score of each of the 284 observed pupils, i.e., "X" variable, was correlated with the data of each of the eight independent variables, i.e., " y_{1-8} " (see appendix G).

The relationship between the predicted criterion and each of the predictor variables was calculated from the Pearson's correlated coefficient "r". The results of the correlation coefficients between the dependent (i.e., pupils' achievement) and each of the eight independent variables are represented in tables 28, 29 and 30 (a-b).

In this study, however, a measure of the relationships between the two sets of variables, i.e., the dependent and the independent variables, was not the ultimate aim of this study. Thus, the Pearson's correlation

coefficient analyses were followed by stepwise-multiple regression analyses so as to investigate further the relative importance of each of the independent variables to that of the predicted achievement variable.

It is apparent from the "r" values represented in tables 28,29, 30 (a-b) that not all the independent variables correlated significantly with the dependent criterion, i.e., pupils' achievement.

7.73 The Correlation Coefficients Measuring the Relationships between Biology Achievement of Girls and Boys, and the Eight Independent Variables

From table 28 (a and b) it is noted that none of the independent variables, in the case of biology, correlated significantly with the achievement of boys. On the other hand, girls' achievement in biology correlated significantly with 'teacher's questions'; 'teacher's directions' and 'pupils' consultations' with "r" values of 0.515 ($p < 0.001$), 0.427 ($p < 0.001$), and 0.423 ($p < 0.001$) respectively.

7.74 The Correlation Coefficients Measuring the Relationships Between Chemistry Achievements of Girls and Boys, and the Eight Independent Variables

In the case of chemistry (see table 29 a and b) the most significant correlations (i.e. $p < 0.001$) with girls' achievement in chemistry were found with "teacher's questions" with an "r" value of 0.465; "pupils' consultations" with an "r" value of 0.381; and "pupils' reference to teachers", with an "r" value of -0.354. On the other hand, the chemistry achievement of boys was found to correlate significantly with "teacher's questions" and "teacher's statements" with an "r" value of 0.395 and 0.335 (both with $P < 0.001$) respectively and with "teacher's attitude" with an "r" value of 0.208 ($p < 0.05$).

7.75 The Correlation Coefficients Measuring the Relationships Between the Physics Achievement of Girls and Boys, and the Eight Independent Variables

In physics, girls' variables which correlated significantly with achievement (see table 30b) were "teacher's personality"; "teacher's attitude"; and "teacher's classroom behaviour" with "r" values of 0.200, 0.216, and 0.200 respectively (all are significant of $p < 0.05$). In addition "teacher's statements" and "pupils' consultations" also correlated significantly with the achievement variable with "r" values of -0.320 ($P < 0.01$) and 0.307 ($P < 0.01$) respectively. In the case of boys (see table 30e), all but two independent variables, namely, "teacher's personality" and "pupils' reference to teachers", correlated significantly with their achievement in physics. In other words, boys' achievement correlated significantly with: "teacher's attitude" with an r-value of 0.20-0 ($P < 0.05$); "teacher's classroom behaviour" with an r-value of 0.235 ($P < 0.05$), "teacher's questions" with an r-value of 0.424 ($p < 0.001$); "teacher's statements" with an r-value of 0.476 ($P < 0.001$) and "pupils' consultations" with an r-value of 0.224 ($P < 0.05$).

Table 28a The Correlation Coefficients Measuring the Relationships Between the Various Variables Introduced into the Boys' Biology Multiple Regression Equation

	Independent Variables								Dependent Variable
	Teacher's Questions 1	Teacher's Statements 2	Teacher's Directors 3	Pupils' Consultations 4	Pupils' Reference to Teachers 5	Teacher's Personality 6	Teacher's Attitude 7	Teacher's Classroom Behaviour 8	Pupils' Achievements 9
Teacher's questions 1	1.00	-0.334	-0.271	-0.192	-0.367	0.106	-0.103	-0.086	-0.164
Teacher's statements 2	-0.334	1.00	-0.355	-0.717	-0.601	-0.057	-0.001	-0.025	0.166
Teacher's directions 3	-0.271	-0.355	1.00	0.652	0.595	0.330	0.307	0.405	-0.170
Pupils' consultations 4	-0.192	-0.717	0.652	1.00	0.978	0.151	0.139	0.193	-0.100
Pupils' reference to teachers 5	-0.367	-0.601	0.595	0.978	1.00	0.094	0.127	0.165	-0.051
Teacher's personality 6	0.106	-0.057	0.330	0.151	0.094	1.00	0.627	0.656	-0.045
Teacher's attitude 7	-0.103	-0.001	0.307	0.139	0.127	0.627	1.00	0.673	0.002
Teacher's classroom behaviour 8	-0.086	-0.025	0.405	0.193	0.165	0.656	0.673	1.00	-0.014
Pupils' achievement 9	-0.164	0.166	-0.170	-0.100	-0.051	-0.045	-0.002	-0.014	1.00

Table 29a

The Correlation Coefficients Measuring the Relationships Between the Various Variables Introduced into the Boys' Chemistry Multiple Regression Equation

	Independent Variables								Dependent Variable
	Teacher's Questions 1	Teacher's Statements 2	Teacher's Directions 3	Pupils' Consultations 4	Pupils' reference to teachers 5	Teacher's personality 6	Teacher's attitude 7	Teacher's classroom Behaviour 8	Pupils' Achievements 9
Independent Variables	Teacher's questions 1	1.00	0.597	0.491	0.108	0.126	-0.298	-0.352	0.395
	Teacher's statements 2	0.597	1.00	-0.730	-0.724	0.317	0.116	0.263	0.335
	Teacher's directions 3	0.491	-0.730	1.00	0.678	-0.743	-0.262	0.275	-0.106
	Pupils' consultations 4	0.108	-0.724	0.678	1.00	-0.587	-0.078	-0.174	-0.101
	Pupils reference to teachers 6	0.126	0.317	-0.743	-0.587	1.00	0.081	0.031	-0.189
	Teacher's personality 6	-0.298	0.116	-0.262	-0.078	1.00	0.566	0.548	0.064
	Teacher's attitude 7	-0.352	0.263	0.275	-0.174	0.031	1.00	0.605	0.208
Dependent Variable	Teacher's classroom Behaviour 8	0.395	0.209	-0.397	-0.156	0.191	0.548	1.00	0.080
	Pupils' Achievements 9	0.395	0.335	-0.106	-0.101	-0.189	0.064	0.208	1.00

Table 30a The Correlation Coefficients Measuring the Relationships Between the various Variables Introduced into The Boys' Physics Multiple Regression Analyses

	Independent Variables									Dependent Variable
	Teacher's questions 1	Teacher's Statements 2	Teacher's Directions 3	Pupils' consultations 4	Pupils' reference to teachers 5	Teacher's personality 6	Teacher's attitude 7	Teacher's classroom Behaviour 8	Pupils' achievements 9	
Independent Variables	Teacher's questions 1	0.761	0.642	0.151	-0.402	0.379	0.382	0.442	0.424	
	Teacher's Statements 2	0.761	0.337	-0.430	-0.253	0.285	0.263	0.393	0.476	
	Teacher's directions 3	0.642	0.337	0.264	0.044	0.502	0.567	0.697	0.278	
	Pupils' consultations 4	0.151	0.264	1.00	0.033	0.092	0.133	0.057	-0.224	
	Pupils' reference to teachers 5	-0.402	0.044	0.033	1.00	-0.047	-0.024	0.115	-0.047	
	Teacher's personality 6	0.379	0.285	0.092	-0.047	1.00	0.685	0.620	0.140	
	Teacher's attitude 7	0.382	0.263	0.133	-0.024	0.685	1.00	0.707	0.200	
	Teacher's classroom behaviour 8	0.442	0.393	0.057	0.115	0.620	0.707	1.00	0.235	
Dependent Variable	Pupils' achievements 9	0.424	0.476	0.278	-0.224	-0.047	0.200	0.235	1.00	

Table 30b The Correlation Coefficients Measuring the Relationships between the Various Variables Introduced into Girls' Physics Multiple Regression Analyses

	Independent Variables								Dependent Variable
	Teacher's questions 1	Teacher's statements 2	Teacher's directions 3	Pupils' consultations 4	Pupils' reference to Teachers 5	Teacher's personality 6	Teacher's attitude 7	Teacher's classroom behaviour 8	Pupils' Achievements 9
Teacher's questions 1	1.00	0.575	0.555	-0.542	-0.722	0.509	0.500	0.587	0.152
Teacher's statements 2	0.575	1.00	0.627	-0.856	-0.852	0.112	0.096	0.170	-0.320
Teacher's directions 3	0.555	0.627	1.00	-0.486	-0.333	-0.129	0.004	0.025	-0.053
Pupils' consultations 4	-0.542	-0.856	-0.486	1.00	0.706	-0.281	-0.223	-0.325	0.307
Pupils' reference to teachers 5	-0.722	-0.852	-0.333	-0.706	1.00	-0.370	-0.285	-0.412	0.092
Teacher's personality 6	0.509	0.112	-0.129	-0.281	-0.370	1.00	0.775	0.753	0.200
Teacher's attitude 7	0.500	0.096	0.004	-0.223	-0.285	0.775	1.00	0.774	0.216
Teacher's classroom behaviour 8	0.587	0.170	0.025	-0.325	-0.412	0.753	0.774	1.00	0.200
Pupils' achievements 9	0.152	-0.320	-0.053	0.307	0.092	0.200	0.216	0.200	1.00

7.86 The Relative Contribution of the Various Measures of Independent Variables to the Variance of Pupil Achievement

To investigate the relative contribution of each of the eight independent variables, namely, 1) teacher's personality; 2) teacher's attitude; 3) teacher's classroom behaviour; 4) teacher's questions; 5) teacher's statements; 6) teacher's directions; 7) pupils' consultation; and 8) pupils' reference to teachers, to pupils' achievement outcomes, a stepwise-multiple regression analysis was undertaken with the data. These data resulted from the perceptions of the observed pupils of their science teachers using the newly-developed Pupil Perception Questionnaire, and from the codings of the teacher-pupil classroom interactions using the STOS behavioural categories (see Appendix G,1)

A Justification for the use of the stepwise-multiple regression analysis

In this study, since more than two variables are to be included in the analysis, one of the multivariate techniques had to be used to assess the relationships between pupils' and classroom variables. The linear-multiple regression analysis is one such multivariate correlational technique. It is considered to be the most appropriate analysis for describing and exploring correlations between pupils' achievement and the pupil-teacher classroom variables.

Youngman (1978)¹ suggests that a linear multiple regression procedure is suitable for any analysis attempting to relate a set of variables, the predictors, to one other single variable, the chosen criterion. Grobe (1973)² views the same technique from another angle. He not only considers

1. Youngman, M.B., 1978, op.cit.

2. Grobe, H.Cary, 1973, "A regression Approach to Evaluating Instructional Programs in Science", Journal of Research in Science Teaching, Vol.10 No.1, pp.55-62

the analysis as a simple and powerful approach applicable to many research problems, but as also having additional advantages over other methods, such as an analysis of variance. This advantage is its provision of an estimate of criterion variance accounted for by each of the independent variables. Moreover, the linear-multiple regression analysis enables us to determine the strength and the direction of the relationship between the analyzed variables (see, Popham, 1967)¹. Borg and Gall (1979)² propose that the multiple regression analysis may also be used to determine whether two or more of the independent variables can be combined to predict the dependent variable, better than any one independent variable operating alone. Moreover, Popham (1967)³ believes that, to get the best prediction, the combined or the added variables, while related to the criterion variable, should not be strongly related to each other. Borg and Gall (1979)⁴ explain the fruitless results of such combinations or additions, by stating that, "as the correlation between two predictor variables increases, the predictive information contained in the one variable becomes increasingly redundant with the predictive information contained in the other variable."⁵

To get a valid prediction of the criterion variable from the independent variables, Popham (1967)⁶ and King (1969)⁷ agree on three assumptions, relating to the variables in the equation, that have to be taken into consideration. These assumptions are, namely, linearity, homoscedasticity and normality between the variables. In other words, to get an accurate prediction:

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1. Popham, W.James, 1967, op.cit.
 2. Borg, R.Walter and Gall, M.D., 1979, "Educational Research", An Introduction, Third Edition, Longman Inc.
 3. Popham, W.James, 1967, op.cit.
 4. Borg, R.W. and Gall, M.D., 1979, op.cit.
 5. Borg, R.W. and Gall, M.D., 1979, *ibid.*, (p.449).
 6. Popham, W.J. 1967, op.cit.
 7. King, W.H. 1969, "Statistics in Education", Macmillan.

- 1) there should be a linear relationship between the "x" and the "y" variables, where the increase in the "x" score implies the increase in the "y" score where a reasonable straight line can be plotted between the "x" and "y" scores.
- 2) the spread of the "y" values for individually considered scores of "x" must be approximately the same, i.e., comparable spread or standard deviation for both "x" and "y" scores and,
- 3) the value of "y" and "x" variables should be distributed in an approximately normal manner.

Finally, the procedure for the calculation of the contribution of each independent or predictor variable to the prediction of the dependent criterion is known as the multiple regression procedure, which yields an appropriate linear multiple regression equation. The linear multiple regression equation is derived from the equation of a straight line which is:

$$y = a + bx$$

The linear multiple regression equation is, however, written as follows:

$$\bar{y} = a + b_1x_1 + b_2x_2 + \dots + b_nx_n$$

where:

\bar{y} is the predicted criterion raw score from $x_1, x_2 \dots$ and x_n .

a is the value of "y" where the regression line intercepts or crosses the ordinate of the "y" axis.

b is the angle between the "x" axis and the regression line (i.e., the regression coefficients of the "x's" variables".

x_{1-n} = the predictor variables raw scores (i.e., x_1 = the raw score of the first predictor variable included in the equation, $\dots x_n$ = the raw score of the last predictor variable included in regression equation).

7.87 Questions posed for the Prediction of the Achievement of Boys and Girls in Kuwaiti High Schools

This part of the project was aimed at finding answers to the following questions:

- 1) Do teacher-pupil classroom interaction variables have the same salience on the attainment of both boys and girls in the three observed science areas ?
- 2) Do teachers' characteristics as perceived by pupils have the same salience on the attainment of both boys and girls in the three observed subject areas?

Statement of Hypotheses

Each of the above questions was stated in the form of a null hypothesis followed by its alternative form as follows:

1: H_0 - Teacher-pupil classroom interaction variables, namely, teacher's questions, teacher's statements, teacher's directions, pupils' consultations, and pupils' reference to teachers, have the same salience on the attainments of both boys and girls in biology, chemistry, and physics.

H_1 - Teacher-pupil classroom interaction variables, namely, teacher's questions, teacher's statements, teacher's directions, pupils' consultations, and pupils' reference to teachers, have different salience on the attainments of both boys and girls in biology, chemistry, and physics.

2: H_0 - Teacher's perceived characteristics, namely, teacher's personality, attitude, and classroom behaviour, have the same salience on the attainments of both girls and boys in biology, chemistry, and physics.

H_1 - Teacher's perceived characteristics, namely, teacher's personality, teacher's attitude, and teacher's classroom behaviour, have different salience on the attainments of both girls and boys in biology, chemistry, and physics.

To test the above null hypotheses, and to assess the relative importance of the predictor variables, the SPSS-multiple regression sub-program¹ was used for the statistical procedures. The use of the computer in such analysis helped to simplify many difficult steps which would have, otherwise, been encountered by the researcher if such a programme was not available.

7.88 The Inclusion of the Predictor Variables in the Multiple Regression Equation by the SPSS Subprogram

The SPSS Program (the stepwise procedures) which was used in the analyses of this section, has considerable control over the inclusion of each of the predictor variables in the multiple regression equation. With this program, the computer controls the entrance of the independent variables in single steps from best to worst on the basis of the amount of variance of the criterion which is explained by each variable. At each step, in the computational procedure, the program computes an F-ratio for each of the possible predictors. The F-ratio reflects the amount of variance of the predicted variable explained by any given predictor which enters the equation on the very next step. The SPSS Subprogram computes more than one F-ratio for each of the selected variables. The first F-ratio (upon which the inclusion of the predictor variable depends) is measured for any specific predictor when all the effect of the other predictors are controlled. In this case, the F-ratio (labelled as F for inclusion) reflects the amount of variance explained by that specific predictor. For the first step, or for the first predictor, which is to be included in the equation, the F-ratio will correspond with the highest individual correlation coefficient of this specific variable and the

1. Norman, H.Nie; C. Hadlai Hull; Jean, G.Jenkins; Karin Steinbrenner; and Dale, H. Bent, 1975, "Statistical Package for the Social Science", Second Edition, McGraw-Hill, Inc.

predicted criterion. For the second step and all steps following, the F-ratio for the selected variable will correspond with the partial correlation of that predictor. After the selection of the first variable, however, another F-ratio will be computed for that variable (the same will happen to all other variables following in each step). The F-ratio (labelled as F-ratio for exclusion), in this case, will be carried out through a hierarchical procedure. In the hierarchical method, the proportion (i.e. R^2) explained by the predictors will be calculated as follows:

As for example, in the presence of three predictors, x, y, and z,

$$R^2 = R^2_x + R^2_{y/x} + R^2_{z/yx}$$

The measured F-ratio in each step for any of the added variables will be compared to that of the specified default F-ratio level (the required level of significance chosen for this study is $p < 0.05$). Therefore, if any of the variables shows an F-ratio less than the required level for exclusion, then that variable will be removed from the multiple regression equation.

7.90 The Relative Contributions of the Various Measure of Independent Variables to Pupils' Achievements in Biology, Chemistry and Physics

To investigate the relative contribution of each of the eight independent variables to pupils' cognitive outcomes (as measured by pupils' post-achievement tests) a stepwise-multiple regression analysis was undertaken on the data (refer to appendix G1) which resulted from: 1) the perceptions of the pupils of their science teachers' personality, attitude, and classroom behaviours, using the newly developed Pupils' Perception Questionnaire and 2) the teacher-pupil classroom behaviour, as indicated by teacher's questions, statements, directions, and pupils' consultations and reference to teachers, using the Science Teaching Observation Schedule.

Since the participating school samples, i.e., both pupils and teachers, were observed in all those sciences, namely, biology, chemistry and physics,

a stepwise-multiple regression analysis was carried out separately in each science area for male schools only and for female schools only.

The results of the Stepwise-Multiple Regression Analyses given in tables 31, 32, and 33 (a and b), are represented as they appeared in the summary tables of the SPSS Computer-Subprogram's output¹ for each analysis in the three academic science areas.

From the summary table one can perceive the pattern of entry of each of the independent variables (determined by the F-ratio for each predictor) in the regression equations. The results of the stepwise-multiple analyses are illustrated for each independent variable in the following sections.

7.91 Significant Predictor Variables Associated with Girls' and Boys'

Biology Achievement

1. Boys' school sample

The first independent variable of teacher-pupil classroom interaction variables to enter this regression equation in the case of boys was "teacher's directions". This variable contributed about 2.9% ($F = 13.90$, $P < 0.001$) to the variance in boys' biology achievement. The second predictor to enter the equation was "teacher's questions". This variable, however, added a significant increase of another 4.8% ($F = 12.44$, $P < 0.001$) in terms of R^2 added. Following this, the addition of "pupils' consultations" explained very little, only 0.01% ($F = 10.61$, $P < 0.001$) of the variance in the male biology achievement. Moreover, the inclusion of "pupils' reference to teachers" and "teacher's statements" explained 1.3% ($F = 10.50$, $P < 0.001$) and 5.0% ($F = 8.52$, $P < 0.001$) respectively of the variance in the achievement of the male pupils' sample. Furthermore, the three

1. Norman, H.Nie; C. Hadlai Hull; Jean, G.Jenkins; Karin Steinbrenner; and Dale, H.Bent, 1975, op.cit.

independent variables arising from pupils' perceptions of the qualities of their teachers, namely, personality, attitude, and classroom behaviour were not included in this multiple regression equation (see table 31a).

ii. Girls' school sample

Among the five predictors related to the teacher-pupil classroom interactions, "teacher's questions" was the only and the first variable entered in the multiple regression equation in the case of biology girls. This variable, however, contributed 26.5% ($F = 58.51$, $P < 0.001$) to the variance in pupils' biology achievement. This variable was followed by "teacher's classroom behaviour" with a contribution of 5.8% ($F = 17.20$, $P < 0.001$) and "teacher's attitude" with a contribution of 3.1% ($F = 6.06$, $P < 0.001$) to the variance of girls' achievement in biology. On the other hand, the other four predictors measured by the STOS namely, "teacher's statements", "teacher's directions", "pupils' consultations", and "pupils' reference to teachers" were not included in this multiple regression equation. Similarly, pupils' perceptions of the "personality" of their science teachers was also excluded from this equation (see table 31b).

7.92 Significant Predictor Variables Associated with Boys' and Girls'

Chemistry Achievements

i. Boys' school sample

The first variable included in the regression equation in the case of boys was "teacher's statements". This variable contributed about 11.3% ($F = 32.95$, $P < 0.001$) to the variance in the boys' achievement in chemistry. The second variable to enter the equation was "pupils' reference to teachers". This variable added a significant increase of another 9.7% ($F = 18.37$, $P < 0.001$) in terms of R^2 added (see table 32a). In the case of boys, however, six of the independent variables were not included in this multiple regression equation. These variables were, namely, "teacher's questions", "teacher's directions", "pupils' consultations" (of the STOS variables)

"teacher's personality", "attitude", and "classroom behaviour" (of the Pupil Perception Questionnaire variables).

ii. Girls' school sample

"Teacher's questions" was the first variable entered in the multiple regression equation in the case of chemistry girls. This variable contributed 21.7% ($F = 86.52$, $P < 0.001$) to the variance in girls' chemistry achievement. It was followed by "teacher's statements" with a contribution of 16.5% ($F = 82.14$, $P < 0.001$); "teacher's directions" with an additional contribution of 6.4% ($F = 47.11$, $P < 0.001$); and "pupils' reference to teachers" with an additional contribution of 11.2% ($F = 31.79$, $P < 0.001$) to the variance of girls' achievement in chemistry. "Pupils' consultations" (of the STOS variables) as well as three independent variables related to pupils' perceptions of their science teachers', namely, "teacher's personality "; "teacher's attitude"; and "teacher's classroom behaviour", were not included in this multiple regression equation (see table 32b).

7.93 Significant Predictor Variables Associated with Boys and Girls'

Physics Achievement

i. Boys' school sample

The inclusion of "teacher's statements" in the boys' regression equation as the first independent variable explained 23.6% ($F = 13.68$, $P < 0.001$) of the variance in the achievement of boys in physics. The next selected significant variables were "pupils' consultations" and "pupils' reference to teachers". These two variables yielded significant contributions to the total variance of male pupils' achievement in physics of about 2.9% ($F = 10.35$, $p < 0.001$) and 3.4% ($F = 7.06$, $P < 0.001$) respectively. Moreover, in the case of this sample, the three independent variables related to the Perceived personality, attitude and classroom behaviour of the observed science teachers together with "teacher's

questions" and "teacher's direction" variables were not included in the multiple regression equation (see table 33a).

ii. Girls' school sample

For the variance in physics achievement of the observed girls explained by the predictor variables, the first variable to be included in the multiple regression equation was "teacher's statements" followed by "teacher's questions". These two variables contributed respectively 10.3% ($F = 59.74$, $P < 0.001$) and 16.8% ($F = 5.61$, $P < 0.001$) to the total variance of girls' physics achievement. "Pupils' reference to teachers"; "teacher's directions"; and "teacher's personality" subsequently followed the first two predictors in the order given above for this equation. These variables contributed additional amounts of 2.2% ($F = 31.64$, $P < 0.001$); 11.3% ($F = 27.97$, $P < 0.001$); and 1.9% ($F = 4.01$, $P < 0.01$) respectively, to the total variance of the achievement of girls in physics (see table 33b). Out of the STOS five variables, "pupils' consultations" was the only variable that was not included in the girls' multiple regression equation. Moreover, "teacher's attitude" and "teacher's classroom behaviour", of the Pupil Perception Questionnaire variables were not included in this "physics" regression equation.

Table 31a

Multiple Regression - Stepwise Solution Indicating the Relative Importance of Both the Characteristics of Science Teachers (Pupils' Perceptions) and the Pupil-Teacher Classroom Interactions (STOS) Variable as Predictors of the Biology Achievement of Boys (N = 153).

Independent Variables	Multiple R	R ²	R ² Change	B
Teacher's Directions	0.170	0.029	0.029	-2.121
Teacher's Questions	0.276	0.076	0.048	-0.271
Pupils' Consultation	0.027	0.076	0.0001	4.677
Pupils' Reference to Teachers	0.298	0.089	0.013	-2.243
Teacher's statements	0.373	0.139	0.050	0.413
Constant				6.840

Table 31b

Multiple Regression- Stepwise Solution Indicating the Relative Importance of Both the Characteristics of Science Teachers (Pupils' Perceptions) and the Pupil-Teacher Classroom Interactions (STOS) Variables as Predictors of the Biology Achievement of Girls (N = 131)

Independent Variables	Multiple R	R ²	R ² Change	B
Teacher's Questions	0.515	0.265	0.265	0.101
Teacher's Classroom Behaviour	0.568	0.322	0.058	0.068
Teacher's Attitude	0.594	0.353	0.031	-0.073
Constant				4.96

Table 32a

Multiple Regression - Stepwise Solution Indicating the Relative Importance of both the Characteristics of Science Teachers (Pupils' Perceptions) and The Pupil-Teacher Classroom Interactions (STOS) Variables as Predictors of The Chemistry Achievement of Boys (N = 153)

Independent Variables	Multiple R	R ²	R ² Change	B
Teacher's Statements	0.335	0.113	0.113	0.134
Pupils' Reference to Teachers	0.458	0.209	0.097	-0.341
Constant				8.004

Table 32b

Multiple Regression - Stepwise Solution Indicating the Relative Importance of Both the Characteristics of Science Teachers (Pupils' Perceptions) and the Pupil-Teacher Classroom Interactions (STOS) Variables as Predictors of the Chemistry Achievement of Girls (N = 131)

Independent Variables	Multiple R	R ²	R ² Change	B
Teacher's Questions	0.465	0.217	0.217	-0.459
Teacher's Statements	0.618	0.382	0.165	-0.874
Teacher's Directions	0.667	0.445	0.064	-3.452
Pupils' Reference to Teachers	0.746	0.557	0.112	0.934
Constant				251.206

Table 33a

Multiple Regression - Stepwise Solution Indicating the Relative Importance of Both the Characteristics of Science Teachers (Pupils' Perceptions) and the Pupil-Teacher Classroom Interactions (STOS) Variables as Predictors of the Physics Achievement of Boys. (N = 153)

Independent Variables	Multiple R	R ²	R ² Change	B
Teacher's Statements	0.486	0.236	0.236	0.114
Pupils' Consultations	0.514	0.265	0.029	-0.240
Pupils' Reference to Teachers	0.546	0.298	0.034	0.049
Constant				8.963

Table 33b

Multiple Regression - Stepwise Solution Indicating the Relative Importance of Both the Characteristics of Science Teachers (Pupils' Perceptions) and the Pupil-Teacher Classroom Interactions (STOS) Variables as Predictors of the Physics Achievement of Girls (N = 131)

Independent Variables	Multiple R	R ²	R ² Change	B
Teacher's Statements	0.320	0.103	0.103	-0.441
Teacher's Questions	0.520	0.271	0.168	-0.055
Pupils' Reference to Teachers	0.541	0.292	0.022	-0.455
Teacher's Directions	0.636	0.405	0.113	1.406
Teacher's Personality	0.651	0.424	0.019	0.088
Constant				41.474

CHAPTER VIII

Synopsis

This chapter is restricted to both the discussion of the findings reached in this study and to recommendations.

The discussion and recommendations cover five parts. The first part deals with:

- I. The teaching of biology, chemistry and physics in Kuwaiti high schools, as assessed by the Science Teaching Observation Schedule.
 - a) categories involving factual transactions
 - b) categories involving practical work in the classroom
 - c) categories involving problem solving activities
 - d) categories involving making hypotheses and speculation

The second part covers:

- I. The relationships of sex of pupils and teachers with the pupils' achievements in biology, chemistry and physics.
- II. The relationships of teaching methods with the pupils' achievements in biology, chemistry and physics.

The third part deals with:

- I. The perception of science pupils, teachers, and supervisors on the relative importance of the qualities describing the characteristics (attitude, personality, and classroom behaviours) of a "good" science teacher.
 1. the classroom qualities of a "good" science teacher as indicated by the items selected in the final version of the Pupil Perception Questionnaire
 - a) in relation to the attitude of the "good" science teacher
 - b) - in relation to the personality of the "good" science teacher and
 - c) in relation to the classroom behaviours of the "good" science teacher.
 2. Items that were rated by all three groups - pupils, teachers, and supervisors - as the most and least important of the characteristics of a "good" science teacher.

3. Items that were rated by both male and female pupils as the most and least important of the characteristics of a "good" science teacher.
4. Items that were rated by both male and female teachers as the most and least important of the characteristics of a "good" science teacher.
5. Items that pupils rated as most or least important characteristics of a "good" science teacher but which did not coincide with the ratings of either teachers or supervisors.
6. Items representing disagreement between the ratings of male and female pupils over the characteristics of a "good" science teacher.
7. Items representing disagreement between the ratings of male and female teachers over the characteristics of a "good" science teacher.

II. The Perceptions of both pupils and supervisors of the teaching characteristics of the observed biology, chemistry and physics teachers.

The fourth part covers:

- I. Assessing the relationships of the sex of pupils and teachers with Pupils' Perceptions of the characteristics of their biology, chemistry and physics teachers.

The fifth part deals with:

- I. The relative contributions of the various measures of pupil-teacher classroom interaction (as measured by the STOS) and Teacher's Perceived Characteristics (as measured by the Pupil Perception Questionnaire) variables to the variances of pupils' achievement in biology, chemistry and physics.
 1. The total amounts of variance in the achievements of boys and girls which were explained by the predictors included in the stepwise-multiple regression equation.
 - a) The relative contribution of "teacher's questions" (i.e., category '1a') to the total variances of pupils' achievement in biology, chemistry, and physics.

- b) the relative contribution of "teacher's statements" (i.e. category '1b') to the total variances of pupils' achievement in biology, chemistry and physics.
- c) the relative contribution of "teacher's directions" (i.e., category '1c') to the total variances of pupils' achievement in biology, chemistry and physics.
- d) the relative contribution of "pupils' consultation" (i.e., category '1d') to the total variances of pupils' achievement in biology, chemistry and physics.
- e) the relative contribution of "pupils' reference to teachers" (i.e. category '1e') to the total variances of pupils' achievement in biology, chemistry and physics.
- f) the relative contribution of the perceived "teacher's personality" to the total variances of pupils' achievement in biology, chemistry and physics.
- g) the relative contribution of the perceived "teacher's attitude" in explaining the total variances in the achievement of pupils in biology, chemistry and physics.
- h) the relative contribution of the perceived "teacher's classroom behaviour" in explaining the total variances in the achievement of pupils in biology, chemistry and physics.

CHAPTER VIII

8.0 Discussion and Conclusion

Two of the main aims of conducting this research were to explore

- 1) how science was being taught to fourth-grade pupils in Kuwaiti high schools and
- 2) how pupils, supervisors and teachers in Kuwait perceived the characteristics of a "good" science teacher.

To be able to answer the above two questions, however, comprehensive data needed to be collected in relation to both the processes of teaching and learning science in Kuwait and the characteristics of a "good" science teacher.

It is well known that to collect appropriate data concerning these processes within any academic area, two main types of instruments could be used. These main categories of instruments are, namely, rating systems (Travers, 1955; Good, 1959; Remmers, 1963; Borg, 1963; Remmers, Gage, and Rummel, 1966; and Thorndike and Hagen, 1969) and systematic observational systems (Medley and Mitzel, 1963; and Parakh, 1967). Moreover, data collection could either be carried out indirectly or directly (Meux, 1963; and Rosenshine, 1970(a)).

Part I

To find an answer to the first question, i.e., how science was being taught in Kuwaiti secondary schools, an appropriate instrument had either to be found or to be constructed for the recording of the science classroom interactions in Kuwaiti high schools.

It was noticed that a large number of systematic classroom observation systems was developed by many educators, such as those developed by

for example, Guilford (1956); Taba, Irvine and Elzey (1964); Gallagher (1965); Taba, (1966); Parakh (1967); Brown, Obler, Soar, and Webb (1968); Flanders (1970); and Delamont (1973), for the recording of teaching-learning processes. Each one of these instruments, however, was developed

to fulfil a special task (see Chapters two and four).

The Science Teaching Observation Schedule, which was developed by Eggleston and his associates (1976), was found to be the most appropriate of all available instruments, for use in this study for describing and systematizing the teaching of science in Kuwait (see Chapter IV, pp.95-112). The idea of developing a new systematic observation system was, therefore, abandoned.

In this study, the observation of classroom interactions was carried out in twelve, six male and six female, Kuwaiti high schools. Three teachers from each school, who taught biology, chemistry, and physics subjects to the same class, were observed. Each of these teachers together with their pupils were observed for three hours during the period January to April 1981. In this project classroom observations were carried out under a natural classroom setting, during which the same science curriculum was being taught in all secondary schools in Kuwait (see Appendix, A1,2, and 3). Moreover, the observer was given the opportunity, by the administration of these male and female schools, to attend the observed classes during the research period without having to turn up at any specific times; hence the finding of this study were all the more reliable because visits were random and not expected.

Classroom interactions were recorded on the basis of the 23 STOS individual categories which covered the two major categories of the schedule namely, activities initiated and/or maintained by the teachers, and those initiated and/or maintained by the pupils in the classroom.

8.10 Types of Science Teaching Behaviour

On the basis of the amount of use made by the observed science teachers and pupils of each category, a cluster analysis was performed to discover whether or not the teaching of the same science topics was conducted in the same way. On the basis of the cluster analysis (see pp.254-260) teachers were divided into two groups, i.e., "group one" and "group two" types of teaching behaviour. The main significant categories that differentiated

between the two groups of teachers (see Chapter VII, *table 17-b*) were a_2 , a_3 , b_1 , b_2 and e_4 (see also Chapter VII, *figure 26*, p.259). "Group one" science teachers, in Kuwaiti high schools, were characterised by making more statements of problems (b_2); and pupils who were taught by these teachers never referred to their teachers "to seek guidance" when working on experimental procedures (e_4).

"Group two" science teachers, in Kuwaiti high schools were characterised by making relatively low use of questions which had to be answered by their pupils either by application of facts and principles to problem solving (a_2) or by making hypotheses or speculations (a_3). Moreover, these "group two" teachers were found to make lower use of " b_1 " category i.e., stating facts and principles, than "group one" teachers.

8.20 The Teaching of Biology, Chemistry and Physics in Kuwaiti High Schools As Measured by the Science Teaching Observation Schedule (STOS)

The classroom behaviours of teachers and pupils in Kuwaiti high schools were compared within each of the three separate subject areas, i.e., biology chemistry and physics, on the basis of the five minor categories (and their component individual categories as explained in *table 2*), namely, teachers' questions (1a), teachers' statements (1b), teachers' directions (1c), pupils' consultation (1d) and pupils' reference to teachers (1e).

A few important trends were noticed about the way in which science is taught in Kuwaiti high schools. Reference will be made in the discussion to categories a_1 through to e_4 (please refer to *figures 3-25*).

I. Categories involving classroom factual transactions (i.e., a_1 , b_1 , c_1 , d_1 and e_1).

From the mean of the uses made by the teachers of the three science areas, regarding the factual transactions categories (see *figure 1*), it is evident that the mean frequencies of use of " a_1 " teaching behaviour

ranged between 22% and 31% of time sampling units (see table 34, p. 351). It can be seen as well, from figure 3, that no teacher failed to ask questions which had to be answered by recalling facts and principles. Moreover, no significant difference was recorded between the teachers of the three science areas regarding their use of such teaching behaviour. Female chemistry and biology teachers, however, asked their pupils more "a₁" types of questions than did their male colleagues ($U = 7.0$, $p < 0.05$ for both cases).

Teachers' statements of facts and principles, i.e., "b₁" category, were the highest used teaching behaviour among not only "1b" statements but also among the STOS 23-categories. The mean frequencies of use made by the 36 observed science teachers were found to range between 71% and 88% of time-sampling units (see figure 10 and table 35, p.253). Also no significant difference was recorded in relation to this category either between the mean frequencies of use made by the observed chemistry, biology, and physics teachers) or between that of male and female teachers within each subject area (see tables 36 and 37, pp. 356 and 357).

Although "1c" minor category was one of the least frequently used teaching behaviour (see table 34), the mean frequencies of use of "c₁" category were observed to be between 2% and 3% of time-sampling units in 58% of the observed science classes (see fig.14). Teachers of the three science areas were observed to direct their pupils to sources of information to acquire facts and principles to a similar extent (see tables 36 and 37).

One of the most highly used teaching behaviour in the observed Kuwaiti classrooms was the "e₁" category, i.e., pupils referring to teachers to acquire or confirm facts and principles (see fig.22). Pupils in all classrooms were observed to refer to their teachers at mean rates ranging from 17% to 27% of time-sampling units (see table 34). Pupils in Kuwaiti high schools were found to refer to their chemistry, physics, and biology teachers to a similar extent in order to acquire their help and assurance

on some facts and principles. Male pupils on the other hand were found to refer to chemistry and biology teachers regarding the " e_1 " teaching behaviour more often than their female counterparts ($U = 5.5$, $P < 0.05$ for chemistry, and $U = 6.5$, $P < 0.05$ for biology).

From the previous presentation one may recognise that the categories involving factual transactions, i.e., a_1 , b_1 , c_1 , d_1 , and e_1 , were found to be among the most highly used teaching behaviours covered by the STOS five-minor categories, namely, teachers' questions, teachers' statements, teachers' directions, pupils' consultations and pupils' reference to teachers. This implies that, in Kuwaiti high schools, teachers of the three science areas together with their pupils spent a great part of their teaching-learning classroom behaviour in non-intellectual transactions. It was also found that factual transactions categories (i.e., the "1" within all five-minor categories) constituted 59.5%, 45.7%, and 61.1% of the total recorded teaching behaviours in physics, chemistry and biology classrooms respectively (see table 35). Dreyfus and Eggleston (1979) reached similar findings when they attempted to study the pattern of intellectual transactions that took place between student-teachers and their pupils in science classrooms. The researchers found that, in their study, the use which the experienced teachers made of the factual transactions categories ranged between 40% and 46% of the total recorded behaviours, whereas student-teachers used the "1" categories for about 50% of the total recorded classroom behaviours. In another study, Eggleston, Galton, and Jones (1976) found that the frequency of use made of the categories relating to factual transactions by the observed 95 science teachers constituted 40.5%, 48.1% and 39.3% of the total recorded behaviours in chemistry, biology and physics classrooms respectively. Moreover, the results of the present study also showed that category " b_1 ", i.e., teachers' statements of facts and principles, is the most widely used not only of the "1" categories but also of the STOS 23-categories. That is 33.8% of the physics, 22.8% of the chemistry, and 39.3% of the

biology total recorded teaching behaviours were spent by teachers on stating facts and principles only. The results reached by Eggleston, et al., (1976) and Dreyfus and Eggleston (1979, p.318) also indicated similar findings (see table 35, p.353).

II Categories involving practical work (i.e., $a_4, a_5, a_6, b_4, c_4, d_4$, and e_4)

In relation to the " a_4 " teaching behaviour, i.e., teachers' questions which have to be answered by the designing of experimental procedure, it was found that this category was amongst the least used of the STOS categories especially by the observed physicists and biologists (see fig.6) in Kuwaiti high schools. In other words, twenty-two teachers, namely 4 chemistry, 11 physics, and 7 biology teachers, failed completely to ask their pupils " a_4 " types of questions. The mean frequencies of use made of this teaching behaviour, however, were found to range between 0.4% and 5% of time-sampling units. Also, chemistry teachers were found to make significantly more use of the " a_4 " questions than their biology colleagues ($U = 30.5$, $P < 0.05$). Male and female teachers within each science area were also found to make similar use of the " a_4 " teaching behaviour (see table 36 and 37).

As regards the " a_5 " category, that is questions which have to be answered by pupils' direct observations (refer to figure 7), it is clear that this category was among the least frequently used teaching behaviour by the observed science teachers, especially by biology and to a lesser extent by physics teachers. The mean frequencies of use made of this type of question were observed to occur within a range of 2% to 17% of time-sampling units (see table 34). Fourteen of the participant science teachers (seven of them were biology teachers) failed to ask their pupils this type of question. Chemistry teachers were also observed to make significantly greater use of this category than their biology colleagues ($U = 34$, $P < 0.05$). Male and female teachers within each science area, were found to make similar use of the " a_3 " type of question (see table 37, p.357).

As with "a₅" teaching behaviour, the "a₆" category, i.e., questions which have to be answered by interpretation of observed or recorded data (see fig.8), was also found to be among the lowest used "1a" categories, especially by biology and physics teachers (see table 34). Seventeen of the observed science teachers, that is, 7 biology, 7 physics and 3 chemistry teachers, failed to use this type of teaching behaviour. Moreover, the mean frequencies of use of this category was recorded within the range of 3% to 10% of time-sampling units. Also chemistry teachers were observed to make significantly more use of this type of question than biology teachers ($U = 0.35$, $P < 0.05$). Male and female teachers in the observed science areas were seen to make use of this type of teaching behaviour to the same extent (see table 37).

In relation to the "b₄" teaching behaviour, i.e., teacher's statements of experimental procedures, it was found that in the cases of biology and physics classes this category was among the least frequently used teaching behaviour of the "1d" categories. In other words, eighteen teachers, namely 3 chemistry, 5 physics, and 10 biology teachers failed completely to make any "b₄" types of statements (see fig.13). The mean frequencies of use made of this teaching behaviour, however, were found to range between 2% and 16% of time-sampling units. Moreover, from the data represented in table 36, it is clear that chemistry teachers made significantly more use of this teaching behaviour than their biology colleagues ($U = 25.0$, $P < 0.05$). Female chemistry teachers (see table 37) were also found to make significantly more use of the "b₄" types of statements than their male chemistry colleagues ($U = 7.0$, $P < 0.05$).

Directions of science teachers to their pupils, so as to lead them to sources of information regarding the type of activity on which they are working "c₄", were the least frequently used teaching behaviours in the observed Kuwaiti classrooms (see table 34). Five chemistry, eleven biology and eleven physics teachers failed completely to direct their pupils to

sources of information when working on experimental procedure (see fig.17). The mean frequencies of use made, however, of the "c₄" teaching behaviour by the observed science teachers were found to range between 0.1% and 4% of the time sampling units. Chemistry teachers were observed to make significantly more use of "c₄" directions than either biology ($U = 37$, $P < 0.05$) or physics ($U = 33$, $P < 0.05$) teachers. Male and female teachers within each science area were also found to make use of the "c₄" category to the same extent.

Pupils' consultation for the purpose of seeking guidance on experimental procedure, i.e., "d₄" category, was one of the activities least used in Kuwaiti classrooms, especially by physics pupils (see Fig.21). There is a great difference between the frequencies of use made of this category by chemistry and either biology ($U = 21$, $P < 0.05$) or physics ($U = 24$, $P < 0.05$) teachers. The mean frequencies of use in all three subject areas, however, were found to range between 0.0% and 20% of time-sampling units. Also male and female pupils within each science area made similar use of this classroom activity.

Pupils reference to teachers especially when working on experimental procedures i.e., "e₄" category, was also found to be among the least used categories in Kuwaiti science classrooms (see fig.25). Pupils in twenty seven of the observed classes, namely 7 chemistry, 10 biology and 10 physics, did not refer at all to their teachers seeking this type of help. The mean frequencies of use of this category were found to range between 0.3% and 4% of time-sampling units (see table 34). However, pupils referred to their chemistry teachers to a significantly greater extent than they did when studying physics ($U = 36$, $P < 0.05$) subjects. No significant differences were recorded between the frequencies of references of the observed male and female pupils to their teachers within each of the three science areas.

Moreover, from the data represented in table 35 regarding the percentage

of time spent on each of the STOS categories, in relation to the total recorded classroom behaviours, it is clear that both teachers and pupils spent more of the recorded time on experimentation in chemistry classes than they did in both biology and physics classes. That is, the ratio of practical time in chemistry lessons constituted 23.8% of the total recorded behaviours compared with 4.6% and 6.9% in biology and physics classrooms respectively. The results, however, found by both Dreyfus and Eggleston (1979) and Eggleston, Galton, and Jones (1976) did not show such discrepancy in the use of practical work within the three different science areas. Thus, Dreyfus and Eggleston (1979) recorded, in their study, that the experimental "design of procedures" categories accounted for about 20% of all the STOS transactions. Eggleston and his associates (1976) also concluded that the practical 'design of procedures' transactions in chemistry, biology, and physics classrooms accounted for 27.4%, 27.7% and 26.0% respectively of the total recorded classroom behaviours.

III Categories involving problem solving activities (i.e., a_2, b_2, c_2, d_2 and e_2 .)

The " a_2 " type of teaching behaviour, i.e., questions which have to be answered by the application of facts and principles to problem solving, was observed to be one of the most frequently used activities in Kuwaiti classrooms. This activity was used by all science teachers except one physicist (see fig.4). The mean frequencies of use of the " a_2 " teaching behaviour ranged between 17% and 21% of time sampling units (see table 34). No significant differences were found between the frequencies of use made of this category by teachers within each of the three science areas. The only significant difference, however, between the frequencies of use made of this teaching behaviour by the two sexes, was found with biology teachers. Thus, female biology teachers were seen to make significantly more use of " a_2 " type of questions than their male biology colleagues ($U = 6, < 0.05$).

The presentation of the subject matter being discussed in the form of a problem, i.e., "b₂" category, was not adopted by seven of the observed science teachers, namely, 3 chemistry, 2 physics, and 2 biology (see fig.11). The mean frequencies of use of this teaching behaviour were within the range of 7% to 14% of time-sampling units. Also, no significant differences, regarding the "b₂" classroom activity, were recorded either between the extent of its use made by the teachers within each of the three science areas, or between male and female teachers within each subject area.

Teachers' directions to pupils regarding sources of information needed to help them in identifying or solving problems, i.e., "c₂" category, was also one of the categories that was omitted completely by many science teachers. Nineteen teachers, namely 6 chemistry, 6 biology, and 7 physics, were seen to make no use of the "c₂" type of direction (see fig.13). The mean frequencies of use made of this teaching behaviour were found to range between 1% and 3% of time-sampling units (see table 34). It was also found that teachers of the three sciences made use of this teaching behaviour to the same extent. Moreover, no significant differences were recorded between male and female teachers within each science area regarding the frequency of use they made of this particular teaching behaviour.

Pupils' consultations for the purpose of solving problems, i.e., "d₂" category, were found to be the second highest used of the consultation activities (i.e., among all the d's categories). Pupils, however, in eight classes, namely 1 chemistry, 4 physics and 3 biology, failed to use this type of consultation (see fig.19). The mean frequencies of use of "d₂" classroom activity ranged between 8% and 11% of the time-sampling units (see table 34). Also, no significant differences were obtained regarding the frequencies of use of this category made by pupils studying within each of the three science areas. With regard to sex differences only female chemistry pupils were found to make significantly more use of this classroom activity than their male counterparts ($U = 6, P < 0.05$).

Pupils' reference to teachers for the purpose of seeking guidance when identifying or solving problems, i.e., "e₂" category, was one of the least frequently used category in the Kuwaiti science classrooms. Pupils in 27 of the observed classes, namely 10 chemistry, 8 biology and 9 physics, failed to seek help from their teachers when working on problem-solving activities (see fig.23). The mean frequencies of use made of the "e₂" category were found to range between 1% and 3% of time-sampling units (see table 34). Moreover, no significant differences were recorded regarding the frequency of use made of this activity either between pupils studying within each of the three science areas or between male and female pupils within each area.

It is also apparent from the data represented in table 35, that with regards to problem-solving activities, chemistry, biology, and physics participants in Kuwaiti high schools spent 14.8%, 16.1% and 18.8% respectively of the total recorded behaviours in their classrooms on such activities. These percentages, however, do not indicate much difference between the time spent on the "a₂", "b₂", "c₂", "d₂" and "e₂" categories by the observed chemists, biologists and physicists. It is also clear that 50% of the time spent on problem-solving activities in each science area is spent on "a₂" teachers' type of questions, which is defined in the STOS as a convergent activity (on the part of the teacher) leading to an expected answer (on the part of the pupil). The findings of Eggleston, Galton and Jones (1976) regarding the same activities, suggest that physics teachers together with their pupils spent relatively more time (i.e., 23.8% of the total recorded behaviours) on "a₂", "b₂", "c₂", "d₂" and "e₂" categories than did both the observed biologists (i.e., 14.1% of the total recorded behaviours) and the observed chemists (i.e., 18.2% of the total recorded behaviours). Moreover, the results reached by Dreyfus and Eggleston (1979), regarding the time spent on the problem-solving activities showed that the observed biologists made much more use of the "a₂", "b₂", "c₂", "d₂", and "e₂", categories than did the participant physicists.

IV Categories involving making hypotheses and speculation (i.e., a_3, b_3, c_3, d_3 and e_3)

Regarding " a_3 " teaching behaviour, i.e., questions which have to be answered by making hypotheses or speculation (see fig.5), it was found that this type of question was used by all science teachers, in the observed Kuwaiti high schools, except for one physicist. The mean frequency of use made of this category was within a range of between 22% and 27% of time-sampling units (see table 34). Teachers within each of the three science areas were also found to make use of the above mentioned teaching behaviour to about the same extent. Also no significant difference was recorded between the frequencies of use made of the " a_3 " teaching behaviour by male and female teachers within each science discipline.

Teachers' statements of hypotheses or speculation, i.e., " b_3 " category, were found to be one of the least frequently used teaching behaviours adopted in the observed Kuwaiti classrooms. Seventeen of the thirty-six participant teachers, namely 7 chemistry, 6 biology, and 4 physics, failed to use this type of teaching behaviour (see fig.12). The mean frequencies of use made of the " b_3 " type of statements by the teachers of the three science areas were found to range between 2% and 7% of time sampling units (see table 34). Also no significant differences were recorded between either the frequencies of use made of this teaching behaviour by the teachers of the three science areas or that of male and female teachers within each science area.

Teachers' directions to pupils to sources of information for the purpose of making inferences and formulating or testing hypotheses, i.e., " c_3 " category, was also one of the least frequently used categories in the observed Kuwaiti science classes. Twenty four science teachers, namely 7 chemistry, 8 biology, and 9 physics, failed to direct their pupils to sources of information needed for " c_3 " activity (see fig.16). The mean

frequencies of use made of this teaching behaviour were found to range between 1% and 2% of time-sampling units (see table 34). Moreover, regarding the "c₃" type of directions, no significant differences were found either between the frequency of use made by the teachers within each of the three science areas or between those made by male and female teachers within each subject area.

Pupils' consultation when making inferences and formulating or testing hypotheses i.e., "d₃" category, was one of the least frequently used of the STOS classroom activities. No pupils in 4 chemistry, 7 biology and 9 physics classes were seen to carry out any "d₃" activity (see fig.20). The mean frequencies of use, however, made of this category by pupils studying in the three science areas were found to range between 1% and 10% of time-sampling units (see table 34). Pupils in chemistry classes were also recorded as making significantly more frequent use of this classroom activity than when they were studying physics ($U = 36, P < 0.05$). No significant difference was recorded between the frequencies of use made of the "d₃" activity by male and female pupils in each science discipline.

Pupils' reference to teachers seeking help when making inferences and formulating or testing hypotheses, i.e., "e₃" teaching behaviour, was also one of the least frequently used activities in the observed Kuwaiti classrooms. No pupils in 75% of the observed science classes, i.e., 7 chemistry, 9 physics and 11 biology, were seen to seek "e₃" help from their teachers (see fig.24). The mean frequencies of use of this classroom activity were found to range between 2% and 3% of time-sampling units (see table 34). Also, no significant differences were recorded either between the frequencies of use made of this category by the observed biology, chemistry, and physics pupils, or between male and female pupils within each science area.

Moreover, the mean frequencies of use of "making of hypotheses or speculations, i.e., a₃, b₃, c₃, d₃ and e₃ categories, were found to be 13%, 16.3% and 12.8% of the total recorded behaviours in chemistry, biology and

physics classes, respectively (see table 35). These percentages, however, indicated that the time spent on the "3" type categories was almost the same within the classes of all the three observed science areas. It is also clear that 50% of the time spent on the categories of "making of hypotheses or speculations" was dominated by teachers' " a_3 " types of questions. Furthermore, the observations carried out by Eggleston and his associates (1976) in some English high schools also showed that the time spent on the above-mentioned activities was similar in each of the three science areas. Thus they found that 11.2%, 7.8% and 8.9% of the total recorded behaviours were spent on the "3" categories in the observed chemistry, biology, and physics classes respectively (see table 35).

From the above summary regarding the different activities conducted during the teaching-learning of science in Kuwaiti high schools, a few conclusions can be drawn.

Firstly, the findings of this study suggest that, in general, the teaching and learning of science in the observed Kuwaiti (as well as some English schools) fourth grades involved the use of "factual transactions" activities to a greater extent than "practical/experimental" activities, "problem-solving", and the "making of hypotheses and speculations". This can be clearly seen from the high percentages of use regarding "factual transactions" (i.e., a range of 45.7% up to 61.1% of the total recorded classroom behaviours) when compared with those of the other activities (see table 34). Moreover, most of the time spent on categories of "factual transactions" was found to be dominated by "teachers' statements of facts and principles", i.e., " b_2 " teaching behaviour, in all three science areas.

Secondly, the activities regarding "problem solving", i.e., the "2" type categories, as well as the "making of hypotheses and speculations", i.e., the "3" type categories, were found to take up about equal proportions of the total recorded behaviours in both chemistry and biology classes. Thus 14.8% and 16.1% of the total recorded behaviours were spent in chemistry

and physics classes, respectively, on "problem-solving" activities whilst 13% and 16% of the same total class time was spent in the same classes on the categories "making hypotheses" or "speculations". In physics classes, however, more time was found to be spent on categories involving "problem solving" (i.e., 18.8% of the total recorded behaviours) than that spent on categories related to the "making of hypotheses" or "speculations" (i.e., 12.8% of the total recorded behaviours). Moreover, in the three science areas, more than 50% of the time spent on "problem-solving" activities was found to be dominated by the " a_2 " category, i.e., convergent thinking types of questions which led to specific or predetermined answers. Similarly, more than 50% of the time spent on the "making of hypotheses" or "speculations" was observed to be used by the teachers, of the three science areas, in asking " a_3 " types of questions.

Thirdly, of the total recorded behaviours in each of the observed biology, chemistry and physics classes it seems that more time was spent by chemistry teachers and their pupils on practical work than the time spent on such activity by physics and biology teachers. In other words, 23.8% of the chemistry, 4.6% of the biology, and 6.9% of the physics classes' total recorded behaviours, were spent on the $a_4, a_5, a_6, b_4, c_4, d_4$, and e_4 categories.

From the previous summary regarding the different approaches adopted during the teaching-learning of science in Kuwaiti high schools, a few conclusions could be drawn.

Firstly, the findings of this study suggest that, in general, the teaching and learning of science in Kuwaiti fourth grade high school classes involve "factual transactions" to a greater extent than "practical" activities, "problem-solving", and the making of "hypotheses and speculations". This can be clearly seen from the high frequencies of use of the factual transactions categories, if compared with those of the other activities (see table 35). Moreover, most of the time spent on the "factual transactions" was found to be dominated by the teachers' statements of facts

and principles (i.e., " b_2 ") in all three science areas. Thus, the majority of the observed teachers in Kuwaiti high schools seem to prefer merely presenting verbally the facts and principles of their discipline rather than eliciting this knowledge in a manner that allows for pupils' participation and encouragement of novel ideas. This approach, however, prevents teachers from spending more time during their teaching routine presenting information in the form of problems, hypotheses or speculations by which pupils may have the opportunity to work through solutions or make relevant comments and speculations. Pupils' reference to teachers also seems to be affected by the teaching behaviour that their teachers adopt. This could be seen in the three science areas where pupils seem to show a greater tendency for seeking help regarding the acquisition or confirmation of facts or principles (i.e., e_1) rather than for reasons outlined in categories " $e_2 - e_4$ ". This again reflects the overall (and probably unhealthy) bias that at present exists in the teaching situation in Kuwaiti high schools. Here there is a preference for easy rendering of knowledge (by the teacher) and easy acquisition of knowledge (by the pupil) without much involvement or active research on the part of the pupil. If the teaching-learning of science is following this particular routine in other Kuwaiti schools, then it is hardly surprising that the participant male and female pupils, when asked to define the qualities of the "good" science teacher (on the basis of the qualities covered by the newly developed perception questionnaire), regarded the ability of the "good" science teacher "in providing clear summarisations and reviews at the end of each session" (item 40) as being particularly important. On the other hand, the same pupils did not view their own participation in practical work (item 104), and the creative application of their own ideas to new situations and areas (item 114) as having any great relevance or significance. This trend, however, was described by Nash (1976) by stating that pupils "say that they should be taught things. They do not demand that they be given the opportunity to find things out for

themselves. In some ways this seems to be particularly disturbing" (p.70).

Secondly, from the data represented in table 36, regarding the practical/experimental work categories (as classified by Eggleston et al., 1976, p.68) namely $a_4, a_5, a_6, b_4, c_4, d_4$, and e_4 (also see Chapter IV, fig.1), it seems that chemistry teachers undertake significantly more practical work than do either biology teachers (in categories, a_4, a_5, a_6, b_4, c_4 and d_4) or physics teachers (in categories c_4, d_4 , and e_4). This is evident from the differences in the frequencies of use of these categories related to the practical work in the classroom. Furthermore, pupils in chemistry classes tended to use their own initiative when working on experimental procedures significantly more often than they did when they were studying biology or physics, and thus they relied less upon their teachers' directions or help. This discrepancy in pupils' behaviours may be due not only to the more practical experimental behaviour encouraged in chemistry classes but also to the fact that such behaviour generally involves the division of pupils into work groups, as seen by the observer during observational periods. These groups tend to develop pupils' initiative, co-operation, and independence from the teacher. The dissimilarity in the teaching-learning behaviour between the three science areas, may be related to the more practical work needed for studying the chemistry syllabus (refer to Appendix A, 1 to 3) compared with the work undertaken in the other two science areas. Although some of the differences in teaching behaviour may derive from varying orientations in the syllabuses, the differences may also arise in part from individual teacher preferences and styles.

From the syllabus assigned for the fourth-grade secondary school pupils regarding the three science areas, it is clear that these syllabuses outline topics which allow both pupils and teachers to carry out some basic experimental work during the teaching-learning periods. Sample elements of the syllabuses are as follows: acids and bases, salts, oxidation and reduction (for chemistry); blood group inheritance and reproduction (for biology); and

magnetic field, electric conductors and insulators, and hydrodynamics (for physics).

The mere inclusion of such practical elements in the syllabuses, however, does not adequately or fully explain the difference in teacher-pupil behaviour. If one looks at the frequency of use regarding $a_4, a_5, a_6, b_4, c_4, d_4$ and e_4 teaching behaviours, one can see that there is a great discrepancy between the frequencies of use made of some of these categories by the teachers and pupils in the three science areas (especially in chemistry) when teaching-learning takes place on the same subject matter (within each science area) at different schools.

With regard to the " a_4 " teaching behaviour one can see from figure 6 that while four chemistry teachers failed to ask their pupils to design any experimental procedure, three other chemistry teachers asked this type of question for about 5% up to 25% of time-sampling units. Similarly, although seven physics teachers did not make any use of the " a_4 " teaching behaviour the rest of the observed physics teachers did so for about 5% or less of time-sampling units.

Regarding the " a_5 " category, that is, questions which have to be answered by direct observations (see fig.7), it is seen that one-third of the observed chemistry teachers did not use this category, while another third asked this type of question for between 20% and 50% of time sampling units. While seven biology teachers failed to ask their pupils " a_5 " types of question another five biology teachers made use of the same teaching behaviour up to 15% of time-sampling units. Moreover, three physics teachers failed to ask their pupils any questions related to direct observations, i.e., " a_5 " questions, whilst one teacher made use of this category for more than 25% of time-sampling units.

In addition, three chemistry teachers were not recorded as having asked their pupils to interpret any observed or recorded data, i.e., " a_6 ", while four other teachers were found to do so within the range of 15% to 25% of time-sampling units (see fig.8). Similarly, seven of the observed biology

teachers never asked their pupils "a₆" types of question, while the other five teachers did so up to 10% of time-sampling units. Moreover, 58% of the observed physics teachers were found not to ask "a₆" types of question. One physics teacher, however, asked pupils to interpret either observed or recorded data for more than 25% of time-sampling units.

As regards "b₄" teaching behaviour, i.e., teachers' statements of experimental procedure (see fig.13), three chemistry teachers failed completely to use this category. On the other hand, three other chemistry teachers made "b₄" types of statement for between 25% and 40% of time-sampling units. Moreover, teachers' statements of experimental procedure were only used by one biology teacher. Five of the observed physics teachers also failed to make any statements regarding experimental procedure. On the other hand, one physics teacher was observed to make use of "b₄" statements for more than 25% of time-sampling units.

With regards to directions of chemistry teachers to their pupils to sources of information when working on experimental procedures i.e., "c₄", five of the twelve observed chemistry teachers did not do so. Three other chemistry teachers, however, directed their pupils to sources of information for between 5% and 20% of time-sampling units (see fig.17). In a similar way to "b₄" teaching behaviour, "c₄" category was also observed to be only used by one biology teacher, up to 10% of time-sampling units, whilst the other eleven teachers did not do so. Similarly, only one physics teacher was observed to direct pupils to sources of information (so as to guide them when working on practical procedures) for about 5% of time-sampling units whilst the rest failed to do so.

As regards pupils' consultations i.e., "d₄" for the purpose of seeking guidance on experimental procedure (see fig.21), consultations amongst pupils in five chemistry classes did not occur. On the other hand, pupils in the other seven chemistry classes consulted with one another within 15% to 75% of time-sampling units. Moreover, in ten biology classes pupils were not

seen to consult with each other to seek guidance on experimental procedure. Only in two biology classes were pupils observed to do so, with mean frequencies of use ranging from 10% to 15% of the time-sampling units. None of the observed physics pupils was seen to consult with each other regarding "a₄" activity.

Finally, in seven of the observed chemistry classes, pupils were not recorded as referring to their teachers to seek guidance when working on experimental procedures, i.e., "e₄" category, while in three other classes pupils did so for between 5% and 20% of the time-sampling units (see fig. 25). Pupils of only two biology classes were observed to refer to their teachers to seek guidance on experimental procedures. Moreover, the mean frequency of use of "e₄" activity made by the biology pupils did not exceed 5% of time-sampling units. Furthermore, pupils in only two of the observed physics classes were seen to refer to their teachers seeking "e₄" guidance up to a maximum of 5% of time-sampling units. On the other hand, pupils in the other ten physics classes failed to do so.

In view of these findings, and from personal observations it is considered that, in comparing the teaching-learning behaviours for similar subject matter in different classrooms in the observed schools, variations in teaching behaviour may arise from teachers' individual preferences and styles as well as from relative differences in the syllabuses and course requirements. Moreover, there is a variety of possible reasons for the considerable incidence of "factual transactions" in the classroom during science teaching in Kuwaiti high schools (the same reasons, of course, may also be responsible for the greater use of "factual transactions" in the English schools observed by Eggleston and his associates, 1979). First and perhaps foremost, the main consideration of the teacher is the optimum use of classroom time as determined by the requirements of the Secondary School Certificate Examination (SSCE). Secondly, the availability of expensive, experimental equipment may be limited, and the skills needed to use

such equipment may be in short supply. Even if the equipment is available, the teacher may feel ill at ease and reluctant to use it or to allow pupils to do so. Thirdly, also because of factors such as the teachers' personality, teaching style, or personal preference, teachers may choose such a "factual" orientation in order to maintain managerial control. Fourthly, not all teachers have the abilities or skills to adopt different teaching behaviours. Finally, pupils' attitudes towards teachers in the classroom may condition the teachers' behaviour.

As an overall conclusion from the results discussed in the previous section, it can be seen that teachers dominated the amount of interaction that occurred in the classroom. This finding is applicable to teachers of the three scientific disciplines (see table 16, p. 353). The situation reflects the general practice of teaching in the observed Kuwaiti high schools which is very much biased towards theory and rote presentation of information as opposed to practical experimentation and problem solving by the pupils themselves. Even the least amount of classroom time dominated by teachers is only just under three-quarters of the time-sampling units (that is chemistry 72%). Conversely, at very best, pupils spend only 28% of their (chemistry) classroom time engaged in activities that involve "learning and seeking information" apart from teacher direction or initiation.

In scientific disciplines that for the most part owe their existence to practical experimentation, individual problem raising, and research by discovery, the above findings may be somewhat strange. Indeed the forms of teaching outlined earlier may eventually prove detrimental to the pupil, especially during the first year of university life. Here, the emphasis is biased towards more individualistic research in both theoretical and practical aspects of the sciences. Lecturers at the university may make statements and point to numerous references, but the onus is on the pupil

with regard to looking up the references, expanding on the information given in lectures, and engaging in practical experimentation. In the first year the university entrant has not previously experienced such a relaxed and unstructured form of teaching and hence may be unprepared. As noted from the present researcher's own personal observations and experience of university, many pupils feel frustrated and at a loss whilst adopting to the very different form of education to that previously experienced in schools. It may be better to adopt a more pupil-oriented form (and consequently less of a teacher-dominated form) of learning earlier on in the educational programme, i.e., in Kuwaiti schools, rather than leave the introduction of such learning to the university.

Table 34 The mean frequencies of use of each of the STOS 23 Categories
in Relation to the frequencies of use of the total observed

Classroom Behaviour

STOS 23 Categories	Chemistry N = 12	Physics N = 12	Biology N = 12
1. TEACHER TALK			
1a Teacher asks questions (or invites comments) which are answered by:			
a ₁ recalling facts and principles	31.0%	29.0%	22.0%
a ₂ applying facts and principles to problem solving	21.0%	21.0%	17.0%
a ₃ making hypothesis or speculation	24.0%	22.0%	27.0%
a ₄ designing of experimental procedure	5.0%	1.0%	0.4%
a ₅ direct observation	17.0%	7.0%	2.0%
a ₆ interpretation of observed or recorded data	10.0%	4.0%	3.0%
a ₇ making inferences from observations or data	9.0%	5.0%	4.0%
1b Teacher makes statements			
b ₁ of fact and principle	71.0%	87.0%	83.0%
b ₂ of problems	7.0%	14.0%	8.0%
b ₃ of hypothesis or speculation	2.0%	7.0%	3.0%
b ₄ of experimental procedure	16.0%	5.0%	2.0%
1c Teacher directs pupils to sources of information for the purpose of:			
c ₁ acquiring or confirming facts or principles	3.0%	3.0%	2.0%
c ₂ identifying or solving problems	3.0%	1.0%	2.0%
c ₃ making inferences, formulating or testing hypotheses	2.0%	1.0%	2.0%
c ₄ seeking guidance on experimental procedure	4.0%	0.1%	1.0%
II TALK AND ACTIVITY INITIATED AND/OR MAINTAINED BY PUPILS			
2d Pupils seek information or consult for the purpose of:			
d ₁ acquiring or confirming facts or principles	17.0%	9.0%	6.0%
d ₂ identifying or solving problems	10.0%	11.0%	8.0%
d ₃ making inferences, formulating or testing hypotheses	10.0%	1.0%	2.0%
d ₄ seeking guidance on experimental procedure	20.0%	0.0%	2.0%
2e Pupils refer to teacher for the purpose of:			
e ₁ acquiring or confirming facts or principles	21.0%	27.0%	17.0%
e ₂ seeking guidance when identifying or solving problems	2.0%	3.0%	1.0%
e ₃ seeking guidance when making inferences, formulating or testing hypotheses	2.0%	2.0%	3.0%
e ₄ seeking guidance on experimental procedure	4.0%	0.3%	1.0%

where:

Total frequency of use of category of any behaviour =

$$\frac{\text{Number of time-units in which a specific behaviour occurred}}{\text{Total number of time-units observed of that specific behaviour}} \times 100$$

total number of time-units observed = 15 x 4 = 45 (see table 2, p.110)
 15 = number of time-units observed during a single observation period,
 and 4 = number of the observation periods.

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Table 35 The Percentages of Each of the STOS 23 Categories in Relation to the Percentages of Total Recorded Classroom Behaviour

Category	Kuwaiti Schools			English Schools		
	Chemistry N = 12	Biology N = 12	Physics N = 12	Chemistry N = 12	Biology N = 12	Physics N = 12
a ₁	9.8%	10.3%	11.5%	9.4%	9.6%	9.6%
a ₂	7.2%	7.7%	7.9%	6.4%	4.9%	8.2%
a ₃	7.8%	11.9%	8.5%	3.5%	2.6%	2.9%
a ₄	1.6%	0.2%	0.4%	2.3%	2.8%	2.6%
a ₅	5.3%	1.1%	2.5%	4.4%	4.6%	3.6%
a ₆	3.1%	1.1%	1.7%	2.7%	2.9%	3.6%
a ₇	2.7%	1.9%	1.8%	2.7%	2.3%	2.0%
b ₁	22.8%	39.3%	33.8%	15.4%	15.1%	14.3%
b ₂	2.6%	3.4%	5.0%	4.2%	2.5%	5.3%
b ₃	0.7%	1.2%	2.6%	1.7%	1.2%	2.1%
b ₄	4.6%	1.0%	2.1%	7.3%	7.0%	8.1%
c ₁	0.8%	1.3%	0.7%	4.8%	7.8%	4.4%
c ₂	1.0%	0.8%	0.5%	1.7%	1.7%	3.0%
c ₃	0.7%	0.8%	0.5%	1.3%	1.1%	0.7%
c ₄	1.4%	0.2%	0.1%	1.0%	1.3%	0.8%
d ₁	5.4%	2.5%	3.1%	7.4%	9.4%	6.4%
d ₂	3.3%	3.6%	4.4%	3.9%	3.0%	4.0%
d ₃	3.1%	1.0%	0.5%	3.2%	1.5%	1.8%
d ₄	6.5%	0.8%	0.0%	4.6%	4.8%	2.9%
e ₁	6.9%	7.7%	10.4%	3.5%	6.2%	4.6%
e ₂	0.7%	0.6%	1.0%	2.0%	2.0%	3.3%
e ₃	0.7%	1.4%	0.7%	1.5%	1.4%	1.4%
e ₄	1.3%	0.2%	0.1%	4.1%	4.3%	3.4%

where: Percentage of occurrence =

$$\frac{\text{Number of time units in which a specific behaviour occurred}}{\text{Total number of time units occurred of the 23 observed behaviours}} \times 100$$

PART IIDiscussion and Recommendations8.30 Sex Differences in Achievement in Biology, Chemistry and Physics

The differences in achievement between female and male pupils in biology, chemistry, and physics subjects were analysed and tested for significance. These data, collected from the administration of three especially designed science tests (see Appendix B 1, 2 and 3) applied to the two samples, i.e., males and females, were subjected to t-analyses for independent groups.

The results of the t-analyses (see Chapter VII, Part II, table 19a, p. 268) showed that female pupils in Kuwaiti high schools achieved better results than did male pupils in all three science areas. The difference between the chemistry achievement of the two samples, however, was not statistically significant. Nevertheless, the tendency remains, especially as female pupils achieved significantly better results than boys in both biology ($t = 2.03$, $P < 0.05$) and physics ($t = 3.87$, $P < 0.001$).

The difference between the achievement of boys and girls at a certain grade level may be related to many factors such as: the difficulty of the subject matter being studied, sex of pupils, age, intelligence, initiated abilities, difference in the instructional methods, and so on. It is considered that the difference between the achievement of the observed male and female pupils in this study may be related mainly to the sex of the observed pupils and not to the above-mentioned factors. This opinion was built firstly upon the results reached through the administration of the three pre-achievement-tests. That is, when the initial abilities or knowledge of the observed pupils were examined on the pre-tests during the period December - January (1980-1981), the mean scores of both sexes were found to differ only slightly from a zero value (see tables 18 a to e). This indicated that the observed pupils had only little previous knowledge and understanding of the subjects to be studied during the period January to April 1981. Therefore, this factor, i.e., previous knowledge or aptitude of pupils, was

eliminated from the factors behind the significant difference between the achievement of boys and girls in Kuwaiti high schools.

Secondly, the difficulty of the three sciences being taught seems to be similar for both sexes. That is, from the mean score of the three sciences post-tests (see tables 18 a,b, and c, pp. 263-264) it is clear that both boys and girls in Kuwaiti high schools had the highest mean scores in biology (mean = 11.11 for boys and 11.76 for girls), followed by chemistry (mean = 10.02 for boys and 10.20 for girls), and lastly physics (mean = 7.69 for boys and 9.12 for girls). This may mean that physics was the most difficult subject for both sexes, followed by chemistry with a moderate difficulty level, and lastly, the easiest science of all was biology. The difficulty of the three science areas to pupils in Kuwaiti high schools seems to be similar to those of pupils in the United Kingdom. In other words, the difficulty level of the three science areas to pupils in Kuwaiti schools also agrees with the findings obtained by Duckworth and Entwistle (1974), when examining the difficulty of the above-mentioned science subjects to the fifth-year grammar school pupils. On asking the participant pupils to rank the three science areas on the basis of their perceived difficulty level, both boys and girls ranked physics subjects as the most difficult ones, followed by chemistry and lastly biology.

Thirdly, when reviewing the differences in the instructional methods used by teachers of the three science areas, no significant difference was found between the instructional methods used either by biology or physics teachers, although physics was considered to be the most difficult science subject to pupils (as measured by each of the STOS 23 categories, see table 36, p. 356), in Kuwaiti high schools, and biology was considered as the least difficult one. Moreover, from the data presented in table 37, the only significant differences between the instructional methods of teachers represented in 1a, 1b, and 1c minor categories (i.e., teacher's questions, teachers statements, and teacher's questions respectively) were found in the

Table 36

As Measured By The Mann-Whitney-U-Test Significance of Differences Between The Teachers of The Three Science Areas To The Extent of The Use They Made of Each of the S.T.O.S. 23 Categories.

S.T.O.S. Categories	Chem/bio	bio/phys	Phys/Chem
Questions a ₁ a ₂ a ₃ a ₄ a ₅ a ₆ a ₇	Ch , u = 30.5* Ch , u = 34.0* Ch , u = 35.0*		Ch , u = 35.0*
Statements b ₁ b ₂ b ₃ b ₄	Ch , u = 25.0		
Directives c ₁ c ₂ c ₃ c ₄	Ch , u = 37.0*		Ch , u = 33.0*
Pupils Consult d ₁ d ₂ d ₃ d ₄	Ch , u = 32.0* Ch , u = 21.0*		Ch , u = 36.0* Ch , u = 24.0*
Pupils refer to teacher e ₁ e ₂ e ₃ e ₄			Ch , u = 36.0*

where:

Ch = chemistry teachers use this teaching behaviour significantly greater than; and

* = significant at the 0.05 level.

Table 37

As Measured By The Mann-Whitney-U-Test Significance of Differences Between Male and Female Teachers of The Three Science Areas To The Extent of The Use Each Sex Made of Each of the S.T.O.S 23 Categories.

S.T.O.S. Categories	Chemistry	Biology	Physics
Questions a ₁ a ₂ a ₃ a ₄ a ₅ a ₆ a ₇	(F) u = 7.0*	(F) u = 7.0* (F) u = 6.0*	
Statements b ₁ b ₂ b ₃ b ₄	(F) u = 7.0*		
Directive c ₁ c ₂ c ₃ c ₄			
Pupils Consult d ₁ d ₂ d ₃ d ₄	(F) u = 6.0*		
Pupils Refer to Teacher e ₁ e ₂ e ₃ e ₄	(M) u = 5.5*	(M) u = 6.5*	

where:-

F = Females made significantly more use of the teaching behaviour than males.

M = Males made significantly more use of the teaching behaviour than Females.

* = Significant at the 0.05 level.

significantly greater use by female biology teachers compared with their male colleagues of questions which had to be answered by both recalling facts and principles (a_1) and by applying facts and principles to problem solving (a_2). Moreover, no significant differences were noticed between the instructional methods used by the observed male and female physics teachers. Therefore, the instructional method factor was also eliminated as a causal element related to the differences in the achievement of girls and boys in both biology and physics subjects.

Fourthly, the difference in performance of the observed pupils in Kuwaiti high schools cannot be readily attributed to differences in mental abilities, though IQ test results, if used, may have established this point. This is because IQ tests are not normally used in Kuwait. It does seem unlikely, however, that innate IQ differences would account for all of the differences in high school achievement, in science, between boys and girls, as the selection of the sample lacked bias. Therefore, the effect of this factor on pupils' achievement was also eliminated.

Similarly, age of pupils cannot be considered as the cause of the difference in the achievement of the two sexes simply because the age of the observed males and females was almost the same, that is, ranged from 16 to 22 years.

Thus the only obvious factor that may be considered as the main cause for the better performances of girls in biology ($t = 2.03$, $P < 0.05$) and physics ($t = 3.89$, $P < 0.001$) than boys, is their sexes. Indeed the findings of this study are in tune with those of other educational researchers to the extent that the importance of the sex factor in measurements of boys' and girls' differential achievements is recognised.

For example, Hilton and Berglund (1974) found out, when examining the performance of 881 boys and 978 girls who were enrolled in grades 7-8 and 9-10, that male pupils achieved significantly better results in mathematics than their female counterpart. Moreover, Kläusmeier and his associates

(1962 and 1964) conducted two separate investigations looking for the effect of sex of pupils on the achievement of high IQ pupils on divergent thinking tests. In the first study, Klausmeier, Harris and Ethnathios (1962) asked the participant teachers to rate 78 boys and 113 girls on their fluency and originality in English, social studies and science. The ratings of these teachers were then correlated with the scores of the participant eleventh-grade pupils. The researchers, accordingly, reported sex difference between the divergent thinking abilities of the boys and girls. In the second study, Klausmeier and Wiersma (1964) conducted a similar study on 160 fifth and 160 seventh-grade high IQ pupils. In all cases, the participant girls were found to achieve higher mean scores, on the divergent thinking tests, than boys. On the other hand, boys were noticed to achieve higher convergent mean scores.

An investigation of the effect of sex on the performance . . . was also carried out by Gates (1961). Gates was interested in finding out who were better readers, boys or girls. The researcher's sample composed of 6,646 boys and 6,468 girls studying in grades 2 to 8. The participant boys and girls in each grade level were selected on the basis of their similarity in the aptitude, intelligence, and socio-economic level. The researcher found out that girls obtained better results in speed reading, level of comprehension, and reading vocabulary, than boys. The researcher also concluded that the better reading performance of girls increases from lower to higher grades.

Buckman (1972) is another researcher whose studies suggest the influence which the sex of pupils may have on their achievement. The researcher conducted a study on a sample of 2,925 twelfth-grade pupils (1,236 Jewish-Whites, 1051 non-Jewish-Whites, 488 Blacks, and 150 Orientals) to investigate the relationship of sex to some patterns of mental abilities of adolescents, namely, verbal knowledge, English, mathematics, and memory. The results of Buckman's study indicated that girls achieved higher gains in English and

memory than boys. On the other hand boys were found to achieve higher mean scores on mathematics and verbal knowledge. Buckman also believes that differences in achievement between girls and boys become more marked with age.

Leinhardt, Seewald, and Engel (1979) are among those educators who believe in the importance of the role that the sex factor may play in the achievement of pupils. The researchers built their belief on the results they reached when examining the achievement of the second-grade American girls and boys in reading and mathematics during the academic year 1974-1975. The researchers found out that girls achieved better results in reading tests than boys. Conversely, boys were found to achieve better gains in mathematics than girls.

Rogers (1982) attempts to explain the difference in the achievement of the two sexes in a different manner. He outlines the major principles of "attribution" theory which tries to account for differences in the performance between boys and girls. Rogers claims that the difference in the expectations of the two sexes for future success is one of the important factors behind the difference in the achievement. Dweck and Gilliard (1975) argue that the difference between the performance of boys and girls depends on the confidence both sexes have in their success. The writers claim that fifth-grade girls have lower expectations for future success than boys in the same grade level. Feather (1969) adds another point to the claim of Dweck and Gilliard, namely, that the lack of self confidence in the 78 girls in the introductory psychology course of the Flinders University of South Australia, is revealed by their attributing their success to luck (i.e., external attribution). On the other hand, the participant 89 boys, from the same grade level, are seen by Feather (1969) to attribute their success to their own efforts or ability (i.e., internal attribution). Furthermore, Nicholls (1975) reached similar results to those of Feather (1969), after asking 48 boys and 48 girls from the fourth-grade

to state the cause of their outcomes, that is, their success or failure. Nicholls claims that girls were less confident in their abilities, consequently they attributed their success to luck (i.e., external attribution) especially in a situation where success is followed by failure. Rogers (1982) believes that such differences in attributional pattern lead to the prediction that girls will do less well in the educational system.

Though attribution theory may well still be relevant (pupils' self-perceptions were not assessed in this study), the prediction that girls are inferior achievers is not supported by this research. The observed girls in Kuwaiti high schools are significantly better achievers than boys in biology and physics. There is no significant difference in the achievement in chemistry, though there was a tendency for girls to score somewhat higher than boys.

It does seem more likely (and even more productive if one is seeking to improve educational programmes) that environmental influences and/or cultural factors play a large role in determining the educational outcomes (Mearig, 1967) of pupils in Kuwait. There are differences in values and expectations, both obvious and discreet, that society places on girls as opposed to males. There may be some sort of pressure on girls to marry, stay at home, and look after their children. Hence, girls may find restricted opportunities open to them especially in careers with scientific emphases. Due to societal restrictions imposed on girls in the realms of careers and opportunities, girls in Kuwait may realise that they must put in even greater efforts to succeed and as a result possibly reach higher levels than boys so as to be considered for long-term employment. Girls at present enjoy freedom of entrance into Institutes of Women's Education, Commercial Institutes for Women, Nursing programmes and universities. Even in traditionally female occupations such as nursing and teaching, it is men who occupy the leading positions. In addition to these careers, men have an almost complete monopoly in the army, police force, industrial

companies (especially managerial positions) that deal in oil or engineering, and in gaining admission to technology centres. Hence, it can be seen that most career opportunities are more readily available to boys than girls. Therefore, some of these factors may contribute to the girls' superior achievement over that of boys: the superior achievement of girls may derive from their determination to overcome perceived restrictions and inequities. This suggests a reversal of "attribution theory" to the extent that the inequality perceived by girls regarding careers and opportunities may stimulate greater effort rather than discourage such effort.

Perhaps this argument is partially supported by the ratio of female to male pupils in science or other departments in Kuwait University where more girls can be found. During the academic year 1978-79 pupils enrolled in Kuwait University were 9911 females and 7212 males (Centre for Arab Studies 1982). During the academic year 1980-81 there were more boys than girls enrolled in science in Kuwait high schools, namely 3148 boys in 31 high schools and 2008 girls in 29 high schools. This means that at high-school level more boys are found at school than girls; however, more girls are found in the University than boys. Yet if the sample of Kuwaiti high-school pupils who participated in this study is representative of the school population as a whole, female pupils achieve better results.

8.31 Pupils' Achievement for "Group One" Science Teachers Compared with Pupils' Achievement for "Group Two" Science Teachers.

Whether a particular type of science teaching (as detailed by cluster analysis applied to teacher behaviour) had a significantly greater effect on pupils' achievement as opposed to the other main type of teaching behaviour (also derived from the same analysis) was analysed (see Chapter VII, table 19b, p.268). Pupils' scores on the post-achievement tests for the two groups of teachers, in the three science areas, were compared with each other using a t-test (for unrelated means). The results of this

analysis showed that pupils who were taught by the "group two" teaching-method (i.e., teachers who depended more on experimental work than on theoretical work) achieved significantly better results in biology than pupils who were taught by the "group one" teaching-method ($t = 3.16$, $P < 0.01$). No significant differences, however, appeared between the achievements of chemistry or physics pupils. Nevertheless, a tendency towards a better achievement level was apparent, in the pupils' performance in chemistry and physics. Thus the results of this study give the impression that a certain teaching method may be more effective when adopted in teaching certain scientific disciplines or areas, but its superiority may diminish when adopted with other samples (Wiske, 1951), or other areas (Herman, Potterfield, Dayton, and Amershek, 1969).

The results of this study, however, may favour the introduction of science subjects to pupils in Kuwaiti high schools in a more practical/experimental approach rather than introducing science to them in a mainly theoretical way. However, since the only significant effect the experimental teaching method had was on the achievement of pupils in biology, then one may suggest that this teaching method may not be as effective when introducing either chemistry or physics topics to pupils in Kuwait. The difference in the effect that a certain teaching method may have on the achievement of pupils has also been investigated by many educators. Some researchers were found who, according to the results they obtained, favoured certain teaching methods while others did not express any such preference.

For example; Obler, Francis and Wishengrad (1977) found that the "teacher-Mentor-Counsellor" teaching method was more effective regarding the achievement of college pupils than the traditional approach known as the "revolving door" system (see Chapter I, p.22). Moreover, Divesta (1953) claimed that pupils in a large classroom favoured the lecture, seminar and illustrative presentation over the discussion method. In another study, Will (1976) concluded that a "longer-worded" instruction was more effective

regarding the achievement of eight-year-old children than a "shorter-worded" one. Flanders (1967) found that the achievement of pupils who were taught both mathematics and social science subjects by an indirect-teaching method was greater than those who were taught the same areas by a direct-teaching method. He also suggested that a better result could be attained by shifting from an indirect to a direct approach. Blaney, et al., (1977) attempted to investigate the impact that two different teaching approaches would have on the academic climate of the classroom. The researchers compared the achievements of fifth-grade pupils, who studied their subject matter through "interdependent" learning groups, with those of similar pupils who studied the same subjects under a "traditional teacher-taught" approach. The results of the comparison indicated that pupils who worked in interdependent groups manifested higher self-esteem and were more satisfied with their peers in contrast to those pupils who worked under the "traditional" teaching method. The researchers also claimed that if the achievement of the two groups was compared with each other, then the academic performance of the interdependent learning group would be as good as, or better than, that of pupils in traditional classes. Moreover, the results of the study carried out by Hermann and Hincksman (1978) on 299 ninth-grade pupils who were taught by the didactic and inductive teaching methods suggested that the two teaching methods would give similar outcomes if a delay retention was desired. On the other hand, if an immediate retention was required then the "deductive" method would be preferred. Furthermore, Tjosvold, Marino and Johnson (1977) found that the perceptions of 80 pupils, from the fourth and fifth grades, with regard to the "inquiry" and "didactic" teaching methods, depended on the activity of pupils in the classroom. Thus, pupils working in a co-operative way did not favour any teaching method over the other. However, pupils who worked under competitive conditions preferred the "didactic" teaching method. Finally, Suchman (1977) through his interest in finding the best conditions under which teaching could be introduced

in a more interesting and exciting way, suggested that the "heuristic" teaching method would be preferable.

On the other hand, Bills (1952), when examining the achievements of 900 pupils some of whom were studying general psychology through the lecture-discussion method whilst the remainder were studying the same subjects through a "student-centred" method found no measurable difference in the achievements of the two samples of pupils. Granville (1952) reached similar results when comparing the effect of a "group-psychotherapy" method and a "direct-teaching" method on the reading skills of 64 freshmen pupils. Veldman and Peck (1963) also expressed their doubts about the superiority of the "democratic" teaching method over the "autocratic" approach in achieving better outcomes. In view of the brief discussion above, it would seem that there are at least two approaches to the question of the effectiveness of given teaching methods. From the prospective of this study, it will be agreed that the effect of a certain teaching method may be influenced by other factors (see Chapter I, pp. 24 - 33) related to either teachers, pupils, subject area, or classroom environment. Class size, for example, may affect the success of the given teaching method which Divesta (1953) and Castore (1951) have suggested. The existence of competitive or co-operative classroom conditions may be relevant (Tjosvold et al., 1977), as may grade level, pupils aptitude (Wispé, 1951), pupils preference to a specific teaching method (Winne, 1977), the socio-economic status of pupils (Brophy et al., 1975), pupil motivation (Bruce and Howard, 1977) and attitudes (Castore, 1951), pupils' self-concepts (Ames, Ames, and Felker, 1977), the demonstration quality of a teacher (Stafford and Graves, 1978) and pupils' classroom behaviour (Brophy et al., 1975 ; Perkins, 1965; and Hunt and Joyce 1967); the teachers' disciplinary or class management capacities; the subject being taught (Dupuis and Woerdehoff, 1967), and the desired educational objectives (Wispé, 1951; Hunt and Joyce, 1967; and Herman and Hincksman 1978).

The comparative success of teaching "method two", i.e., the experimental

approach in this study, is evident with regard to biology in particular but also to chemistry and physics, though to a lesser degree. Consequently, the effectiveness of the experimental approach may sustain participatory rather than passive pupil behaviour which, it is argued is more suited to scientific careers. Furthermore, the design of teacher training curricula should take the effectiveness of "teaching method two" (or any other effective teaching method) into account so that the experimental approach may be undertaken by teachers who are familiar with its requirements and skilled in its implementation and who may introduce the method early in Kuwaiti schools. Eventually, better preparation of university entry may occur if pupils have direct personal experience of "teaching method two", especially in scientific departments in which independent study and the application of experimental methods are required.

PART III

Discussion and Recommendations

8.40 The Perception of Science Pupils, Teachers and Supervisors On the Relative Importance of the Qualities Describing the Characteristics (Attitude, Personality, and Classroom Behaviour) of a "Good" Science Teacher

This section is devoted to a discussion of the qualities that the participant groups, namely, pupils, supervisors and teachers, regarded as most or least important to be associated with a "good" science teacher. Before carrying out such analysis, however, it was considered that a discussion of the final version of the newly developed Pupil Perception Questionnaire (see pp.171-173) would help in providing a clear idea of the characteristics chosen to describe and define the "good" science teacher.

8.41 The Classroom Quality of a "good" Science Teacher as Indicated by the Items Selected in the Final Version of the Pupil Perception Questionnaire

The following section outlines some of the qualities considered by fourth grade pupils (i.e., pilot sample) in Kuwaiti high schools (see the map of Kuwait) that should characterise the attitude, personality and classroom behaviours of the "good" science teacher,

1. In relation to the attitude of the "good" science teacher the chosen items could be classified under the following headings:

a) Fairness of the Teacher

Fairness, as expressed by the pilot sample of pupils in Kuwaiti high schools, is seen in terms of no bias in grading examinations and assignments (item 22) and in terms of not allowing a pupil's popularity stemming either from previous years (item 43) or even from outside the classroom (item 46) to affect the teacher's present treatment of that pupil or the rest of the class. Pupils also feel that fairness entails that a teacher does not allow his personal problems to interfere with the way he treats his pupils in the classroom (item 19). Fairness is also viewed by pupils in terms of methods

of punishment a teacher adopts. Hence, a teacher should not equally punish the whole class when only one or a few individuals deserve punishment (item 26) or deduct marks from deserved grades (item 32).

b) Impartiality Towards Pupils

Pupils in Kuwaiti pilot schools viewed impartiality on the part of the teacher in terms of not having "teacher's pets" such as pupils of their own nationality (item 27) or pupils with high levels of academic ability (item 39). It can be seen that, to some extent, "fairness" and "impartiality" overlap each other.

c) Trust and Respect for Pupils

The showing of both trust and respect for pupils (item 18) is another important teacher characteristic that is valued by the pilot Kuwaiti sample. The participant pupils felt that such respect can be shown by teachers by not publicly making fun of pupils for giving incorrect answers (item 28). These pupils also wished their teacher to feel proud of them (item 33).

II In relation to the personality of the "good" science teacher the chosen items could be classified under the following headings.

a) Cheerfulness

This is one of the most important qualities that is mentioned in the Pupil Perception Questionnaire. Pupils considered "cheerfulness" as comprising of a teacher's willingness to smile, hence causing a relaxed atmosphere within the classroom situation. Such a teacher should have a sense of humour (item 3) and at the same time allow a sensible amount of humour to be displayed by pupils (item 2).

b) Discipline

Being a cheerful teacher does not necessarily correlate with lack of control or poor discipline in the classroom. Findings in this study indicate that pupils from Kuwaiti high schools value a teacher who does not allow cheating during examinations and/or answering questions (item 11), and one who is both punctual and reliable in attendance (items 38, 49 and 53).

c) Self-confidence

Also pupils regard the teacher with an appropriate personality as one who has self-confidence. Having self-confidence, in the judgement of the pilot sample, means that a teacher permits a fair amount of pupil questioning (item 122). The initial questions may be related to the course topic, but the teacher who is not afraid of an ensuing discussion that may consist of questions and answers which are not directly related to the text book or even expected to be known in the Secondary School Certificate Examination (SSCE) is perceived by pupils as possessing confidence. Such a teacher, on the one hand, allows a broader area of discussion than is perhaps called for by the syllabus but, on the other hand, does not allow the discussion in the classroom to digress to subjects unrelated to topics under study (item 4). Perhaps the quality of allowing more open discussion is reflected in the teacher who has a wide knowledge and understanding of his/her own subject. Pupils may feel more secure and hence show a greater level of respect towards teachers who are well acquainted with their subjects. Moreover, having a strong personality, in terms of discipline, does not mean, for pupils, the behaviour of ordering pupils around for no good reason (item 12), i.e., "leadership tendency". A strong personality was also viewed as a teacher's ability to hold class activities as scheduled (item 10).

III In relation to the classroom behaviour of the "good" science teacher

the chosen items could be classified under the following headings:

a) Teaching skills

The classroom behaviour of a "good" science teacher is mainly described by items related to the teacher's instructional skills for example in his/her ability to adopt different methods of teaching (items 118 and 119); arouse pupils' interest in the subject being discussed through questioning (items 97 and 71); encourage pupils' participation in class discussion (item 78); and motivate pupils in the classroom by means of questioning and providing clues (item 77) that will cause pupils to think over problems. This is

seen in preference to teachers providing both questions and immediate "ready-made" answers, thus lessening the degree of pupil dependency on the teacher. Moreover, the "good" science teacher is seen as the one who explains the subject matter in clear, concise, simple language, and in an organised and orderly manner (items 66 and 84); clarifies the subject being discussed with the aid of appropriate audio-visual techniques (item 50); summarises and reviews the main ideas of a lesson (item 70); and makes sure before discussing any further tasks that pupils fully understand previous ones (items 67 and 80). Furthermore, these pupils in Kuwaiti high schools favour the teacher who shows some interest in the practical aspect of their subjects, i.e., who does not, for whatever reasons he may have, leave any incomplete practical work (item 121) or substitute any practical work for a theoretical lesson (item 123). Pupils like to see teachers give clear guidelines and explanations as to the necessary procedures that need to be taken before and during the carrying out of any practical work (item 91). The same pupils, however, prefer a teacher who encourages them both to search for principles, information, and hypotheses for themselves (items 104, and 106) and to discuss their findings objectively (item 109). The "good" science teacher is also viewed as the one who does not restrict his teaching of results reached from discussion and/or experimental work to that simply given in a textbook or to the SSCE course level (items 79 and 87). In other words, the teacher should encourage the pupils to apply and therefore extend their knowledge to new situations, preferably those related to the world around about them (item 114).

b) Evaluation Skills

Finally, a "good" science teacher is perceived as the one who, when examining pupils, uses their results to improve their future educational achievement and the quality of their work. Thus by both consultation with the pupil and reference to their examination grades the teacher seeks both to discover those areas in which the pupil finds difficulty and helps the

pupil to overcome these problems (items 100 and 115). Being a "good" science teacher, however, involves not necessarily challenging pupils with long and difficult exams (item 74).

Hence some of those characteristics that were found to be important in characterising the "good" teacher, and thus covered by the Pupil Perception Questionnaire's 46 items, were also considered to be of general importance in the findings of many other educators.

For example, in an attempt to determine the desirable teacher traits, through opinions of pupils, Butsch (1931) reviewed twelve studies which were carried out during the period 1896-1930. The researcher found that, according to the opinions of the several thousands of pupils from grade two to high-school grades, fairness of the teacher was considered (in seven of the reviewed studies) among the most important factors to be seen in any good teacher, followed by mastering of teaching skills (in six of the reviewed studies); good disciplinarian (in four studies); sense of humour (in three studies); strong character and ability to make class interesting (in two of the studies); and efficiency in use of classtime (in one study). In another research devoted to describing the qualities of a "good" teacher, Butsch (1931) reviewed five of the early studies which were conducted during the period 1917-1930. In these studies, however, a total of 1260 adult participants, namely superintendents, supervisors, teachers, city superintendents, presidents of school boards, and persons engaged in educational work, described the characteristics of a "good" teacher. Butsch (1931) concluded that the adult participants, in three out of the five studies, considered the teaching skills of a teacher among the most important qualities to be found in a "good" teacher. Moreover, in two of the reviewed studies, teacher's fairness was the second selected important quality. Witty (1948) also reviewed two of the earliest studies that were conducted during the period 1946 and 1947 regarding analyses of pupils' opinions of the effective teacher. Witty (1948) concluded that fairness and impartiality (unfair and

inclined to have favourites); sense of humour (lacking in sense of humour); and unusual proficiency in teaching, were considered by the participant pupils to be of prime importance in effective teaching. From the review of literature carried out by Hargreaves (1972) regarding the behaviour of the teacher that American and English pupils like and dislike, he concluded that pupils, prefer the teacher who keeps good control of pupils' behaviour in the classroom; is fair and has no favourites; is moderate in his punishment; explains the subject being discussed in an interesting manner; and has a good sense of humour.

In an empirical study to find the desirable qualities of a "good" teacher, Nash (1976) interviewed one class of 12 to 13 years old pupils by giving each pupil several cards which described some good/bad traits of teachers. Each of the interviewed pupils was then asked by Nash (1976) to describe each of his teachers on the basis of the qualities mentioned in these cards. Nash (1976) argued that the pupils sorted out their teachers in terms of those whom they got on with, kept order in the classroom; explained clearly the main points of the subjects being discussed; provided interesting lessons; were fair with their pupils (by not punishing the whole class for any individual mistake); and had no favourite pupils. Roberts and Becker (1976) through their work on "Communication and Teaching Effectiveness in Industrial Education", concluded that both pupils and supervisors rated some of the participant 123 teachers more highly than the rest of the teachers. Those teachers, i.e., rated favourably by the two participant samples, were seen as warm, supportive, using praise, not mean with pupils, having a sense of humour but not sarcastic, displaying confidence in the ability of their pupils, and giving pupils a clue but no answer when pupils had difficulty finding solutions. Tylor (1962) in "Children's Evaluations of the Characteristics of the Good Teacher", attempted to develop a rating scale to measure pupils' views of the "good" teacher. Tylor (1962) asked a total of 1379 pupils enrolled in junior, secondary-modern, and grammar schools to write a short essay on a "good/poor" teacher. The analysis revealed four

major areas describing the teacher's classroom behaviour. These areas were teaching, discipline, personal qualities, and organisation. The following characteristics were found by this researcher to be among the important qualities given by pupils in describing what they consider as a "good" teacher: firm and keeps order in the classroom, fair in his punishment, has no favourites, explains clearly the work to be done in the classroom, has sufficient knowledge of his subject, explains the subject in an interesting manner, has sense of humour, and who is fair in marking pupils' work. Moreover, 360 members from the National Association for Research in science teaching were asked by Chiappetta, Shores, and Collette (1978) to described the desired characteristics of secondary-school science teachers. These members who train science teachers, conduct research on teacher preparation, and have taught science at the precollege level, have described some of the desired qualities. Some of the qualities listed included the abilities to communicate effectively; to incorporate effective laboratory activities into instruction; to use the inquiry, process, and discovery methods when teaching science; to use a variety of instructional strategies and techniques; and to relate science to society. Goldsmid, Gruber, and Wilson (1977) on their efforts to assess the nomination of faculty members for an award for distinguished teaching, 978 students, from the University of North Carolina, were asked to give descriptions to teachers they preferred most or whom they would like to nominate for their superior teaching. Students' opinions, revealed from their perceptions, were found to concentrate on two general traits, namely, the teacher's competence and his/her conscientiousness. The importance of these two areas was expressed in the following descriptions, namely, his/her concern about pupils' mastery of the subject; respect for and interest in the pupil as a person; encouragement of pupil participation; clarity of explanation and ability to communicate ideas; fairness in treatment of pupils; sense of humour; teaching reveals command of, insight into subject matter; and inspiring, stimulating, interesting teaching.

Moreover, the opinions of the Kuwaiti sample pupils on the qualities of a "good" science teacher were also found to resemble some of the traits covered by some of the available rating scales that were used by many researchers in the United States of America. For example, Bending (1954) asked students from Pittsburgh University to rate eleven psychology instructors during the academic year 1951. Out of the ten factors in his rating scale (i.e., Purdue Rating Scale For Instruction) three factors were found to cover items already mentioned by pupils in Kuwaiti high schools. The first factor contained items dealing with self-confidence, the second factor included items relating to the ability of the instructor to stimulate intellectual curiosity, and the third factor consisted of items relating to the instructor's fairness in grading. The first two factors, however, referred to aspects of the behaviour of the instructor associated with lecturing performance, while the third factor referred to the "objectivity" of the instructor. In another study, Coffman (1954) introduced the Oklahoma A and B Rating Scales for rating instructors of students at the Oklahoma A and M College. This instrument covered such instructor's qualities as ability to arouse interest in pupils; sense of humour; self-confidence; ability to express thoughts expertly, ability to prevent cheating in examinations; tolerance and liberality in inviting and welcoming differences of opinion; punctuality in meeting classes; and correct enunciation. Also, Frey, Leonard, and Beatty (1975) adopted the Endeavour Instructional Rating Form² to analyse seven aspects of the performances of instructors in three American universities. These aspects were, namely, clarity of presentation, workload, personal attention, class discussion, organisation planning, grading, and pupil accomplishment. Some of the traits included in the above-mentioned rating form were instructor's clarity and summarisation of the discussed subject, encouragement of pupils' participation, welcoming of discussion, encouragement to pupils to express their ideas, and his fairness and impartiality in grading. Furthermore, Isaacson et al., (1963 and 1964)

conducted two studies in the University of Michigan. In the first study, all students enrolled in introductory psychology were asked to fill out an instructor rating form. In the second study, 1260 pupils taking the same psychology course as the first sample (i.e., in the first study) were also asked to rate their psychology instructors. The rating instruments used in both studies consisted of several scales describing the instructor's skill, work load, pupil rapport, group interaction and so on. The items which were included in these rating instruments in both studies and which were, no doubt, felt by the researchers to be of considerable importance in measuring salient aspects of a teacher's qualities, were found to be similar to some of the items mentioned in the Kuwaiti Perception Questionnaire. The content of these items were "stimulates intellectual curiosity", "tries to increase interest of class in subject", "sensitive to pupil's desire to ask questions", "decides in detail what should be done and how it should be done", "has everything going on, on schedule", and "spends classtime in a productive manner".

Nevertheless, the excellent tutor in Bloom's opinion (Bloom 1976) is the one who is likely to master a variety of skills explaining or illustrating what is to be learned; to encourage pupils' participation in the teaching-learning process; and to generate friendly relationships with pupils by smiling at them. Argyle (1967) claims that one of the most important qualities in establishing a good rapport with another person is to develop trust between them. He also argues that if one wants to motivate that person, as in the case of a teacher attempted to motivate pupils, he must raise certain questions in which, it may be assumed, the other person is interested. Hallworth (1962) also thinks that a person should evaluate friends and acquaintances (and presumably teachers) on the basis of certain traits such as sense of humour and self-confidence.

Thus the Kuwaiti science pupils' choice of qualities associated with teaching performance and behaviour, which formed the basis of the Pupil

Perception Questionnaire, did not differ to any great extent from those qualities considered important in other studies.

8.42 Items that were rated by all Three Groups - Pupils, Supervisors, and Teachers - as the Most and Least Important of the Characteristics of A "Good" Science Teacher

Once the Pupil Perception Questionnaire had been constructed and its reliability established from the pilot studies (see Chapter V, table 12, p. 178 , i.e., $r = 0.95$.) results were subsequently obtained, using the newly-constructed questionnaire, on the main samples' (pupils, teachers and supervisors) perceptions of the characteristics of a "good" science teacher.

Thus, from the data represented in table 20 (pp. 272-273) regarding the perceptions of pupils, supervisors, and teachers in Kuwaiti high schools, of the characteristics of a "good" science teacher (on the basis of the qualities covered by the items of the newly-developed perception questionnaire), it is seen that all these groups emphasised the following qualities:

A teacher should convey trust and respect towards his pupils (item 18); be fair in marking examinations and classroom assignments (item 22); and show no prejudices against any nationality (item 27). Also, a "good" science teacher should restrict punishment to those who deserve it rather than blame the whole class (item 32). His personal problems should not be allowed to enter into his relationship with and treatment of pupils (item 19).

Regarding more physical attributes a quality that was admired in a "good" science teacher was that of making good use of classroom time. This quality was manifested by not being late in arriving at class (item 38) or digressing onto irrelevant activities that serve no intellectual benefit to the pupil (item 53). Moreover, the importance of clarity in explaining a topic was indicated by all three groups stressing the use of audio-visual aids (item 50).

The above findings were found to agree with those of other researchers. For example, the opinions of pupils who were examined by Argyle (1967); Roberts and Becker (1976); and Goldsmid, Gruber and Wilson (1977) paid great attention to the trust and respect of the teacher towards his pupils. Tylor (1962), Hargreaves (1972) and Nash (1976) emphasised the importance of a 'teacher's fairness towards his pupils in terms of punishment, grading of assignments and examinations, and having no favourites. The importance of classtime and how it should be spent was also one of the factors felt, by the sample examined by Isaacson, et al., (1963), to be of great importance by which a "good" teacher should be evaluated. Rosenshine and Furst (1971), also argued that the use of audio-visual materials in the classroom as well as the variety of other instructional materials used to clarify the subject being discussed would increase the intellectual outcomes of pupils. Regarding the use of audio-visual aids, observations of the twelve Kuwaiti high schools which participated in this study, during the period of January to April, indicated unfortunately that the majority of science teachers did not use audio-visual aids. These teachers used the conventional methods of teaching involving much use of the blackboard rather than the large number and variety of visual-aids that are readily available either in their schools or at the Ministry of Education Centre. Use of such aids would have no doubt added interest to both lectures and topics being studied.

The role of "non-prejudicial" behaviour on the part of the teacher has special relevance in Kuwait. A large number of pupils enrolled in the Kuwaiti government schools are not Kuwaiti but originate from other Arabic and Islamic countries. Similarly, the majority of science teachers are non-Kuwaiti. As a consequence, some discrimination may arise in that some teachers may tend to show preference to pupils of their own nationality. This point was noted by the participant groups and is reflected in their ratings of a "good" science teacher, that is, one who at least displays unbiased attitudes.

With regard to the interference of personal problems in the classroom situation, teachers being ordinary human beings may not always be able to suppress anxiety or other emotional problems that are caused by factors unrelated to his pupils. As ratings indicate, however, teachers do regard personal problems as something they must accept and keep to themselves without allowing their feelings to control or affect their behaviour in the classroom.

There may be several reasons as to why not punishing the whole class for a misdemeanor of one or two pupils has been selected as a most important quality of a "good" science teacher. The teacher may have not adequately prepared a lecture, hence may find any excuse to punish the whole class by, for example, cancelling that particular lecture or discussion point and setting it as an exercise for homework. Another reason may be based on terms of fairness: if a teacher does not definitely have the identity of the wrong-doer (Nash, 1976) and feels that the wrong act should be punished, rather than picking on the wrong individual, it may prove more a disadvantage in the future to punish the whole class.

Items describing a "good" teacher that were considered as of least importance in the opinions of the three participant groups (see table 20, pp. 272-273) will now be examined. Pupils, teachers and supervisors were found not to pay much attention to the following qualities: a teacher who confines classroom discussion to text-book material rather than introducing other sources as a means of saving classtime (item 4); does not complete his/her experimental work (item 121); does not hold classroom activities as scheduled (item 10); deliberately does not administer examinations on the day decided upon (item 69); and treats the better achievers differently from the rest of the pupils (item 39).

Regarding the lack of importance paid to item '4' by all three participant groups, this reaction may be explained by the fact that teachers and supervisors are often convinced that the information mentioned in text-books

is sufficient to provide pupils with all the knowledge needed to understand the subject under discussion (since the supervisors are the ones who have constructed the text books teachers may have considerable faith in the sort of information their supervisors want them to feed to pupils). Teachers and supervisors, therefore, may consider the extra information which can be gained through extra materials is of less importance in comparison with other activities the "good" science teacher has to perform in the classroom. Pupils may also have the same feelings towards such behaviour since all the questions in their examinations are only concerned with the specific information already mentioned in their text books. Pupils may also think that such an activity as relying on extra materials provided by their teachers may involve them in extra homework, which most pupils try to avoid. In relation to item '121' pupils may not object to their teachers when they leave uncompleted practical work, simply because the information which they are about to gain through experimentation may be as readily dictated to them by their teachers. The same reasoning may apply to the teacher's attitude towards such behaviour; in addition there is the factor of time that all teachers are concerned about. Supervisors' opinion of this behaviour may also be influenced by the factor of time to which science teachers are often restricted. It is surprising that supervisors do not place more importance on the knowledge pupils may gain through observing experimental work performed by their teachers.

With regard to the holding of classroom activities as scheduled (i.e., item 10), the only possible explanation that may account for the lack of concern paid by the three groups to this behaviour, may be that the carrying out of classroom activities are often constrained by the circumstances in the classroom, laboratory, or school with such activity. In other words, a teacher may show his/her pupils a film when the laboratory and the film are available, or when the technician is present. On the other hand, a teacher may not be able to take pupils on a field trip when the weather is bad, if

no bus is available, or if the teacher is ill, and so on. In these circumstances, the teacher may not be blamed for his act. As regards item '69', teachers and supervisors may think that pupils should be prepared to take an examination at any time and, therefore, when a teacher does not give an examination on a pre-specified day, pupils will not be harmed. This may be the case because supervisors and teachers take for granted that pupils will study hard for any examination and consequently whether pupils are tested or not, on a specific day is not of prime importance. The reaction of pupils towards the same behaviour (i.e., item 69) on the part of the teacher, is a bit confusing, because a pupil who spends considerable time studying and preparing for an examination (and who may accordingly ignore other subjects during his revision) may feel annoyed for not having the examination and getting it over with. The little attention, however, paid by pupils to this item may be explained by the fact that for many pupils examinations are events to be avoided as they are often regarded as mere drudgery. Also, for fourth-grade secondary pupils, the most important examinations are the SSCE at the end of the school year. For many of these pupils any intermediary examinations whether taken or not, may not affect substantially their final performances.

It was also noticed that impartiality shown by a teacher towards his pupils irrespective of their relative abilities (item 39) was regarded as a teacher behaviour of least importance. This comes as a surprise as the conventionally accepted role of a 'good' teacher is that of impartiality (Butsch, 1931; Witty, 1948; Tylor 1962; Hargreaves 1972; Nash 1976; and Goldsmid, Gruber and Wilson 1977). Pupils, supervisors and teachers in Kuwaiti high schools, however, regarded this behaviour as not as essential as other qualities. It is not easy to find explanations for this result but a few tentative suggestions are offered. Pupils may prefer their respective merits to be recognised in subjects in which they show ability. Such teachers' biases towards pupils may be reinforcing in that they please

the pupils which in turn acts as a factor in the improvement or maintenance of their future performances. The same argument could be applied to both supervisors and teachers, whose aim presumably is to see academic improvement and success in their pupils. Also, interacting with the "brightest" pupils may be more interesting and less frustrating for teachers (Holland 1961; and Barker Lunn, 1972) and supervisors. One wonders how such behaviour or attitudes may affect the less 'bright' pupils. As previously mentioned, the possession of no prejudice on the part of the teacher regarding nationality was an item which was highly esteemed by all three participant groups. Perhaps relatively 'lower' achievement pupils accept this type of teacher behaviour as nationality to most pupils is something for which they are not responsible. Perhaps these pupils have somehow come to feel that their peers, who possess different levels of intelligence, can and should be treated differently by teachers. It must be stressed, however, that the above are only some of the possible plausible explanations and hence, should not be taken as true value judgements as to the results found in this study.

8.43 Items that were rated by both Male and Female Pupils as the Most and Least Important of the Characteristics of a "Good" Science Teacher

From the general summarisation of the findings related to the agreement between male and female pupils regarding the most and least important characteristics of a "good" science teacher (see table 21-d), it can be seen that all pupils, irrespective of sex, place great importance on teaching behaviour that shows a teacher's trust and respect for them (item 18) by not openly criticising them and especially making them feel he is proud of them (item 33). Cantrel, Stenner, and Katzenmeyer (1977) suggest that one profile of the effective teacher is the use of a high rate of praise or encouragement. Herman, Pottersfield, Dayton and Amershek (1969), and Wright and Nuthall (1970), in reviews of literature regarding teacher criticism, concluded that teacher criticism is negatively correlated with pupils'

achievement. The decrease in academic achievement, as a consequence of teacher criticism, was explained by Perkins (1965) in terms of pupils' withdrawal. In other words, Perkins suggested that when pupils find themselves in a position where their teacher criticises them all the time, these pupils will, then, try to avoid such adverse reaction from their teacher, by withdrawing from classroom activity. Moreover, Roberts and Becker (1976), felt that praise and criticism, by the teacher, are of prime importance in affecting the psychological atmosphere in the classroom. It seems, then, that for pupils in Kuwaiti high schools, there is a distinction, albeit a fine one, between trust or respect and proudness. Perhaps the former relate to equalities that lie more in the individual, in this case pupils, while the latter can be conferred on a person but need not involve a two-way interaction between the conferer and recipient. A teacher may be proud of his pupils but this need not involve the more personal aspect of trust. Argyle (1967) also points to this as an important quality of a "good" teacher. He stresses that this attitude readily leads to the reciprocal action of trust and respect for the teacher by pupils. This leads to a conducive teaching atmosphere.

A second conclusion that arises with particular reference to item '78' is that pupils in Kuwaiti high schools, prefer a teacher who is not afraid of inviting different points of view regarding the subject matter being discussed. There is little doubt that a teacher who allows such behaviour in the classroom is the one who has self-confidence and mastery of the subject he/she is teaching. This behaviour, on the part of the teacher, however, may generate feelings of confidence in and respect for teacher from his/her pupils. Washburn and Heil (1960) related the self-confidence of the teacher to levels of pupil achievement. They found, when examining "What Characteristics of Teachers Affect Children Growth" that pupils of the fearful teachers in grades 4,5 and 6 achieved the least, while those pupils of the self-controlling teachers achieved the most (see Washburn and Heil 1960, pp.426-427).

Pupils in Kuwaiti high schools also viewed two other characteristics as being most important to them in defining a "good" science teacher. These items were the necessity for a clear presentation of a topic (item 80) and the provision of a clear summary and review of a topic just taught by the teacher (item 40). Solomon, Rosenberg and Bezdek (1964) tried to justify why pupils pay great attention to teacher's clarity of explanation by arguing that when pupils find that they easily understand what their teacher is explaining, these pupils, may "feel intellectually secure and relatively more confident of their academic competence" (Solomon, et al., 1964, p.29). Moreover, Milgram (1979) concluded, from his research on the "Perception of Teacher Behaviour in Gifted and Non-gifted Children", that pupils, from grades 4 to 6, judged the way in which the teacher presents materials, e.g., in an interesting, clear, and organised manner, as a very important factor. Rosenshine and Furst (1971) suggested that clarity of explanation is significantly related to pupils' achievement. Furthermore, Wright and Nuthall (1970) on the basis of their research on the "Relationship Between Teacher Behaviours and Pupil Achievement in Three Experimental Elementary Science Lessons", found that the summary which a teacher may provide at the end of an episode/lesson is related to better pupil performance. Therefore, the greater confidence and security felt by pupils may help to explain pupils' emphasis on the two activities associated with items '80' and '40'. Nevertheless, the same Kuwaiti sample of pupils viewed the opportunity given to them by their teacher to seek out information on an individual level (item 104) or to interpret their observations of experimental work and to apply the findings to new situations (item 114), as of least importance in describing a "good" science teacher. The same results were also concluded by Nash (1976). Nash argued that pupils "disliked teachers who told them to work it out for themselves and to 'think'. They appreciated the teacher who made her lesson flow and who made the main points of the lesson clearly and in a way that they could understand" (p.68). Moreover, Flanders, Anderson

and Amidon (1961), claimed that pupils who feel helpless in the classroom are always in need of help and reassurance from their teachers. The authors argued that these pupils, or the so-called 'dependent-prone', will probably learn more and achieve better results if their teachers provide them with all the support they need.

As regards these two items '104' and '114', which are considered to be of negligible importance to both male and female pupils, in Kuwaiti high schools, it may be suggested that these views may be the product of the standard teaching practice (Hargreaves, 1972) that pupils are often exposed to in Kuwaiti high schools. Up to the fourth grade (i.e., "0" level), pupils are rarely given the opportunity to work alone or in small groups. Consequently for many pupils the notion of individual self-activity and/or the application of results may have little meaning. Pupils have possibly become accustomed to being presented with "ready made" information by the teacher and at this stage (the fourth grade) the pupils do not consider any other form of acquiring data as particularly important.

8.44 Items that were rated by both Male and Female Teachers as the Most and Least Important of the Characteristics of a "Good" Science Teacher

In addition to those items which were agreed upon by the three participant samples, namely, pupils, teachers and supervisors, as being most or least important in characterising the behaviour of a "good" science teacher, both male and female teachers also placed great importance on the following items: not allowing cheating during examinations and/or answering questions (item 11); not being partial towards pupils of their own nationality (item 27); asking questions during the session to hold pupils' attention (item 71); asking pupils to interpret their observations of experimentation and to apply them to new situations (item 114); and not being afraid of pupils raising questions regarding the subject matter being discussed (item 122).

From a teacher's point of view, the purpose of examinations or questioning

is to test and gauge the pupil's ability or understanding of the topics under discussion. This, however, cannot be ascertained by pupils cheating, nor can cheating be viewed as very fair to other pupils. Cheating on the other hand, may not hold the same importance to pupils (or to some pupils) as they may feel that examinations together with questioning exist to "make their lives a misery" rather than as a point of reference which can be utilised by the teacher for the future benefit of the pupil.

Regarding impartiality on the part of the teacher towards pupils of their own nationality (item 27), teachers in Kuwaiti high schools placed great emphasis on this behaviour. This, of course, does not come as a surprise, simply because most of the teachers in Kuwaiti high schools come from different Arabic or other nationalities. Therefore, these teachers would not like to see themselves looked down upon; treated, or evaluated differently (Ryans, 1954) by their pupils, heads of department, supervisors, or head masters/mistresses just because of their nationality. Walberg and Anderson (1968) claimed that the lack of impartiality or 'isomorphism' may be responsible for diverted or unwanted outcomes, that is, when a pupil or any other member "is unfairly favoured or set above the other, the energies of the group are diverted from the attainment of institutional or private goals into the resulting dissention" (p.418). Teachers, pupils, or any person no doubt would prefer to be treated and evaluated according to their own efforts, accomplishments, and perhaps their attitudes and behaviours towards others, but not on the basis of their nationality. Therefore, if teachers think that 'this is the way that things should work' then their pupils have the right to be treated similarly.

The choice of item '71', that is, "the teacher who asks questions, rather than just continuously expanding information during a class session in order to hold the pupils' attention and interest", perhaps has obvious explanations. Any teacher wishing to pass information in a manner that keeps the pupils' attention realises that pupils, when interested, are more willing

to learn and consequently will probably retain a greater degree of information. No doubt a greater level of classroom control can be obtained with keen pupils. An interested class will, from the teacher's point of view, make teaching less frustrating and more enjoyable (Hargreaves, 1972).

Both male and female teachers from Kuwaiti high schools also highlighted the importance of allowing and welcoming pupils' questions in the classroom (item 122). Teachers no doubt like to find out whether their pupils understand the subject being taught either through questioning their pupils by themselves or by allowing pupils to initiate questions. Teachers, however, sometimes may get annoyed or may not give pupils the opportunity to ask or to inquire about obscure points either because they do not want their pupils to interrupt the flow of the lesson or to prevent wastage of classtime; also, they may be frightened of not having the right answer, especially if the question requires information from sources other than the text books. On the other hand, teachers who have sufficient knowledge of their subject (Tylor 1962), will no doubt feel more confident (Hallworth, 1962) and will welcome pupils' desire to ask questions particularly if the factor of time is of less importance to them than pupils' understanding of the subject matter.

With reference to item '114' that is, "asking pupils to interpret their observations of any experimental work and to apply them to new situations", both male and female teachers regarded this behaviour as of prime importance to be seen in any "good" science teacher. It is the job of a "good" science teacher to produce or make good scientists of his/her pupils. This, however, cannot be accomplished if pupils are taught to accept all facts given to them without questioning the factors behind their existence. Any good scientist should have a talent for observing, making use of his observations, and testing or applying data drawn from one circumstance to another situation.

With regards to the items that were considered of least importance by both male and female teachers in Kuwaiti high schools, it is a little

surprising to find that a sense of humour (i.e., item 3) is seen as of minimal importance. One would have thought that the portrayal of a sense of humour would have alleviated an atmosphere of restrictiveness, rigid discipline, and teacher superiority that many pupils have come to regard as often associated with learning in schools. Hence, this would have resulted in the creation of a more cooperative pupil-teacher atmosphere. Revealing a sense of humour, however, may be regarded by the teacher as undermining his/her authority and consequently his control and necessary management of pupil behaviour (Hargreaves, 1972). Goodenough (1957) regarded discipline in the classroom as one of the important factors affecting pupils' academic success. Goodenough, concluded from his research on the public school that the greatest single factor responsible for pupils' failure was the lack of teachers' ability to control the behaviour of children in the classroom, or what is popularly called "poor-discipline". It may be important to point out that though both male and female teachers viewed a sense of humour as of minimal importance, male pupils regarded this characteristic as of moderate importance and female pupils regarded the same characteristic, within the classroom situation, as of high importance. Perhaps this is an indication of sex differences in preferences for a particular teaching behaviour, which disappears through teacher training (Mitzel, 1960). It seems that in general pupils would prefer a greater sense of humour admitted into lessons (Butsch, 1931; Witty, 1948; Tylor, 1962; Hallworth, 1962; Hargreaves, 1972; Roberts and Becker, 1976; and Goldsmid, Gruber and Wilson, 1977) while teachers do not see this particular aspect of teaching behaviour as terribly important. Perhaps this discrepancy should be further investigated.

Regarding item '74', that is, the "good" science teacher is one who "does not give long and difficult exams", both male and female teachers agreed on the least importance of this characteristic. Teachers may think that pupils appreciate 'easy' and 'short' examinations. Pupils' knowledge or understanding of the subject matter, however, may not be fully explored.

Of course, the description "long" and "difficult" examinations implies that, they are inappropriate to the objectives being taught; teachers would regard it a waste of time if most pupils do not attempt successfully items within a test. Such an examination would be useless in evaluating both the content and objectives of a course. Indeed the teacher could be accused of not ensuring that the examination questions matched the competence and abilities of the pupils. No wonder they regard such an item as inconsequential.

Also, both male and female teachers in Kuwaiti high schools did not consider "ordering pupils around for no good reasons" (item 12) to be a particularly important attribute of a "good" science teacher. This may mean that the participant teachers feel that pupils have to be told what, when, and how to do things in the classroom all the time. This behaviour, however, may give teachers the feeling of superiority over their pupils (Hargreaves, 1972) as well as the ability to command and control the behaviour of their pupils. Goldberg (1968) argued that the authority vested in a teacher, which commands his attitude or behaviour towards his pupils, may also affect the pupil's daily school life. Hargreaves (1972) described the relationship between pupils and teachers in the classroom by stating that "What is notable about the teacher-pupil relationship is the fact that the pupil spends so much of his time directly in such a relationship and that the power differential between teacher and pupil is so great. In classroom, teachers are permitted to and frequently do make almost all the decisions affecting the child's behaviour. What the teacher says goes. It is the duty of the pupil to accept and obey preferably without question" (pp.138-139). Moreover, Ryans (1961a) and Roberts and Becker (1967) also agreed that the behaviour of pupils in the classroom is a function of teacher behaviour. Roberts and Becker (1967) justified this opinion by stating that "in the classes where the teacher is constantly moving and busy and interested in his work, the students tend to keep busy and interested; where the teacher appears to waste a great deal of time, many of the students tend to waste a great deal

of time. In one class where the teacher often yells at the students, the students, tend to yell all the time also". (p.196)

8.45 Items that Pupils rated as Most or Least Important Characteristics of a "Good" Science Teacher but which did not coincide with the Ratings of either Teachers or Supervisors

Regarding, for example, item '118' (see tables 25, a and b, p.286) which concerns the use of different teaching methods with different topics, the participant pupils did not place high emphasis on this particular teaching behaviour. This result, however, contradicts those concluded by Butsch (1931); Witty (1948); Hunt and Joyce (1967); and Roberts and Becker (1976), regarding the opinions of pupils about what characteristics are to be found in any "good" teacher. These researchers indicated that the "good" teacher is the one who is skilled in using a variety of appropriate teaching methods in different teaching situations. It seems that pupils in Kuwaiti high schools do not mind whether or not different teaching methods are adopted by a teacher with different topics or situations. This could be because pupils' main interest is that of receiving clear and comprehensive instructions and information from the teacher (Nash 1976). They, therefore, may not be so concerned with what techniques are employed so long as they understand what is being said (Wispe, 1951). Teachers who also did not stress this behaviour may not have felt that such behaviour is important, as they may think that adopting different teaching methods may lead to confusion on the part of the pupil (pupils, of course, may also feel that confusion could be caused by different forms of teaching). Again, the time element may be relevant. Teachers may waste more time by the adoption of new and different techniques that could be more usefully employed in other areas of teaching. Therefore, teachers may consider that if a science teacher only adopts a single teaching method while teaching different groups or topics, this lack of flexibility should not necessarily, if pupils are

satisfied with that specific teaching method, affect his image as a "good" science teacher. When Wispe (1951) questioned elementary school pupils as to their preference for a permissive-teaching method over a directive-teaching one, Wispe found to his surprise that although the participant pupils enjoyed working with their permissive teacher because of the greater sense of humour allowed, interest, and more active participation in the classroom, these pupils were generally in favour of the directive-teaching method. Pupils thought that the directive approach was of more help in preparing them for their examinations. Wispe (1951), therefore, related this conflicting attitude of pupils to the "objective-examination-oriented-atmosphere" with which pupils were surrounded. On the other hand, supervisors in Kuwait (see table 20 and pp. 272-273) felt this item to be of high importance in classifying a "good" teacher. This opinion is in harmony with those results reached by Butsch (1931) regarding the opinions of adults on the characteristics of a "good" teacher. Again, the discrepancy between the views of teachers and supervisors in Kuwait regarding this behaviour may be explained by that of practicality. Supervisors may feel that a change in the teaching method may be of more interest to the pupil. Though a teacher may agree with this opinion, she/he realises that in the day-to-day situation, a change of techniques may not be feasible or even desirable for some of the reasons given below.

A summarisation and review of the main points at the end of a lesson (item 40) was viewed by pupils, in Kuwaiti high schools as one of the most important characteristics to be associated with a "good" science teacher (see table 20). The same teaching behaviour, however, was viewed by supervisors in Kuwaiti high schools as one of least importance. Pupils may find that the recapitulation of the main points or ideas at the end of each lesson may help them to remember, through reinforcement, the most important facts that should be retained. This behaviour, on the part of the teacher, may reduce some of the work pupils would otherwise have to do by themselves.

Supervisors in Kuwait, however, paid little attention to this specific behaviour. The discrepancy between the pupils' and supervisors' points of view may be explained in that supervisors may consider that if they have to choose between some of the essential characteristics which they would like to see in their teachers, then such behaviours as not allowing cheating (item 11) the ability to adopt different teaching methods (item 118); helping pupils to reason and to judge facts by themselves (item 114) and so on, would seem to be more important than this specific teaching behaviour. Supervisors may wish to see pupils less dependent on their teachers. Thus if a teacher does explain a lesson effectively, the pupil should be able to finish the tasks by finding or summarising the main points by themselves without the help of their teacher.

The "good" science teacher as the one who "does not allow cheating during examination and/or answering questions" (item 11) was one of the characteristics that pupils, in Kuwaiti high schools, viewed differently from both teachers and supervisors. Supervisors and teachers viewed the ability of a teacher to prevent cheating or the passing on information from one pupil to another, when pupils' knowledge and achievement are being evaluated as one of the most important characteristics. Pupils, on the other hand, did not place the same emphasis on this specific behaviour. This discrepancy in the attitudes of the participant samples may be explained in that a teacher who spends so much time in explaining, clarifying, and developing concepts and skills with pupils has the right to know how each pupil is actually performing. Thus, by allowing the passing of information between pupils, the reliability of the teacher's evaluation of such cognitive skills will be questionable. Moreover, supervisors and teachers may think that if any teacher allows such behaviour to happen in the classroom, then pupils may rely on the help they receive from each other during any examination, and consequently, they may not bother to study or to prepare for such examinations. Also a teacher may lose control of discipline if such behaviour is allowed to happen in the

classroom. The low emphasis which pupils give to this teaching factor may be related to the fact that pupils in classrooms often like to help each other, especially if they consider that good relationships with each other are desirable.

8.46 Items representing Disagreement between the Ratings of Male and Female Pupils over the Characteristics of a "Good" Science Teacher

The item "asking questions during any practical work to keep the pupils' attention" (item 97) was the only characteristic that male and female pupils in Kuwaiti high schools significantly disagreed upon as to its relative importance (see table 25c, p. 288). Male pupils rated this behaviour as most important whereas female pupils gave it only a moderate emphasis. This may be because girls tend to be more quiet than boys during class sessions. There is less chatter among girls and they seem to be less easily distracted. These sex differences indeed were noted during the observation sessions in the present study. This may mean that girls focus more attention on the teacher than boys and hence the importance of teacher questioning is not so apparent in maintaining concentration. The boys who are more likely not to be listening to the teacher very attentively may acquire additional stimulation and focusing through more detailed questioning.

8.47 Items representing Disagreement between the Ratings of Male and Female Teachers over the Characteristics of a "Good" Science Teacher

Item 40 (see table 25d, p. 288) was considered by female teachers to be highly important whereas male teachers and science supervisors regarded it as not so very important. Hence the behaviour of "summarising and reviewing the main ideas of the subject matter at the end of each lesson", showed a discrepancy between the opinions of male (i.e., male teachers and supervisors) and female participants. These differences may result from male teachers and supervisors wishing to see less dependency on the part of pupils in the

classroom. Another explanation may be related to management differences evident in male and female classes. In other words, since female pupils, as observed during the present study, are more quiet and well behaved (Linhardt, Seewald, and Engel, 1979), then their teachers may feel more relaxed than their male colleagues, and hence more time may be available to summarise and review the main ideas of the subject than may be possible in male classes. Moreover, the difference between the opinions of the two sexes of teachers may be related to the reactions of male and female pupils to the item regarding questioning by the teacher in order to maintain the pupils' attention (i.e., item 71). Female pupils did not rate this behaviour as important as male pupils (see table 20). Assuming, then, that girls do not require, or respond to questioning, female teachers may feel the need to summarise, review, and discuss information and evidence as many points in a lesson may not have been clarified sufficiently by questioning. Perhaps male teachers assume that questioning covers and clarifies points raised that may have otherwise required elucidation.

Regarding the item "discussing the evidence that supports the previous findings and the expected results of an experiment" (item 109), female teachers rated this teaching behaviour as of prime importance, but male teachers and supervisors only considered it of moderate importance. Reasons for the distinction between the sexes in their responses to item 109, are more difficult to offer. Although the item is one of those rated as least important by male teachers, this rating does not necessarily mean that it is of no importance. Male teachers may feel that this item has a role to play but one that is relatively minor in comparison to other items mentioned in the Perception Questionnaire. One tentative explanation, however, for the sex differences in ratings regarding this particular item may lie in classroom discipline or control. As already noted, female pupils generally are more quiet than boys within the classroom situation. Hence classroom control may be more readily obtained and maintained by female teachers than male

teachers. In Kuwaiti high schools, however, there is segregated school whereby female teachers only teach girls and male teachers only teach boys. Nevertheless, Linehardt, Seewald, and Engel (1979) also obtained similar findings when observing the teaching of reading and mathematics to elementary-school boys and girls. The researchers observed that boys always received more management contacts from their teachers than girls. Hence, as girls seem to be on the whole more disciplined, discussion may be allowed without undermining the teacher's authority. However, as boys tend to be less attentive and more disruptive (as for example chatting to each other), more time may be taken up by the male teacher in acquiring and maintaining classroom control through which he is able to teach. Consequently, there may be less time for the actual discussion of evidence and hypotheses that lie behind practical experimentation. If male pupils do have the tendency to be more unruly, a discussion may lead to a situation where a teacher is less able to control events occurring in the classroom, as, for example, when an argument arises from the expression of different viewpoints. Hence to some extent the teacher's disciplinary control may be undermined.

The third item that the two sexes of teachers disagreed upon in regard to its relative importance, refers to whether "the changing of any practical/experimental work into a theoretical one" (item 123) affects the quality of the so-called "good" science teacher. Female teachers have rated such a change as highly inappropriate, i.e., science teachers should not replace any experiment by only theoretical explanations, such as demonstrating it on the blackboard. Male teachers, however, (as well as supervisors) have rated the same teaching behaviour (i.e., item 123) as not an important factor amongst the qualities which they used to rate a "good" science teacher. Male teachers appear to be unconcerned if their tuition becomes more theoretically based. Hence it appears that female teachers place more emphasis on the practical nature of a science course. There seems to be no obvious reason why this should be. A number of variables, however, could be inter-

acting together to make such differences between the opinions of the two sexes. One could be due to normal maturational factors. Girls mature earlier than boys and hence they may be viewed by female teachers as more responsible. This view may lead to teachers allowing girls more opportunities to handle valuable experimental apparatus and perhaps potentially dangerous chemicals. It has also been noted that teachers and supervisors do not regard practical work very highly (i.e., item 121). Sex difference seems to be a factor here. Due to the greater number of males in the participant groups (i.e., eighteen female teachers in comparison with eighteen male teachers and seventeen male supervisors) the majority of teachers and supervisors may prefer a more theoretical framework.

It may very well be that the less emphasis on a "process" approach with male teachers may reflect the concern of these teachers for boys to succeed in examinations that often reflect knowledge and understanding. Thus a more theoretical approach is tolerated with boys. Girls, on the other hand, may not have the same pressures to do well in science and hence their teachers can spend more time on developing "process" skills such as hypothesising and discussing findings more fully.

Perhaps further research into the differences between teachers, pupils and supervisors or between the two sexes may prove useful. The narrowing down of such differences may result in a more effective and coherent educational programme in science.

8.50 The Perceptions of both Pupils and Supervisors of the Teaching Characteristics of the Observed Biology, Chemistry, and Physics Teachers

From the r-values presented in table 26b it can be seen that, in Kuwaiti high schools, significant agreement exists between the perceptions of pupils and those of science supervisors regarding the characteristics of some of the observed biology, chemistry, and physics teachers. In other words, out of the 36 correlations measured, pupils in 28 (i.e., 78%, of the observed 36 classes) science classes were found to agree significantly with the supervisors on the behaviours of the observed science teachers. On the other hand, no significant

agreement was recorded between the opinions of pupils and supervisors concerning eight science teachers, namely, two biology, two chemistry, and four physics teachers. The significant agreements between the two participant groups, i.e., pupils and supervisors, on the characteristics of the observed teachers may be interpreted as showing that certain teaching behaviours, practised by 28 of the observed teachers, were rated similarly by both pupils and supervisors. (Denton, Calarco, and Johnson, 1977; and Marsh, Overall, and Kesler, 1978). With the other 8 teachers there appeared to be some disagreement as to the types of teaching behaviour observed by supervisors and those observed by pupils.

Thus the first suggestion that may arise from the above results is that if we believe that supervisors are among the best adult judges capable of evaluating the classroom behaviours of teachers, which is the common belief and practice in almost all schools (Denton, Calarco, and Johnson 1977; and Veldman and Peck, 1957), then the results of this study may suggest that pupils in Kuwaiti high schools are also just as capable of giving similar and reliable judgements as are supervisors (Roberts and Becker 1976). Nevertheless, there were some disagreements between pupils and supervisors on the characteristics of the other eight science teachers which may be interpreted or related to the fact that only one group of judges, i.e., either pupils or supervisors, observed the presence or the absence of certain characteristics in the evaluated teachers, which the other group of judges did not observe.

On the basis of the vast amount of educational research that was carried out to justify both pupils' participations in the evaluation of their teachers (see Chapter II, pp.60-64), and the reliability and the validity of such evaluations (see Chapter II, pp.64-70), it may be suggested that if we have to decide which one of the two groups, i.e., either pupils or supervisors, is possibly giving the right description or impression of the characteristics of the eight teachers, the pupils may be considered the ones most likely to do

so. This view is held, not only because of previous research results but also because pupils are the ones who usually spend more time with any specific teacher than any other outside observer. Pupils may, then, be in the most advantageous position to observe in detail what goes on in their classrooms (Goldberg, 1968; Tisher, Power and Endean, 1972; and Scott, 1975), and thus to give, more than any other observer, an honest, reliable, and comprehensive (Veldman and Peck, 1967; Davidoff, 1970; Anderson and Walberg, 1974; Donald and Penny, 1977; Denton, Calarco and Johnson, 1977; and Shingles, 1977) picture of classroom events, or, more specifically, of how their teachers are behaving during a certain period of time. Goldberg (1968) justifies the reasons behind the ability of pupils to give a better picture of what goes on in their classrooms by arguing that pupils are directly involved in the teaching-learning process. Moreover, Christensen (1960) regards pupils, within a class, as consistent observers in describing or rating a teacher. Veldman and Peck (1963) express their opinions about the reliability of pupils' evaluation of their teachers by stating that:

"No one would seriously argue that the pupils taught by a teacher are inevitably the best judges of her effectiveness or ability. Nevertheless, the pupils have one major advantage over other observers: they see the teacher perform on many different occasions, as she encounters a wide variety of problems, as she attempts quite varied tasks, and as she deals with individuals known personally to the observer. Not only does each pupil have the advantage of many separate observations upon which to base his judgement, the use of pupils as observers also affords the increased reliability and reduction of bias that multiple judges afford" (p.347)

Another observer, such as a supervisor, merely visits a teacher for a short time on separate occasions and, thus, his opportunity for sampling typical teacher behaviours is rather limited (Webb and Bowers, 1957). Hence supervisors only catch glimpses of the 'reality' of the classroom situation and of the observed teacher's characteristics (Veldman and Peck 1963). Teachers are sometimes warned of the impending supervisor's visits and in the light of this knowledge, some teachers not only prepare themselves for this visit but (in my experience as a student!) also ask pupils to go

over subject matter previously discussed and to organise their notebooks in a more thorough manner. Thus, the presence of a supervisor, in the classroom may alter the normal routine or day-to-day teaching behaviour of the teacher. Ryans (1954) also argues that if the behaviour of a teacher is to be judged or evaluated by an outside observer, then it may be "true that the classroom observations would be artificial in a sense that the teacher might attempt to put on a good show for the judges". (p.702) This behaviour on the part of the teacher is hardly surprising in view of the fact that supervisors can make decisions which will affect a teacher's future career opportunity and promotion. Teachers, therefore, aim to show their best teaching behaviour and skills (Medley and Mitzel, 1963) such as a positive attitude towards their pupils, good knowledge of the subject matter, the way they control pupils in the classroom, their teaching techniques, and so on. Therefore, it can hardly be said that the supervisors' reports of teaching behaviour obtained from 3 or 4 visits in a school year, constitute a true and accurate picture of either the teacher's or the pupils' behaviours within the classroom. Hence pupils' comments may be the more valid and relevant to future reassessments of teaching methods, attitudes, and educational programmes in general.

Another point worth mentioning is that one may question the relative importance of the characteristics mentioned in the newly-developed Perception Questionnaire upon which teachers were evaluated. In other words, one may think that the qualities described in the Perception Questionnaire may not be considered as important traits either by pupils and supervisors in observing the teacher-pupil classroom interactions or be considered by the teachers to be of importance. These characteristics, were the ones upon which the quality of a "good" science teacher was evaluated by the three participant groups, namely, pupils, teachers, and supervisors. The results of the analyses (see Chapter VII, tables 20 and 21 a-d) indicated that the three participant groups agreed significantly on most of the

characteristics of a "good" science teacher. In other words, an "r" value of: (1) 0.36 ($P < 0.05$) was recorded between the opinions of pupils and those of supervisors; (2) 0.53 ($P < 0.05$) between the perceptions of both pupils and teachers; (3) 0.72 ($P < 0.01$) between the views of teachers and those of supervisors; (4) 0.86 ($P < 0.001$) between the opinions of both male and female pupils; and lastly (5) 0.68 ($P < 0.001$) between the perceptions of male and female teachers, as to the relative importance of traits associated with any "good" science teacher. Therefore, the difference in the opinions between supervisors and those of pupils regarding the evaluation of eight science teachers cannot altogether be attributed to the lack of basic agreement on the relative importance of the evaluated characteristics by the participant groups but that real differences in teacher behaviours were possibly observed for certain teachers.

PART IV

Discussion and Recommendations

8.60 Assessing the Effects that the Sex of Pupils and Teachers has on Pupils' Perceptions of the Characteristics of their Biology, Chemistry and Physics Teachers

From the t-values obtained in Chapter VII (see tables 27 a-d) regarding the effects that the sex of pupils/teachers may have on the perception of pupils of the characteristics of their science teachers, it is clear that the fourth grade girls and boys in Kuwaiti high schools perceived the attitude ($t = 0.425$, N.S.), personality ($t = 0.885$, N.S.), and classroom behaviour ($t = 0.740$, N.S.) of their biology teachers in a similar way. The same results were found regarding the perception of girls and boys of the personality ($t = 0.711$, N.S.), attitude ($t = 0.250$, N.S.), and classroom behaviour ($t = 1.469$, N.S.) of their physics teachers. With regard to the evaluation of the characteristics of male and female chemistry teachers, again no significant difference was recorded between the perception of boys and girls of the personality ($t = 0.818$, N.S.) of their teachers. Nevertheless girls and boys in Kuwaiti high schools differed significantly when perceiving the attitude ($t = 4.006$, $P < 0.001$) and the classroom behaviour ($t = 4.304$, $P < 0.001$) of their chemistry teachers. In other words, girls were found to be more satisfied with the attitude and the classroom behaviour of their chemistry teachers than were boys. From the above findings, one may conclude that since the perception of boys and girls in Kuwaiti high schools only differ in two cases (i.e., attitude and classroom behaviour of chemistry teachers) out of nine, then the sex of pupils/teachers may not be considered an important factor that affects pupils' opinions of the characteristics of their science teachers.

These findings, however, may add some importance to the reliability of pupils' evaluation of the characteristics of their teachers. This reliability may lie in the fact that the sex of pupils, which is among several factors that a teacher is not responsible for or cannot control, has little or no

effect on the way pupils view the behaviour of their teachers. It is important to state, however, that Kuwaiti high schools are segregated, whereby girls are taught by female teachers and boys are taught by male teachers. Therefore, the effect of sex may not be considered an important factor affecting the perceptions of pupils in Kuwaiti high schools. This is simply because these pupils have never experienced working with teachers of the opposite sex. Thus, the effect of sex may appear if this study was conducted in the University of Kuwait, where the two sexes are taught by both male and female teachers. Also several findings by educational researchers do not highlight the influence of either sex of pupils or teachers on pupils' opinions of their teachers. For example, in a study carried out by Elmore and Lapointe (1975) on the perception of 838 college students of the behaviour of their instructors, the researchers concluded that the warmth of the instructor was the most important variable which influenced pupils' ratings and not the sex of pupils or the sex of their instructors. Moreover, Elmore and Lapointe (1974) agreed on the lack of effect that the sex of pupils may have on pupils' evaluation of their teachers' behaviour. Furthermore Veldman and Peck (1967) and Marsh, Fleiner, and Thomas (1975) also believed that there is considerable evidence confirming that sex of pupils has little or no correlation with pupils' perceptions of the characteristics of their teachers.

Another conclusion may be extracted from the results of the t-analyses represented in both table 19a, regarding the significance of the difference between the achievements of boys and girls, and table 29 (a-d) relating to the difference in the perceptions of boys and girls of the behaviour of their science teachers. It is apparent that the evaluation of boys and girls of their science teachers was not affected by their own levels of achievement. In other words, although girls in Kuwaiti fourth-grade high schools achieved significantly better in biology and in physics than did boys (see table 19a), no significant differences were found between the ratings of the two sexes

of pupils of the behaviour of their biology and physics teachers. On the other hand, although the achievements of girls and boys in chemistry were not significantly different, girls rated the attitude and the classroom behaviour of their chemistry teachers significantly higher than did boys.

Consequently, one could suggest that sex of pupils as well as their level of achievement have little or no influence on how teachers were later rated by their pupils. Thus the findings of this study are in harmony with and may add support to the findings of other researchers. Thereby, pupils' evaluation of their teachers is not biased by variables which are either unrelated to the characteristics of, or beyond the control of, the evaluated teacher. For example, when university students were asked to nominate the best instructor with whom they worked, Goldsmid, Gruber, and Wilson (1977) pointed out that the most important factors mentioned for the selection of the nominee teacher were his/her competence (i.e., his/her command of and handling of the subject matter) and conscientiousness (i.e., his/her concern for pupils' achievement). These factors, however, are no doubt under the control of the nominated or any other teacher. Christensen (1960), when measuring the effect that the affect-need of the fifth-grade pupils may have on pupils' perceptions of their teachers' behaviours, concluded that what pupils required of their teachers had no effect on the evaluation of those pupils of the behaviour of their teachers. Christensen (1960) also suggested that pupils' liking of a teacher may not be related to the achievement of pupils. Moreover, when pupils and supervisors were asked by Roberts and Becker (1976) to evaluate the teaching effectiveness of 123 teachers in industrial education, the researchers found that the two samples, i.e., pupils and supervisors, were more interested in the communication/delivery skills of the teachers than in their background variables. In other words, teachers who received high evaluation were judged as significantly more skilled and higher in their liking for pupils than those teachers in the low evaluation group. Furthermore, Marsh (1977), through his research on

the evaluation of college students of sixty-two of their "most-least" outstanding instructors, concluded that the only important area that these students were concerned about and which at the same time differentiated between the so-called "most outstanding" and "least outstanding" instructors, was the instructor's work in the classroom and not background variables (such as class size, physical appearance, or popularity of instructor) or the difficulty/work load factor. Also, from two studies carried out by Elmore and Lapointe (1974 and 1975), in two consecutive years, warmth of the teacher and his interest in pupils were found to weigh heavily on the way pupils viewed their teachers. Finally, Marsh et al., (1975) added to the reliability of pupils' evaluation to the behaviour of their teachers, by confirming that pupils' evaluation is not related to work load. Thus the reliability of pupils' perception of the behaviour of their teachers may depend on only those aspects which they are competent to report on. To get more reliable information about the teacher from his/her pupils, researchers should not include variables beyond the control of the teacher (Shingles, 1977) in evaluation instruments. This is because these variables will only help to bias the pupils' evaluative system.

PART V

Discussion and Recommendation

8.70 The Relative Contributions of the various Measures of Pupil-Teacher Classroom Interaction (as measured by the STOS) and Teacher's Perceived Characteristics (as measured by the Pupils' Perception Questionnaire) Variables to the Variances of Pupils' Achievement in Biology, Chemistry and Physics

This discussion is concerned with assessing the relative contribution that the eight independent variables, used in this study, may have on science achievement of the Kuwaiti male and female samples. The included predictors are from two main sources, namely, pupil-teacher classroom interaction and teacher's perceived characteristics. The first source of data covers five predictors, namely, teacher's questions (1a); teacher's statements (1b); teacher's directions (1c); pupils' consultations (1d); and pupils' reference to teachers (1e). The second source of data consists of the three predictor variables, namely, teacher's personality, attitude, and classroom behaviours as perceived by the pupils they teach. A summary of the results obtained from the stepwise multiple regression analyses, in terms of R^2 change by each of the predictor variables (see tables 31, 32, and 33 (a-b)) is represented in table 38 below.

Before discussing the results of the analyses, i.e., the stepwise multiple regression analyses, it was considered important to note that since this study is of a process-product type (Mitzel, 1960) whereby its results are correlational and not experimental, the results reached in this study must be treated with some caution. This is because results of the process-product type of research can be deceptive (Rosenshine and Furst 1971) in that they may suggest the presence or absence of effects between any of the predictor variables and pupil achievement, although such effects may be related to a complex of behaviours that we have not yet identified or studied in this project.

8.71 The Total Amount of Variance in the Achievements of Boys and Girls which were explained by the Predictors included in the Stepwise-Multiple Regression Equations

The R^2 values (see Chapter VII, p. 318) regarding the total amounts of variance in the achievements of boys and girls which were explained by the predictors included in the multiple regression equation were found (see tables 31, 32 and 33) to be as follows:

- a) 13.9% for boys' and 35.3% for girls' achievement in biology
(see table 31 a & b);
- b) 20.9% for boys' and 55.7% for girls' achievement in chemistry
(see table 32 a & b); and
- c) 29.8% for the boys' and 42.4% for the girls' achievement in physics
(see table 33 a & b).

From the above R^2 values, it is apparent that the total amounts of achievement variance, that are explained by the teaching-behaviour predictor variables are higher for girls than for boys in all three science areas. Thus, this may mean that, in general, the achievement of girls in biology, chemistry and physics can be more easily predicted from the different classroom variables than that of boys. Consequently, one may suggest that sex of pupils, in Kuwaiti high schools, could be an important factor affecting the predictive power of the achievement of boys and girls (the effect of sex of pupils on their achievement will be discussed later on in this section).

Table 38 Statistical Summary of the R^2 change values as indicators of the relative importance of both the Characteristics of Science Teachers (Pupils' Perceptions) and the Pupil-Teacher Classroom Interaction (STOS) variables as Predictors of the Achievement of Girls and Boys in Biology, Chemistry and Physics

Samples	Independent Variables									
	Teacher's questions	Teacher's statements	Teacher's directions	Pupils' consultations	Pupils' reference to teachers	Teacher's Personality	Teacher's attitude	Teacher's Classroom Behaviour		
<u>Biology</u>										
Boys	4.8%	5%	2.9%	0.01%	1.3%	-	-	-	-	-
Girls	26.5%	-	-	-	-	-	3.1%	5.8%		
<u>Chemistry</u>										
Boys	-	11.3%	-	-	9.7%	-	-	-	-	-
Girls	21.7%	16.5%	6.4%	-	11.2%	-	-	-		
<u>Physics</u>										
Boys	-	23.6%	-	-	3.4%	-	-	-	-	-
Girls	16.8%	10.3%	11.3%	-	2.2%	18.5%	-	-		

where: (-) = means that this specific variable was not included in the stepwise-multiple regression equation.

I. The relative contribution of "teacher's questions" (i.e., category '1a') to the total variance of pupils' achievement in biology, chemistry and physics

Category '1a' refers to "teacher's questions and invitations for comments" from pupils. This form of teaching behaviour was found to contribute significantly in explaining the variances in girls' achievement in biology ($R^2_{ch} = 26.5\%$, $F = 58.51$, $P < 0.001$), chemistry ($R^2_{ch} = 21.7\%$, $F = 86.53$, $P < 0.001$) and physics ($R^2_{ch} = 16.8\%$, $F = 5.61$, $P < 0.001$). The same teaching behaviour, however, contributed only in explaining the variance in boys' achievement in biology ($R^2_{ch} = 4.8\%$, $F = 12.55$, $P < 0.001$) but not in either physics or chemistry. The lack of contribution of the 'teacher's questions' in explaining the variances in physics and chemistry achievement of boys, however, does not necessarily mean that this teaching behaviour has no achievement predictive value. This is because in the cases of chemistry and physics the "teacher's questions" category was preceded by both the "teacher's statements" and the "pupils' reference" categories which correlated significantly with it (see table 28 a & b). In other words, the '1a' teaching behaviour was found to correlate significantly with 'teacher's statements' and 'pupils' reference to teachers' categories with r-values of -0.597 ($P < 0.001$) and 0.317 ($P < 0.01$) respectively in the case of boys' chemistry and with r-values of 0.334 ($P < 0.001$) and -0.367 ($P < 0.001$) respectively, in the case of boys' physics. Hence the significant correlations that this teaching behaviour, i.e., 'teacher's statements' and "pupils' reference to teachers", may be the reason behind its exclusion from the physics and chemistry stepwise-multiple regression equations, in that these two predictors have already explained the variances in the boys' physics and chemistry achievements (Popham 1967; and Borg and Gall, 1979). According to these results (i.e. R^2_{ch} and r-values) it can be said that the teacher's use of questions, inviting comments from pupils, and allowing pupils to elaborate upon their answers may be considered as one of the

important factors that may affect the educational attainment of pupils. In other words, it may not be unreasonable to suggest that this teaching activity (i.e., category '1a') is an important factor in the prediction of the achievement of pupils in Kuwaiti high schools. It seems that discussion using questioning and commenting techniques may be an invaluable and successful means of improving pupils' achievement.

The "questioning activity" of a teacher with pupils has been investigated by several educational researchers, some of whom were convinced, on the bases of the results they reached, that this particular teaching behaviour is an important factor in contributing to teacher effectiveness as measured by the achievement of pupils, while others either doubted or denied its importance. For example, Herman, Potterfield, Dayton and Amershek (1969) believed that there is increasing evidence that when a teacher asks questions and/or accepts pupils' feelings and ideas, achievement of pupils is higher than when teachers lecturing or provide explanations without allowing pupils to participate. The same opinion of welcoming pupils' participation in discussions particularly through questioning procedure, because of its productive effect on the achievement of pupils, was held by Cantrell, Stenner, and Katzenmeyer (1977). In another investigation, Wright and Nuthall (1970) attempted to examine the effect of teachers' questions on the achievement of 8 year-old pupils. The investigators, however, concluded that the achievement of these pupils, who worked with teachers having the tendency to only ask one question rather than several questions before receiving the answer, was better than the achievement of pupils who worked with teachers observed to ask several questions before receiving the final answer. The tendency of a teacher to ask only one question before receiving the right answer was, however, related by Rosenshine and Furst (1971) to the clarity of a teacher's language in the classroom. Rosenshine and Furst (1971) believed that when a teacher is able to state a question clearly, then pupils will answer the question without any need for additional information. The clarity of the question that a teacher gives is, then, another important

factor that may affect the impact of the 'questioning procedure' variable on the achievement of pupils. Wright and Nuthall (1970) also concluded that, on the one hand, the tendency of asking several unclear questions is negatively related to the achievement of pupils. On the other hand, teacher's redirection of a certain question to another pupil is positively correlated with the achievement of pupils. The better performance which is related to the redirection of a question may be explained in that more participation on the part of pupils is encouraged by the teacher, whereby, more ideas are exchanged, which in turn may give pupils a better understanding of the subject being discussed. Finally, Rosenshine and Furst (1971) claimed that, on the basis of their review of many researches regarding questions put by teachers to pupils, no concrete evidence could exclusively explain the relationship between the type or the number of teachers' questions and the achievement of pupils.

II The relative contribution of "teacher's statements" (i.e., category 1b) to the total variances of pupils' achievement in biology, chemistry and physics

The "statements" of a teacher refer to the talk a teacher makes in providing appropriate cognitive material for what is about to occur or for what has already happened. Such statements usually happen at the start, during, and at the end of a lesson; and/or at the start, during, and at the end of a section of a lesson. "teacher's statements" category was also found to make a significant contribution to predicting the achievement of boys and girls (see table 38 above). Thus, in predicting the achievement of boys, "teacher's statements" contributed significantly in explaining 5% ($F = 8.51, P < 0.001$); 11.3% ($F = 32.95, P < 0.001$); and 23.6% ($F = 13.69, P < 0.001$) of the variance in biology, chemistry, and physics achievement respectively even when other variables may have preceded "teacher's statements" in the regression equations. The same teaching behaviour, however, was only found to contribute significantly in explaining 16.5% ($F = 82.14, P < 0.001$)

and 10.3% ($F = 59.74$), $P < 0.001$) of the variances in the chemistry and physics achievement of girls respectively, and contributed little to biology achievement. Again the exclusion of this teaching behaviour from the girls' stepwise-multiple regression equation for biology achievement may be related to the significant correlations that this predictor has with "teacher's questions" ($r = 0.317$, $P < 0.01$), "teacher's attitude" ($r = 0.357$, $P < 0.001$), and "teacher's classroom behaviour" ($r = 0.296$, $P < 0.01$). It is noted that these three variables which were already included in the regression equation may have provided the necessary explanations of the variance in the biology achievement of girls (Popham, 1967; and Borg and Gall 1979) that the '1b' teaching behaviour would have done if these former variables had been absent.

Hence, generally, "statements of teachers" may be considered as having a significant contribution to make in predicting the achievement of boys and girls in Kuwaiti high schools. The importance of this particular teaching behaviour may be explained by the noticeable domination of "teachers statements" over other teaching behaviours within the observed classes in Kuwait (see tables 34 and 35, pp. 351, 353). Teachers may think that by talking while pupils are listening, a large amount of cognitive material can be covered. This behaviour on the part of the teacher, in a way, may relieve some of the burden that lies on the shoulders of teachers to have well-disciplined classes and to cover the material assigned to them through the text books, which they have to finish within a certain time.

Many researchers during the past few years have expended much effort in their attempts to uncover the relationship between "statements of a teacher" and product outcomes of pupils. For example, Solomon, Rosenberg and Bezdek (1964) concluded that the intellectual gains of evening college pupils is significantly related to the tendency of a teacher to lecture. The same authors, however, expressed their doubts on whether or not the tendency of a teacher to lecture would be as significant when more complex

learning was required. This opinion may be justified in that pupils may gain a large amount of factual information when their teachers lecture efficiently, but they may not have the opportunity to express or discuss their thoughts during any class sessions. Unless the teacher allows some pupil participation in the classroom, pupils may develop a passive attitude and become more dependent on their teachers for the sole provision of knowledge to be attained. Hiller, Fisher and Kaess (1969), and Solomon, Rosenberg and Bezdek (1964) highlighted the importance of clarity in teacher's statements. They believed that vagueness in the statements of a teacher may hinder the ability of pupils to follow a train of thought. This behaviour on the part of the teacher may, however, require more efforts from the pupils to get the right information necessary for their success. Moreover, some educators tried to examine the effect of comments of teachers when lecturing to pupils in the classroom. Comments, such as praise, criticism or encouragement, were considered by many researchers as having as much importance on pupils' achievement as the "cognitive talk" of a teacher. This is because the comments that a teacher makes, whether good or bad, may affect the way the pupil feels about the teacher or the subject being studied, which in turn may affect the pupil's intellectual outcomes. Wright and Nuthall (1970) reached the conclusion that teacher's praise and encouragement to pupils are significantly related to pupil achievement. Furthermore, the timing of statements was another factor that stimulated the interest of many educators. For example, Wright and Nuthall (1970) concluded that, when a teacher makes statements before raising a question, these statements have no significant effect on pupils' achievement. Moreover, statements of a teacher that follow a question are found to be negatively correlated with achievement of pupils. Furthermore, statements introduced, by the teacher at the end of an episode initiated by a question were found to be positively related to the achievement of pupils. Finally, revision by the teacher, i.e., statements at the end of an episode, was also found, by

Wright and Nuthall (1970) to correlate significantly with the achievement of pupils. Walberg (1969), also argued that the statements of a teacher which are accompanied by the use of more clarifying materials, such as audio-visual aids, are significantly correlated with the achievement of pupils.

III The relative contribution of "teacher's directions" (i.e., category '1c') to the total variances of pupils' achievement in biology, chemistry and physics

Regarding the relative contribution of "teacher's directions" to the achievement of girls and boys in the three science areas, it is apparent that this teaching behaviour contributed significantly to the achievement of boys in biology ($R^2_{ch} = 2.9\%$, $F = 13.9$, $P < 0.001$) but not to either chemistry or physics achievement (see table 38 above). The same teaching behaviour was found to contribute significantly to explaining the variance in the achievement of girls in chemistry ($R^2_{ch} = 6.4\%$, $F = 47.11$, $P < 0.001$) and physics ($R^2_{ch} = 11.3\%$, $F = 27.97$, $P < 0.001$) even when other variables preceded it in the regression equation but not in biology. Thus, the above results may imply that the predictive value of "teacher's directions" may be more apparent in contributing to the achievement of girls than boys. From the results of the Pearson product moment correlation coefficient (see tables 28a, 29a, and 30a), the "teacher's directions" category was found to correlate significantly, in the case of physics boys, with the categories of "teacher's statements" ($r = 0.355$, $P < 0.001$), "pupils' consultations" ($r = 0.652$, $P < 0.001$), and "pupils' reference to teachers" ($r = 0.595$, $P < 0.001$). Moreover, the same teaching behaviour was also recorded in the case of chemistry boys, to correlate significantly with the "statements of their teachers" ($r = 0.730$, $P < 0.001$) and the "degree of their reference to teachers" ($r = 0.743$, $P < 0.001$). Furthermore, in the case of biology girls, "directions of the teacher" was found to correlate significantly with the "teacher's questions" variable ($r = 0.761$, $P < 0.001$). Thus,

these highly significant correlations may provide good reasons why this specific teaching behaviour, i.e., '1c' category, was not included in the stepwise-multiple regression equation of boys in chemistry and physics and that of girls in biology (Popham, 1967; and Borg and Gall, 1979). Nevertheless, in this study the predictive value of "teacher's directions" may not be easily realised because the recorded categories, that describe the directions of the teacher, as covered by the STOS, only examine those directions which occur in the actual classroom and to which pupils respond. It may happen, however, that teachers may direct their pupils to other sources of information or to carry out extra activities that might be of importance to their later achievement, such as solving problems, but which are not recorded in the observation sheet since pupils do not carry out immediately these activities in the classroom. Nevertheless, the predictive value of "teacher's directions" to the achievement of pupils seems to be clear in the case of both boys and girls.

Many educational researchers combined, in their studies, the effect that both the "directions of a teacher" and the "reference of pupils to teachers" may have on the achievement of pupils. For example, Flanders, Anderson and Amidon (1961) tried to relate the achievement of pupils to both the directions of the teacher and the pupil's need or degree of dependence on teachers. Those researchers suggested that the effect that the "directions of a teacher" may have on the achievement of pupils may depend on the pupils' degrees of need for help from their teachers. Hence if pupils feel that they are in need of their teacher's help and assurance (in terms of help, confirmation, approval and affection or affiliation) and if they get the help they need, then these pupils will achieve better results than those pupils who need the help but who do not receive it from their teachers. Flanders, Anderson and Amidon (1961) also found that the amount of help that pupils need from their teachers depends on the maturity of these pupils, the type of classroom activity, and the clarity of the subject being discussed.

The less mature pupils probably need more help from their teachers, especially if the task they are working on is difficult for them. Moreover, the type of classroom activities differs from one subject to another, thus the directions of a teacher may also differ accordingly. Also, the clarity of the task/subject matter may condition both the directions of a teacher to pupils and the amount of help pupils may seek from their teachers. Rosenshine and Furst (1971) found that pupils may gain better results if their teacher spends less time on answering their questions which require more interpretation of what the teacher has said. Such time might be better used for other classroom activities. Some educational researchers, therefore, may interpret the types and the necessity for "teacher's directions" differently. Some researchers, such as Flanders, Anderson and Amidon (1961); and Rosenshine and Furst (1971) may consider that the effectiveness of directions of the teacher may be conditioned by pupils' need, their maturity, the clarity of the task, and so on. Others, such as Eggleston, Galton and Jones (1976) may explain the effectiveness of directions of the teacher to pupils simply in terms of the extra information or activities that may help to increase pupils' understanding of their subjects. Therefore, in order to interpret the effectiveness of "directions by a teacher" on the achievement of pupils, it may be necessary to consider other factors associated with both the pupils and the task being undertaken.

IV The relative contribution of "pupils' consultation" (i.e., 'ld' category) to the total variances of pupils' achievement in biology, chemistry and physics

The relative contribution of this classroom activity to the explanation of the total variances in the achievement of girls is consistent, in that it appears to be of little significance in the prediction of their achievement in all three science areas. Boys' achievement, however, is significantly predicted from this variable in both biology ($R^2_{ch} = 0.01\%$, $F = 10.61$,

$P < 0.001$) and physics ($R^2_{ch} = 2.9\%$, $F = 10.35$, $P < 0.001$) even when other variables preceded it in the regression equation but not in chemistry. Yet, when this teaching behaviour, i.e., 'ld' category was correlated (using the Pearson product moment correlation coefficient, see tables 28, 29 and 30 (a-b)) with the other predictor variables that were included in the multiple regression equations, it was found that in the case of girls, the 'ld' teaching behaviour correlated significantly with "questions" of their biology teachers ($r = 0.312$, $P < 0.001$); "questions" of their physics teachers ($r = 0.886$, $P < 0.001$); "statements" of their physics teachers ($r = 0.533$, $P < 0.001$); "directions" of their physics teachers ($r = 0.381$, $P < 0.001$); their "references" to their physics teachers ($r = 0.658$, $P < 0.001$); "questions" of their chemistry teachers ($r = 0.312$, $P < 0.01$); "statements" of their chemistry teachers ($r = 0.693$, $P < 0.001$); "directions" of their chemistry teachers ($r = 0.495$, $P < 0.001$); and their "reference" to their chemistry teachers ($r = 0.400$, $P < 0.001$). In the case of boys "consultation activity" was found to correlate significantly with the "statements" of chemistry teachers ($r = 0.724$, $P < 0.001$); and their "references" to chemistry teachers ($r = 0.587$, $P < 0.001$). Thus the exclusion of the "pupils' consultation" activity from the multiple regression analyses in the cases of girls (in the three science areas) and boys (in chemistry) may be explained by the fact that other predictor variables, which were already included in these equations and which contributed significantly, have already provided an explanation of the achievement variances (Popham, 1967; and Borg and Gall, 1979). Hence it is not surprising that the 'ld' category does not contribute any significant further explanation to the prediction of achievement. It is agreed by many educators, such as, Walberg and Anderson (1968); and Wright and Nuthall (1970) that the activity that a pupil undertakes in the classroom is an important factor that may affect his/her intellectual gain. That is, the more active the pupil is in his classroom the better achiever he may become. The results of this study also confirm this point of view by showing that the

activity of pupils in the classroom is often an important factor contributing to the achievement of pupils in Kuwaiti high schools.

V The relative contribution of "pupils' reference to teachers" (i.e., 'le' category) to the total variances of pupils' achievements in biology, chemistry and physics

The relative contribution of this teaching activity in explaining the total variances in achievement of boys is consistent, in that it is only significant in predicting boys' achievement in biology ($R^2_{ch} = 1.3\%$, $F = 10.50$, $P < 0.001$), chemistry ($R^2_{ch} = 9.7\%$, $F = 18.37$, $P < 0.001$), and in physics ($R^2_{ch} = 3.4\%$, $F = 7.06$, $P < 0.001$) even after preceding variables had already entered the multiple regression equations. In the case of girls, the "pupils' reference to teachers" only contributed significantly in explaining the total variances in their chemistry ($R^2_{ch} = 11.2\%$, $F = 31.79$, $P < 0.001$) and physics ($R^2_{ch} = 2.2\%$, $F = 31.64$, $P < 0.001$) achievements, but not in biology (see table 38 above). Nevertheless, the results of the Pearson product moment correlation coefficients (see table 30b) indicate that this specific classroom behaviour (i.e., 'le' category) has a significant correlation with "teacher's questions" ($r = 0.831$, $P < 0.001$), which was found to be the most significant independent variable explaining 26.5% of the total variance of the girls' biology achievement. Therefore, the exclusion of the 'le' category from the girls' biology multiple-regression analyses may be as a consequence of the presence of the "teacher's questions" variable in the multiple regression equation (Popham, 1967; and Borg and Gall, 1979).

The results of this study, therefore, imply that the amount of help which a teacher gives to his/her pupils can be considered as an important factor upon which the achievement of pupils may depend. Flanders, Anderson and Amidon (1961) claim that the degree of significance that the "directions of a teacher" may have on the achievement of pupils depends on the need of

pupils for help, assurance, or approval from their teachers. Thus the more help a pupil gets, the greater the opportunity he has to achieve.

Overall the degree of "pupils' reference to teachers" may be considered as an important factor relating to the achievement of both girls and boys, because seeking either information that pupils may have missed or additional help from the teacher should enhance achievement. By doing so, difficulties in a lesson may be lessened and more understanding of skills may be developed.

VI The relative contribution of the perceived "teacher's personality" to the total variances of pupils' achievement in biology, chemistry and physics

From the results of the stepwise-multiple regression analyses (see table 38 above) it is apparent that the perception of boys concerning the "personality" of their science teachers has little significance in explaining the variances in their achievement. The same is true for the girls except that the perception of girls of the "personality" of their physics teachers is found to contribute significantly to the explanation of the variance of girls' achievement in physics ($R^2_{ch} = 18.5\%$, $F = 4.01$, $P < 0.01$). Moreover, from the results represented in tables 28, 29 and 30 (a-b), regarding the degree of relationship between the eight independent variables, it is clear that in the case of boys, the teacher's "personality" variable was found to correlate significantly with the "directions" of the biology teacher ($r = 0.330$, $P < 0.001$) but not with any of the independent variables included either in the physics or chemistry multiple regression equations. Hence these results may imply that the "personality" of a teacher may be considered as important factor relating to the achievement of boys in biology but not in either chemistry or physics. Moreover, in the case of girls, teacher's perceived "personality" was found to correlate significantly with the "questions" of chemistry teachers ($r = 0.275$, $P < 0.01$); "attitude" ($r = 0.609$, $P < 0.001$); and "classroom behaviours" ($r = 0.527$, $P < 0.001$) of biology teachers. Thus, the exclusion of the teacher's perceived

"personality" variable from the girls' chemistry and biology multiple regression equations may be related to the presence of these latter variables, i.e., "teacher's questions", "attitude", and classroom behaviour", already in these equations. These latter variables are considered by Popham (1967); and Borg and Gall (1979) as providing the necessary explanation of the variance in achievement of girls, without having to include "teacher's personality". The same may be said for the exclusion of this specific characteristic from the boys' biology multiple-regression equation.

On the basis of the above results, the "personality" of a teacher may be considered as an important predictor in the achievement of girls. The same variable, however, may be regarded as holding less importance in the achievement of boys in Kuwaiti high schools.

No one can deny that the teacher is an important element in the classroom (Washburne and Heil, 1960) and that his/her importance lies in the effect that his/her behaviour may have on the behaviour of pupils in the classroom. The personality of the teacher is, no doubt, one of the teacher's characteristics that, at least, affects the atmosphere in the classroom, which in turn may have an important impact on the behaviour of pupils. Nevertheless, many of the studies that were carried out to examine the effect that the personality of the teacher may have on pupils' achievement have failed to uncover any real significance (Frumkin and Howell, 1954). The failure in these researches is, however, explained by Goodenough (1975) by reference to the inadequacy of instruments which were used by many researchers for the measurement of the teacher's personality. Moreover, many educational researchers have noted that the existence of a significant relationship between the personality of a teacher and the outcomes of pupils is conditioned by the presence of other factors. For example, Washburne and Heil (1960) considered that one of these factors may be the type of pupils enrolled with any specific teacher. The sex of a pupil was another factor given by Milgram (1979) to explain the difference between the effect that

the personality of a teacher may have on the achievement of boys and that of girls in grades four through six. He thus claimed that the personality of a teacher is more apparent to girls than to boys.

Overall, the effect which the perceived "personality" of a teacher may have on the achievement of pupils may, then, be conditioned by the type of pupils, sex of pupils, the instrument used, as well as by other unstudied classroom factors. Therefore, the lack of significance between the chemistry and physics achievement of boys and the "personality" of their teachers may not necessarily mean that this specific characteristic of the teacher is not important. Its importance, however, may not have either a direct or a measurable effect on the achievement of pupils but it is possible that their effect appears with other behaviours of the pupil, such as his personality or his attitudes towards the subject, school, teacher, and so on.

VII The relative contribution of the perceived "teacher's attitude" in explaining the total variances in the achievement of pupils in biology chemistry and physics

From the data represented in table 38, regarding the relative contribution of the perception of boys and girls of the "attitudes" of their science teachers in explaining the variances in their achievement, it is clear that this teacher characteristic has the least apparent predictive value among all the other measured independent variables in the case of pupils in Kuwaiti high schools. In other words, this specific predictor was only included in the girls' biology multiple-regression analyses with a value of $R^2_{ch} = 3.1\%$ ($F = 6.06$, $P < 0.001$) although other variables had preceded it in the regression equation. Thus, the exclusion of the teacher's "attitude" variable from five of the six multiple-regression equations may give the impression that this perceived teacher's behaviour is of little importance to the achievement of pupils in Kuwaiti high schools. The results of the r -values (see tables 28, 29, 30 (a-b)), however, show that

this variable has significant correlations, in the case of chemistry girls, with the "directions" variable of chemistry teachers ($r = 0.254$, $P < 0.01$). The same predictor was also found to correlate significantly, in the case of physics girls, with the "teacher's statements" ($r = 0.357$, $P < 0.001$), "pupils' reference to teachers" ($r = 0.270$, $P < 0.01$), and "teacher's perceived personality" ($r = 0.609$, $P < 0.001$). Moreover, in the case of boys "teacher's attitude" was found to correlate significantly with the "teacher's directions" ($r = 0.307$, $P < 0.001$) and the "teacher's statements" ($r = 0.263$, $P < 0.01$) variables, respectively, in biology and chemistry lessons. Therefore, the exclusion of the perceived "attitude of the teacher" from the girls and boys multiple-regression equations may point not so much to its minor significance in predicting the achievement of pupils but due to the presence of other predictors that have already explained the variance in achievement (Popham, 1967, and Borg and Gall, 1979).

According to the above results, the perceived "attitude of the teacher" may be considered an important factor by which the achievement of girls and boys may be predicted, although this variable has little significance in explaining the variance in the biology achievement of boys.

The significance of a teacher's attitude was also investigated by many educators. Again, conflicting results were obtained. Some researchers considered that this characteristic was related to the achievement of pupils, while others were more sceptical of any such relationship. For example, Mastin (1963) obtained a significant correlation between pupils' attitudes towards certain topics and the attitudes of their teachers towards these same topics, materials displayed, and the ideas their teachers presented to them in the classroom. Walberg and Anderson (1968) explained the importance of a teacher's attitude, in terms of his/her impartiality towards pupils, for its predictive power over pupils' achievement. Moreover, Khan (1969) argued that the sex of a pupil has an effect on the degree of impact the attitude of a teacher plays on the achievement of pupils. Khan, however,

claimed that the achievement of boys in junior high schools is more affected by the teacher's attitude than that of girls in the same grade level. Ryans (1961b) also highlighted another area that may affect the significance of a teacher's attitude to pupils' achievement. He claimed that the attitude of a teacher only has an impact on the achievement of elementary school pupils but not on that of high-school ones. Furthermore, Nas (1976) believed that the effect of a teacher's attitude on pupils' achievement is not conclusive. Finally, Chippetta, Shores and Collette (1978) denied the existence of any impact of a teacher's attitude on the achievement of pupils.

VIII The relative contribution of the "teacher's perceived classroom behaviour" in explaining the total variances in the achievement of pupils in biology chemistry and physics

The small predictive value that "classroom behaviour" of the teacher, as perceived by pupils, has on the achievement of pupils is very noticeable. A significant contribution of the "teacher's classroom behaviour" was obtained only in the case of biology. This predictor contributed significantly in explaining 5.8% ($F = 17.2$, $P = 0.001$) of the total variance of girls' achievement even after other predictors preceded "classroom behaviour" in the equation. The r -values represented in tables 28, 29 and 30 (a-b), however, may explain the exclusion of this specific characteristic from five of the six multiple-regression equations. In other words, in the case of chemistry girls, it was found that perceived teaching behaviour correlated significantly with "teacher's questions" ($r = -0.200$, $P = 0.05$) and "teacher's directions" ($r = 0.204$, $P = 0.05$). "Teacher's perceived classroom behaviour" also correlated significantly, in the case of physics girls, with "teacher's statements" ($r = -0.296$, $P = 0.01$); "pupils' reference to teachers" ($r = -0.375$), $P = 0.001$; and "teacher's personality" ($r = 0.527$, $P = 0.001$). In the case of chemistry boys, the "teacher's perceived classroom behaviour" correlated significantly with "teacher's statements" ($r = 0.209$, $P = 0.05$). In the case of biology boys, this same teaching behaviour correlated significantly with "teacher's directions" ($r = 0.405$, $P = 0.001$).

Therefore, the exclusion of the "teacher's perceived classroom behaviour", in the case of girls (in chemistry and physics) and boys (in biology and chemistry), may be related to the presence of other predictors in the equations which correlated significantly with it, and which at the same time acted as substitutes in explaining the variance in the achievement of pupils in Kuwaiti high schools (Popham, 1967; and Borg and Gall 1979). Moreover, the "teacher's perceived classroom behaviour" was neither found to be included in the boys' physics multiple-regression equation nor to have any significant correlation with other predictors which were included in the equation (the same conclusion was also found in the cases of both the "teacher's attitude" and "teacher's personality" for physics boys. On the basis of the above results, one may conclude that "teacher's perceived classroom behaviour" is an important element that may have some impact on the achievement of both girls and boys in Kuwaiti high schools. Nevertheless, since the perceptions of teacher's personality, attitude, and classroom behaviour were neither included in the boys' physics multiple-regression analyses, nor did they correlate significantly with any of the other predicted variables included in the multiple-regression equation, then the subject matter, in this case physics, may be considered as an important factor that affected the impact of these three predictors may have had on the achievement of boys in Kuwaiti high schools.

As in the case of teacher's "personality" and "attitude", the effect of the "classroom behaviour", on the outcomes of pupils is also viewed differently by many educators and educational researchers. For example, Webb and Bowers (1957), Goodenough (1957); Ryans (1961 a and b); Walberg and Anderson (1968); Rosenshine and Furst (1971); Roberts and Becker (1976) are among those researchers who believe in the importance of a "teacher's classroom behaviour". For example, Goodenough (1957) concluded that children who are rude, disorderly, mischievous, and unnecessarily noisy with certain teachers, often go about their concerns in an orderly and efficient manner when taught by other teachers. This difference in the

behaviour of the children may be the result of the difference in the classroom behaviour of the teacher. Webb and Bowers (1957) also concluded that differences in the performance of Naval Aviation Cadets, whom they have examined, are significantly related to differences in the teaching behaviour of their instructor. Moreover, Walberg and Anderson (1968) also emphasised the importance of a "teacher's classroom behaviour" by confirming that the achievement of high school (junior and senior) pupils may be predicted significantly from the teacher's organisation and direction of classroom activities. The importance of encouragement by teachers of pupils to expand their knowledge before reaching a final answer was also emphasised by Rosenshine and Furst (1971) as having a significant effect on the achievement of pupils. Ryans (1961 a and b) in two studies, concluded that the behaviour of a teacher observed as either being dull or stimulating correlated significantly with the achievement of secondary school pupils. Moreover, Ryans (1961b) claimed that the ages and form grades of pupils are important factors in determining the effect of a teacher's classroom behaviour on the achievement of pupils. Thus a favourable attitude of a teacher towards democratic classroom teaching behaviour only correlates significantly with the achievement of elementary school pupils, but not with that of the secondary school ones. Furthermore, Washburne and Heil (1960) considered that the effect of the behaviour of teachers (in grades 4,5 and 6) is dependent on the types of pupil enrolled or the subject matter being taught. The sex of a pupil is also one of the elements considered by Washburne and Heil (1960) as of importance in affecting the achievement of pupils in that a teacher may present the subject matter differently to either sex. Solomon, Rosenberg, and Bezdek (1964) were among those researchers who still have doubts about the effect the classroom behaviour of a teacher may have on the outcomes of pupils. Solomon and his colleagues (1964) expressed their doubts in stating that "Although studies attempting to relate the teaching behaviour to the learning of students have been done

in great number, the rest to date, while giving some signs of promise, are far from conclusive or definitive" (p.23). The same researchers also added that, on the basis of the research they conducted on evening-college pupils, the mean gain in pupils' knowledge was not correlated with the evaluation of pupils of the different variables describing the behaviour of their teachers in the classroom. Moreover, Medley and Mitzel (1959) also agreed on the lack of significance between the classroom behaviour of a teacher and the achievement of pupils. They claimed that the gain of pupils (grades 3 to 6) in reading and in the skills of problem-solving do not correlate with the recorded classroom behaviours of both teachers and pupils.

Overall, from the results stated above regarding the relative contributions of the various measures of both pupil-teacher classroom interaction and ^{the} perceived teacher characteristics to the variances of pupils' achievements in biology, chemistry and physics, one may conclude that:

- 1) all the five STOS independent variables (observed by the researcher) namely, teacher's questions, teacher's statements, teacher's directions, pupils' consultations, and pupils' reference to teachers, may be considered as important predictors of the achievement of girls and boys in Kuwaiti high schools.
- 2) the personality of the observed science teachers, as perceived by girls and boys using the newly-developed Pupil Perception Questionnaire may be thought of as:
 - a) an important predictor of the achievement of girls in the three science areas;
 - b) an important predictor of the achievement of boys in biology but not in either chemistry or physics.
- 3) the attitude of the observed science teachers, as perceived by boys and girls using the newly-developed Pupil Perception Questionnaire may be recognised as:
 - a) an important predictor of the achievements of girls in the three science

areas;

- b) an important predictor of the achievements of boys in both biology and chemistry but not in physics.
- 4) the classroom behaviour of the observed science teachers, as perceived by boys and girls using the newly-developed Pupil Perception Questionnaire, may be considered as:
 - a) an important predictor of the achievement of girls in the three science areas;
 - b) an important predictor of the achievement of boys in both biology and chemistry but not in physics.

The discrepancy between the effect that some of the independent variables, namely, teachers perceived "personality" and "classroom behaviour" had in explaining the total variances in the science achievement of pupils in Kuwaiti high schools may be related to some non-cognitive (Khan 1967-68) or non-intellectual (Khan and Roberts 1969) factors. Such variables are believed by many educators as having an important impact on the behaviour and outcomes of pupils. An example of those variables are: 'pupils' anxiety (Reese, 1961); pupils' attitude either towards school, subject, or a teacher (Chansky and Bergman, 1957; Christenson, 1960; Holtzman and Brown 1968 and Volker and Simonson, 1974); pupils' interest in the subject he/she is studying (Dispenzieri, Kalt, and Newton, 1967; Khan 1967-68; and Walberg and Anderson 1968); Pupil's motivation for learning (Chansky and Bergman 1957; Mitzel 1960; Bruce and Howard 1977); pupil's efforts to improve his level of competence (Frieze and Snyder, 1980); pupils' aptitude (Dispenzieri, Kalt and Newton, 1967; and Khan and Roberts, 1969); pupil's sex (Gates, 1961; Klausmeier and Wiersma, 1964; Blackman, 1972; Hilton and Berglund, 1974; and Leinhardt, Seewald and Engel, 1979); pupil's intelligence (Palardy, 1969); pupil's mental age, readiness and health (Edmiston and Hollahan, 1946); teacher's belief towards the success and the failure of his/her pupils (Palardy, 1969); the type of teacher, pupil, or subject

matter (Washburne and Heil, 1960); and the dynamics, and climate of the classroom (Walberg and Anderson 1968; and McNeil and Popham, 1973).

8.80

General Conclusion Summarising the Overall Research
and the Importance of Its Findings

This study was based upon an empirical examination of behaviours and perceptions in Kuwaiti fourth-grade high schools. A carefully constructed series of instruments were applied to a representative sample of pupils and teachers, whose cooperation and helpfulness greatly facilitated the completion of the initial gathering of data. Moreover, this investigation constituted the first study of Kuwaiti education to be grounded upon detailed science classroom observations. Furthermore, this study also represented the first attempt not only to obtain accurate information concerning pupils' perceptions of science teachers but also to compare pupils' perceptions with those of science supervisors. The data obtained from the various instruments have subsequently been subjected to statistical analyses. The various findings have been examined and interpreted in the light of empirical studies and theoretical developments elsewhere. Although the observations of this study were based on a representative sample of Kuwaiti high schools, the results of those observations provide a factual foundation for further analysis of behaviours and practices occurring or expected to occur in the teaching process by which the achievement of most science pupils might be better predicted. Moreover, it is hoped that this information will help educationalists and teachers in the future to isolate possible problems and strengths in the teaching of science within Kuwaiti high schools.

In this study two predominant groups of science teachers were isolated from the analyses of the observational data. When the achievement of pupils were compared according to the teaching methods by which they were taught. A tendency for better achievement was noticed in the cases of pupils who were taught by "group two" teaching methods. The result of this study seemed to favour the introduction of science subjects to pupils in Kuwaiti high schools in a more practical/experimental manner rather than

introducing the same subjects to them in a mainly theoretical way. On the basis, however, of the above findings, another point is worth mentioning. This is from the observational data, that the majority of the observed teachers in Kuwaiti high schools seemed to: a) prefer merely presenting verbally the knowledge of their discipline rather than eliciting this knowledge in a manner that allowed for pupils' participation and encouragement of novel ideas; and b) carry out the greatest part of the activities themselves in the classroom. These tendencies on the part of teachers in Kuwait seemed to affect both pupils behaviour as well as their expectations of their teachers. This was noticed from pupils' preference for teachers who provided them with a full explanation of the subject matter followed by a meaningful summary without demanding that they play an active part in finding this knowledge for themselves. This attitude of pupils gave the impression that when teachers tried to dominate or play the part of the main active donor of knowledge in the classroom, pupils seemed to enjoy being the passive recipient of that knowledge. Teachers, of course, may think that by adopting a more theoretical teaching method that most of their problems, such as maintaining classroom management, covering the required materials in a reasonable time, and so on, may be solved. However, by doing so they may fail to sustain pupils' participatory behaviour, which is argued to be more appropriate to scientific careers and which at the same time is shown by this study to lead to a better performance.

The results of this study, then, partly implies that there is an apparent disjunction between school and university/higher education. The tendency within Kuwaiti high schools for science to be taught in a highly theoretical teacher-centred way ill-prepares pupils for university science study in which there is great emphasis on independent laboratory and experimental method. Unfortunately, current educational practice in Kuwaiti high schools constrains the development of more participatory learning practices through the discouragement of "undue" pupil activity, adventurous

teaching methods, and experimental methods, by for example, misplaced faith in the educational value of quietness in the classroom, the rigid adherence to a textbook dominated syllabus, and an over-emphasis on narrow scholastic measurement of achievement as compared with broader educational values. These factors may constrain teacher behaviour and thereby influence the perception of what is possible in classroom teaching. Unless there is some change in these and other factors present in the school environment, the application of the recommendations made regarding science teaching, will be hindered.

Girls in Kuwaiti high schools were found, in this study, to achieve better intellectual results. The main two factors which were found to be responsible for this achievement discrepancy are sex of pupils and the society pressure/environmental influence. The effect of the social environment on the achievement of girls may be explained by the fact that boys in Kuwait (or in most of the Arabic countries) are always looked upon as the most important element not only in the family but also in their society, while girls come second. Girls, on the other hand, in an attempt to overcome such inequities and to prove their importance to their society, put greater efforts to succeed into their scholastic work. Therefore, in the case of the Kuwaiti female sample, the pressure of society and the inequality that girls have to bear patiently have, in a way, worked to girls' scholastic benefit. In other words, inequality demonstrated by our society seems to stimulate greater efforts on the part of the girls rather than to discourage them, which in turn leads to better females' performances. This result encourages us to carry out further research in an attempt to locate those explicit factors that may affect the achievement of boys and girls in different grade levels. Moreover, several socio-cultural factors have been suggested which might explain the differential performance of boys and girls in Kuwaiti high schools. Other factors, however, may be relevant particularly to a further explanation of why girls in Kuwait tend

to do better. Why does the Kuwaiti female sample, for example, respond to the inequities they face with a greater resolve to overcome such obstacles rather than resigning themselves to a second-class state? This is a promising area for further research, especially research which draws upon comparative data.

The perception of pupils, supervisors, and teachers of the qualities of a "good" science teacher does provide a useful perspective on behaviours and practices required in science classrooms. Nevertheless, further research into the differences between the opinions of the three participant groups, or between the opinions of the two sexes, is needed to narrow down such differences. The narrowing down of such dissimilarity in opinions may result in a more productive and coherent educational system in science education.

As mentioned earlier in this study, one of the primary purposes of this investigation was to clearly identify variables which might predict the achievements of pupils in biology, chemistry, and physics. Pupils' perceptions of the qualities of their actual science teachers, although not as important as other predictive variables, investigated in this present study, nevertheless constitute substantially in some cases to the prediction of pupils' achievements. Moreover, the importance of the variable pupils' "perceptions of their teachers' qualities", gives the impression that pupils in Kuwaiti high schools can be considered as a reliable source of information regarding what happens in their classrooms. Hence, pupils' perceptions can be taken as an accurate guide to classroom practice.

Even with a restrictive choice of classroom variables being used to predict the achievement of the observed samples, the results of this study clearly indicate the importance of the quality of pupil-teacher classroom interaction variables, namely, teacher's statements, questions, and directions; pupils' consultations, and reference to their teachers. It was also found that a high degree of pupils' consultations in the classroom

results in better girls' performance. Moreover, for both girls and boys a tendency for better performances is realised with a high degree of teachers' questions. Furthermore, a large number of teachers' statements is found to result in better achievement by boys. However, the opposite may be true in the case of girls.

Hence these findings point to certain behaviours and attitudes of teachers that appear to be strongly related to pupil achievement. Also, classroom behavioural variables, it is found, can also be supplemented by pupil perception variables that proved here to be both reliable and meaningful ways of predicting pupil achievement. These latter instruments seem to offer a fruitful means of measuring relevant classroom relationships, attitudes and personalities that cannot be assessed by any other means.

This research has attempted to measure these latter variables in the context of the classroom and thereby, ensure that they are more relevant predictors of achievement than if more general attitude and personality instruments had been used. The development of further instruments, in which pupils' themselves assess their teachers, would seem to offer scope for further research. Now that this present research has indicated their usefulness and relevance.

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Appendix A.1.

Contents of Biology Curriculum (during the period January - April 1981).

Chapter two:-Evolution and variationPart 1:- Asexual and Sexual Reproduction:- (22 sessions)

- a. Vegetation propagation; (x)
- b. Ovulation;
- c. The sexual cycle in human female; and
- d. Egg fertilization. (x)

Part 2. Heredity:- (24 sessions)

- a. Protein synthesis; (x)
- b. Linkage and crossing over; (✓)
- c. Pedigrees; and (✓)
- d. Blood group inheritance. (✓)

Part 3 Evolution (8 sessions)

- a. Evolution evidence; and (x,✓)
- b. Comparative serology. (x,✓)

Part 4 Ecology (Organism and its Environment) (12 sessions)

- a. Associations (relationships) between organisms in the environment;
- b. Balance in nature;
- c. Food chains and food webs; and
- d. Animal distribution. (✓)

Part 5 Animal Behaviour:- (3 sessions)

- a. Learned behaviour; and (x)
- b. Conditioned reflex behaviour.

Appendix A.1 (continued)Chapter Three:-

Physiology

(5 sessions)

where:-

- (x)= lower thinking ability questions which were not included in the final version of the biology Achievement test.
- (✓)= higher thinking ability questions which were not included in the final version of the biology Achievement test.

Appendix A.2.

Contents of Chemistry Curriculum (during the period January-April 1981)

Chapter Two:-The New Theories of Acids and Bases (16 sessions).Part one Acids and Bases

- a. Definitions of acids and bases;
- b. Brunstead's-Lawry theory; (✓)
- c. Common acids; (✓)
- d. Common bases;
- e. Strengths of acids and bases; (✓)
- f. Basicity of acids and acidity of bases;
- g. Acidic and basic groups;
- h. Preparation of acidic and bases solutions; and
- i. General properties of acids and bases.

Part two: Salts

- a. Definition of salt; (x)
- b. Preparation of salts; (✓)
- c. Dissociation of salts;
- d. Dissolubility of salts; and
- e. Examples and problems.

Chapter Three:-Oxidation and Reductions Reactions (7 sessions)Part One

- a. Oxidants and reductants;
- b. Weighing up the oxidation and reduction equations; and
- c. Examples and problems.

Chapter four:Electrochemistry (13 sessions)Part one

- a. Conducting of electricity;

Appendix A 2 (Continued)

- b. Electronic conductors; and
- c. Ionic conductors;

Part Two

- a. Electrochemical cells;
- b. Galvanic cell; and
- c. Electrochemical chains.

Part Three

- a. Practical cells;
- b. Dry cells; and
- c. Electrodes Potentials.

Part four

- a. Electrolysis of salts;
- b. Electrolysis of electrolytic solutions;
- c. Examples of electrolysis;
- d. Faraday's laws; and
- e. Examples and problems.

Chapter five.Preparation of Metals From Its OresPart One

- a. The main sources of metals (2 sessions)
- b. Extraction of metals from its ores.

Part TwoSodium (6 sessions)

- a. Properties of sodium;
- b. Exploitation of sodium;
- c. Extraction of sodium from sodium chloride; and
- d. Compounds of sodium.

Part ThreeIron (6 sessions)

- a. Extraction and types of iron;
- b. Pure iron-chemical and physical properties; (x)
- c. Iron oxides; and
- d. Iron salts. (x)

Part FourLead (5 sessions)

- a. Extraction of lead; (x)
- b. Properties of lead;
- c. Exploitation of lead;
- d. Lead compounds;
- e. Lead oxides [II, IV];
- f. Lead salts;

Part 5

Basicity of salts (3 sessions)

Chapter SixPart One

Industrial Chemistry (5 sessions)

- a. Chemicals obtained from natural gas and petrol;
- b. Synthesis gas; and (x)
- c. Detergents. (✓)

Part two

- a. Chemicals obtained from the sea.

Chapter SevenPart One

Nuclear chemistry (5 sessions)

- a. Nuclear reactions;

- b. Types and properties of nuclear bombs; and
- c. Conditions required for nuclear reactions.

Part two

Kinds of Nuclear Reactions

- a. Nuclear chain reactions;
- b. Atomic bomb; (X)
- c. Nuclear reactors; and
- d. Radioactive particles.

where:-

(x) = lower thinking ability questions which were not included in the final version of the Chemistry achievement test.

(✓) = Higher thinking ability questions which were not included in the final version of the Chemistry achievement test.

Appendix A.3

Contents of Physics Syllabus (during the period January-April 1981).

Chapter Two

Hydrodynamics (12 sessions)

- a. The two types of flow; (✓)
- b. Stream Line flow;
- c. Turbulent flow;
- d. Equation of continuity;
- e. Bernoulli's theorem;
- f. Application's of Bernoulli's theorem;
- g. Viscosity; and
- h. Measuring Viscosity coefficient by the falling ball method.

Chapter Three

Central Forces and Gravitation (8 sessions)

- a. Kelper's laws;
- b. Universal law of gravitation;
- c. Satelllites motion round the earth; (✓)
- d. Angular momentum; (x)
- e. Conservation of angular momentum;
- f. Conservation of angular momentum and Kelper's second law; and
- g. Escape velocity of a rocket. (✓)

Chapter Four

Atomic Physics.

- a. Photo electric emission; (6 sessions)
- b. Laws of photoelectric emission;
- c. The quantum theory;
- d. Plank's constant; (x)
- e. Matter waves;

Appendix A.3 (Continued)

- f. Bohr's model of atom; (8 sessions)
- g. Thomson's atom;
- h. Rutherford model;
- i. Atomic spectrum;
- j. Line emission spectrum;
- k. X-rays; and (x)
- l. Laser.

Chapter Five.

Electronics and Solids.

- a. Electronics; (8 sessions)
- b. Thermionic emission;
- c. Diode;
- d. Triode;
- e. Photoelectric emission; (x)
- f. Photoelectric cell; and (✓)
- g. Electron phototube.
- h. Solids; (5 sessions)
- i. Transistors;
- j. Amplitude; and
- k. Solarcell photo-junction. (x)

Chapter Six

Nuclear Physics.

- a. Atomic weight; (6 sessions) (✓)
- b. Mass spectrum;
- c. Discovery of neutron;
- d. Neutron and Proton masses; (x)
- e. Binding energy per nuclear.

Appendix A.3 (continued)

- f. Nuclear Forces. (2 sessions)
 - g. Nuclear disintegration; (6 sessions)
 - h. Half life;
 - i. α - Decay.
 - j. β - Decay;
 - k. γ - Decay; and
 - l. Penetration of Power of the rays; (✓)
 - m. Nuclear reactions; (4 sessions)
 - n. Direct and complex reaction;
 - o. Nuclear Diffusion;
 - p. Fusion Reaction; and
 - q. Solar energy.
-

where:-

(x)= Lower thinking ability questions which were not included in the final version of the physics achievement test.

(✓)= Higher thinking ability questions which were not included in the final version of the physics achievement test.

Appendix - B - 1Objective Test in Biology

- Q 1 - Ribosomes, (submicroscopic cell organelles) are specialised for:
- a - Formation of the cell wall.
 - b - excretion.
 - c - protein synthesis.
 - d - respiration.
-
- Q 2 - One of the following characteristics is not considered a learned behaviour:-
- a - common to all individuals of all species.
 - b - serves the organism in its changing environment.
 - c - confers adaptive plasticity upon the organism.
 - d - depends on experience.
-
- Q 3 - The relationship between mites and the flagellates that live in their intestines is called:-
- a - Commensalism.
 - b - mutualism.
 - c - parasitism.
 - d - competition.
-
- Q 4 - [The best example of the plants that undergo] Vegetative reproduction occurs in:-
- a - potatoes.
 - b - tomatoes.
 - c - soya beans.
 - d - wheat

Q₅ - The size of an animal's egg, usually depends on:-

- a - amount of cytoplasm.
 - b - size of the nucleus.
 - c - rate of growth.
 - d - amount of yolk.
-

Q₆ - The importance of the extinct animal Archaeopteryx, as evidence for organic evolution, lies in its being a transitional fossil that provides a link between:-

- a - fish and reptiles.
 - b - reptiles and primitive mammals.
 - c - reptiles and birds.
 - d - amphibians and reptiles.
-

Q₇ - The possibility of diabetics leading a normal life now-a-days is due to the fact that:-

- a - extraction of insulin from animals is easily obtained.
 - b - insulin can be synthesized.
 - c - sugar-free diets are easy to obtain.
 - d - fat-free diets are easy to obtain.
-

Q₈ - Inheritance of the Rh blood group System in man is an example of a (an):-

- a - sex-linked phenomena.
 - b - incomplete dominance.
 - c - complete dominance.
 - d - lack of dominancy.
-

- Q₉ - The ability of the jerboa to live in arid environments is due to:-
- a - its sluggishness and remaining near its burrow.
 - b - the (sufficient) amount of water that is produced as a result of internal metabolic process.
 - c - storing water within its body.
 - d - feeding on juicy seeds.
-

- Q₁₀ - The following graph represents the monthly cycle of a human female -
In which part of the cycle is it possible for fertilization to take place?

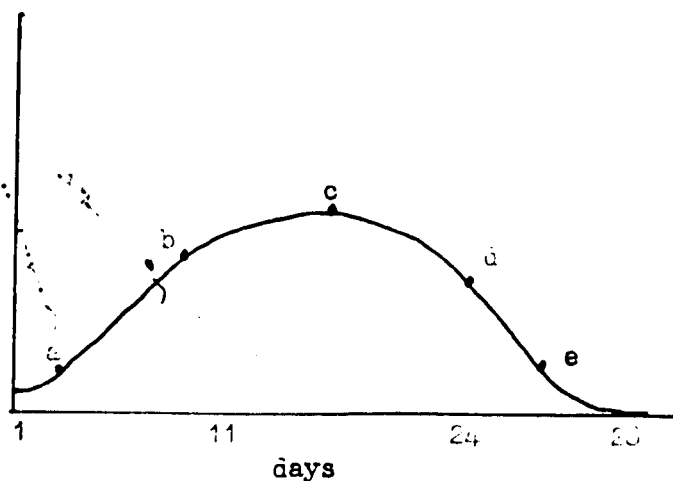
a - (a-b).

b - (b-c).

c - (c-d).

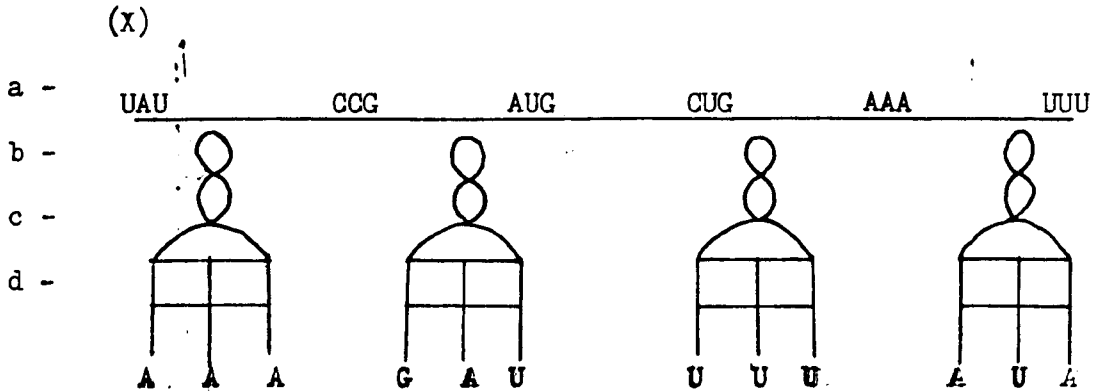
d - (d-e).

growth of
internal
uterine
lining



- Q₁₁ - In spite of having a normal uterus, a female animal whose fallopian tubes had been removed in surgery: pregnancy did not occur even after a number of matings had taken place, because:-
- a - no follicle was formed.
 - b - fertilization did not take place.
 - c - ovulation did not take place.
 - d - all of the above.
-

- Q₁₂ - In the following m-RNA segment, on which nitrogenous bases are arranged according to the genetic code, select the t-RNA that becomes attached to the m-RNA segment at X.

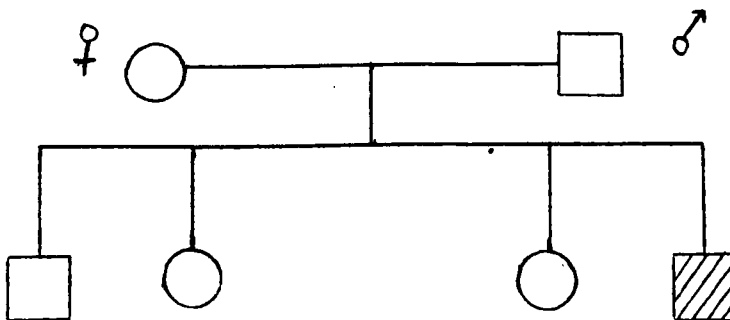


- Q₁₃ - A rabbit's blood, after being injected with human blood, was added to a sample of human blood and precipitation took place. This is because:-
- a - human blood is from a group near that of rabbit's blood.
 - b - antibodies against human blood were formed in the rabbit's blood.
 - c - antibodies against rabbit's blood were formed in the human blood.
 - d - none of the above.

- Q₁₄ - What would happen to the following food chains commonly found in a large pond if algae are poisoned?
- (algae - protozoa - small water insects - large water insects - small fish - large fish):-
- a - new algae will grow to form new food chains.
 - b - other plants will grow to replace the algae.
 - c - the food-chain will continue without the algae.
 - d - the food-chain will collapse.

- Q15 - A scientist presented an amount of powdered dry meat to dogs and rang a bell at the same time; he noticed saliva coming out of the dogs' mouth. After repeating the experiment several times the dogs salivated to the sound of bell without it being accompanied by dry meat. His explanation was that the dogs learned by:-
- a - abolition by habituation.
 - b - trial and error.
 - c - learning and reasoning.
 - d - conditioned reflex action.

-
- Q16 - In the following pedigree if the shading means affliction then the probability of the affliction of the parents would be:-
- a - father afflicted, mother normal.
 - b - father normal, mother afflicted.
 - c - mother carrier of disease, father afflicted.
 - d - mother carrier of disease, father normal.



Q₁₇ - The following diagram (1) shows two homologous chromosome carrying allelic genetic factors, a change that happens in (2) could be explained by:-

- a - linkage.
- b - crossing over at points known as centromeres.
- c - multiple alleles.
- d - crossing over at points known as chiasmata.

A B C D E F G H
a b c d e f g h
(1)

A b C D e f G h
a B c d E F g H
(2)

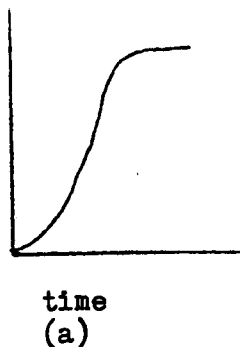
Q₁₈ - When a population occupies a new area, it will start to grow at an increasing rate, then at a decreasing rate till it finally reaches a state of equilibrium. Which of the following curves represents such a case?

a -

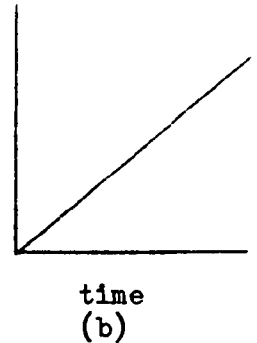
b -

c - number of
individuals

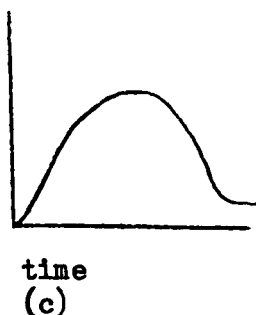
d -



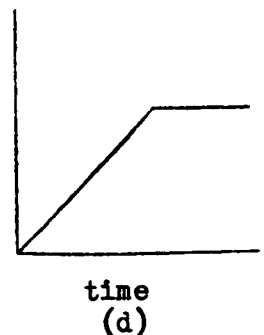
number of
individuals



number of
individuals



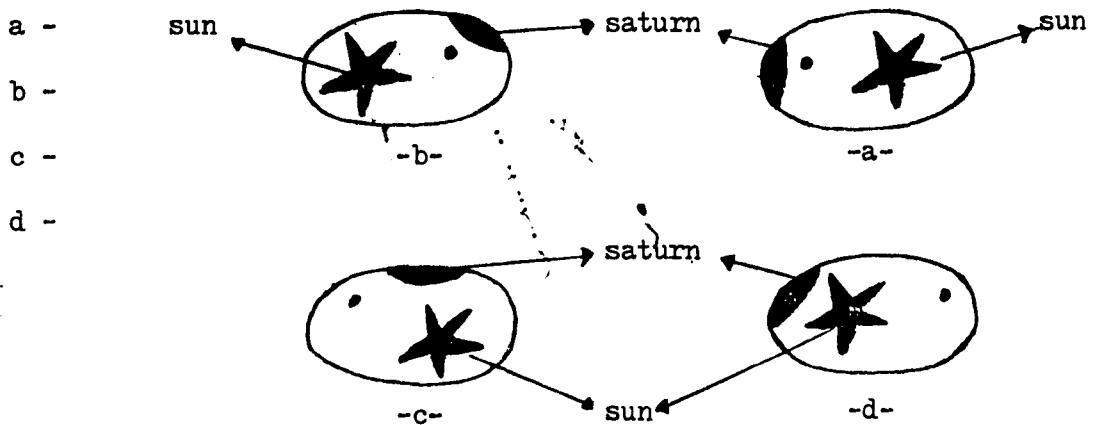
number of
individuals



Appendix - B - 2Objective Test In Physics

- Q₁ - For emission of electrons from a metallic surface, it is better to use ultraviolet instead of normal light because the ultraviolet:-
- a - is more reflectable.
 - b - heats the material's surface more.
 - c - has a higher frequency.
 - d - has a higher velocity.
-

- Q₂ - Which of the following figures show the largest linear speed of Saturn which orbits the sun in an elliptical path?



- Q₃ - The cathode in an X-ray tube should be heated in order to:-
- a - obtain higher energy X-rays.
 - b - reduce the pressure inside the tube.
 - c - obtain more electrons.
 - d - speed up the emission of electrons from the cathode.
-

Q₄ - To rectify and amplify an AC current at the same time, we have to use:-

- a - diode.
- b - triode.
- c - negative (N) transistor.
- d - positive (P) transistor.

Q₅ - Which direction does an (α) particle take when projected into the nucleus?

- a -
- b -
- c -
- d -



-a-



-b-



-c-



-d-

Q₆ - In a stationary orbit, a satellite will move around the earth:-

- a - with a speed that is equal to speed of earth around the sun.
- b - in the same direction and with a speed equal to that of the earth.
- c - in the opposite direction but with a speed equal to that of the earth orbiting the sun.
- d - in the same direction but faster than the speed of the earth when it turns around itself.

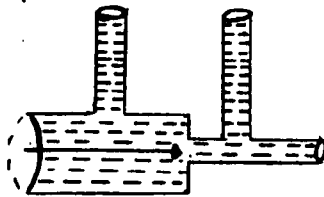
- Q7 - For nonturbulent water flow through a two-diameter pipe, with two pizometers inserted (as shown below). The figure showing expected level of water is:-

a -

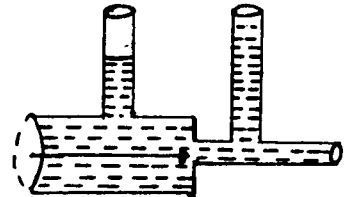
b -

c -

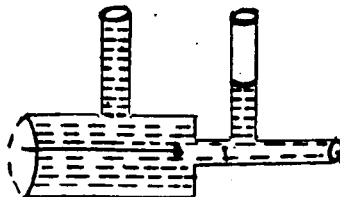
d -



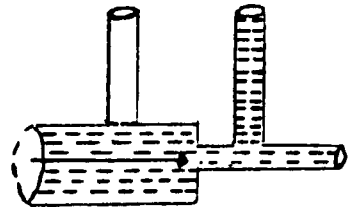
-a-



-b-



-c-



-d-

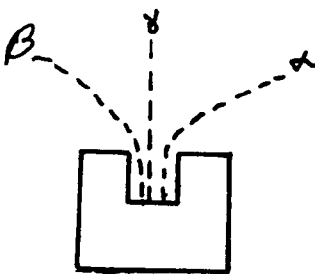
- Q8 - A radioactive material is put in a lead box, and a magnetic field is applied to the resulting radiation. Which diagram shows the deflection produced in the magnetic field?

a -

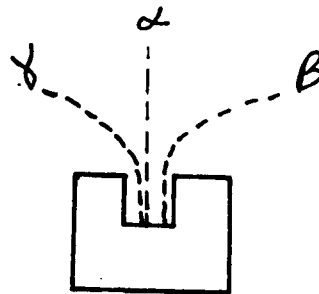
b -

c -

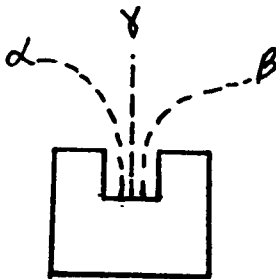
d -



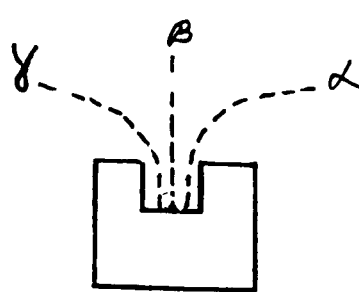
- a -



- b -

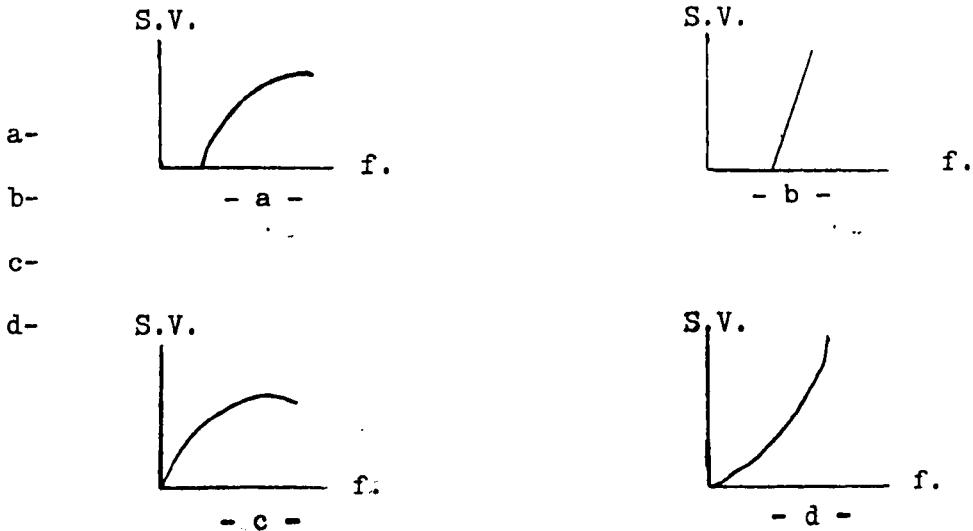


- c -

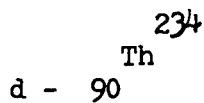
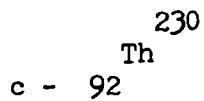
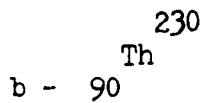
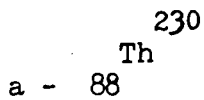


- d -

Q₉ - The following graphs show the relationship between the frequency of the incident radiation and the stopping voltage, in a photoelectric effect experiment. The figure that represents such a relationship is:-



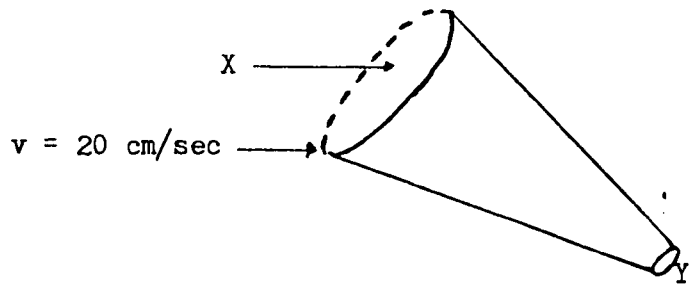
Q₁₀ - An atom of uranium-238 decays with the emission of two alpha particles and two beta particles and leaves an atom of:-



Q₁₁ - In the following diagram the cross sectional area $X = 4Y$, if water flows continuously in the tube and it is flowing at the rate of 20 cm/sec at X, then the water will flow through Y at a rate

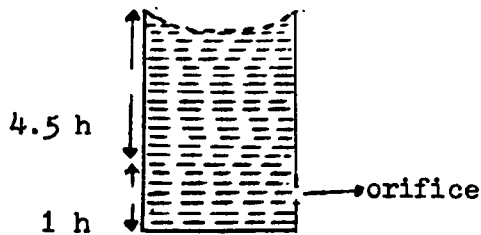
of:-

- a - 5 cm/sec.
- b - 20 cm/sec.
- c - 40 cm/sec.
- d - 80 cm/sec.



- Q₁₂ - An atom of (${}^9_4\text{Be}$) decays through ray emission, given a residual particle consisting of (${}^8_3\text{Li}$) atom, what particle has been emitted?
- a - an electron.
 - b - a neutron.
 - c - a proton.
 - d - the nucleus (${}^9_3\text{Li}$).

- Q₁₃ - Water is kept in a container with an orifice at a 4.5 cm below the (water) surface (as shown below). The velocity of water discharge from the orifice is:-



- a - longitudinally downwards with a speed of ($\sqrt{2gh}$)
- b - longitudinally downwards with a speed of ($3\sqrt{gh}$)
- c - horizontally to the right with a speed of ($3\sqrt{gh}$)
- d - horizontally to the right with a speed of ($\sqrt{2gh}$)

Q₁₄ - Given that the radius of Mars equals half that of the Earth and mass of Mars equals one-eighth of the Earth the acceleration of gravity on Mars will equal to:-

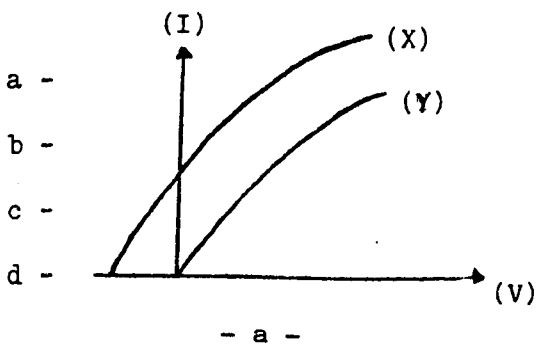
a - 10 m/sec^2

b - 7.5 m/sec^2

c - 5 m/sec^2

d - 2.5 m/sec^2

Q₁₅ - Graph (X) shows the relationship between intensity of photoelectric current (I) produced from a photoelectric cell and anode voltage (V). If the intensity of the light falling on the cell is reduced to half its original value, the correct (Y) is represented in graph.



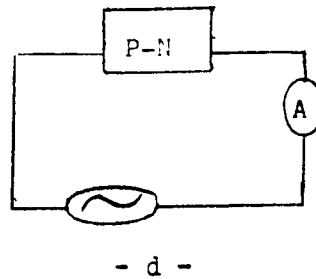
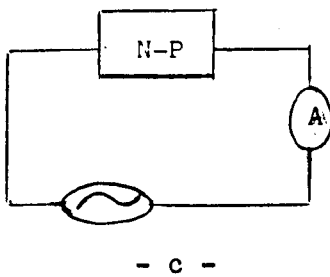
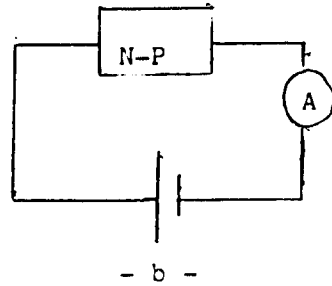
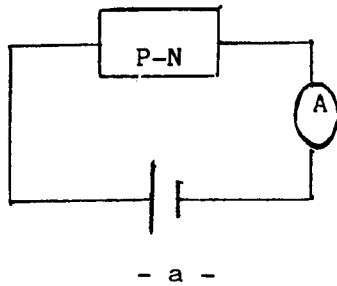
Q₁₆ - The (P - N) junction allows current to pass one way only. The circuit in which the pointer of the ammeter remains undeflected is shown in figure number:-

a -

b -

c -

d -



Q₁₇ - If the energy of an electron in the first level of a hydrogen atom is (- 13.6 e.v.); then the energy in the third level is:-

a - - 4.53 e.v.

b - - 1.51 e.v.

c - - 40.8 e.v.

d - - 2.36 e.v.

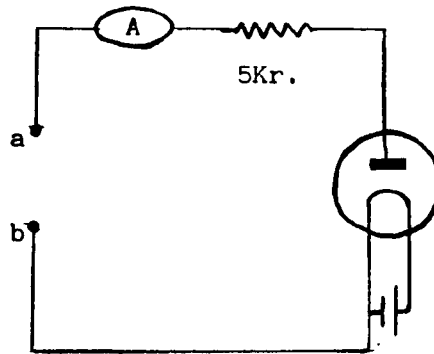
Q18 - In the figure below, the potential difference between (a) and (b) is (300v.) and ammeter reading is (20m.A.). The valve's resistance is then equal to:-

a - 5 Kr.

b - 10 Kr.

c - 15 Kr.

d - 20 Kr.



Appendix - B - 3.

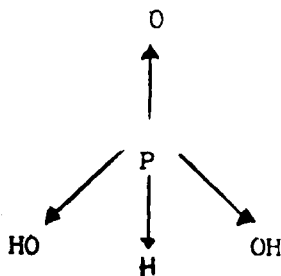
- I -

Objective Test In Chemistry

- Q₁ - Aluminium chloride is considered as a Lewis acid because:-
- a - The atomic orbitals do not accept or donate electrons.
 - b - The atomic orbitals accept or donate electrons.
 - c - It accepts up to two electrons in the outer orbital which is vacant.
 - d - It can donate a pair of electrons.
-

- Q₂ - Which of the following is a double salt?
- a - $K_4Fe(CN)_6$.
 - b - $PbI_2 \cdot 2PbCl_2$.
 - c - $Zn(OH)Cl$.
 - d - $NaHS$.
-

- Q₃ - Phosphorous acid (Shown in the diagram) is:-
- a - Monobasic.
 - b - Dibasic.
 - c - Tribasic.
 - d - Tetrabasic.



- Q₄ - The metal ore used in the industrial preparation of lead is:-
- a - Haematite.
 - b - Siderite.
 - c - Galena.
 - d - Magnetite.
-

- Q₅ - The measured standard potential of element is the potential difference in a solution initiated between the element and its ion:-
- a - at 50 C when its concentration is one normal.
 - b - at 25 C when its concentration is one normal.
 - c - In a solution of one mole ion/lit concentration at 10 C. .
 - d - In a solution of one mole ion/lit concentration at 25 C.
-

- Q₆ - The substance precipitated as result of the action of diluted nitric acid one lead tetraoxide is:-
- a - $\text{Pb}(\text{NO}_3)_2$.
 - b - PbO .
 - c - PbO_2 .
 - d - PbO , $\text{Pb}(\text{NO}_3)_2$.
-

- Q₇ - Synthesis gas is a mixture of both hydrogen gas and:-
- a - Carbon monoxide.
 - b - Carbon dioxide.
 - c - Hydrogen sulphide.
 - d - Methane.
-

- Q₈ - Cadmium is used in the nuclear reactor as a:-
- a - Control Rods.
 - b - Cooler.
 - c - Moderator.
 - d - Heater.
-

Q₉ - Which one of the following salts if added to hydrochloric acid, results in release of a gas that is strong in odour and changes the orange color of potassium dichromate (vi) into green a solution?

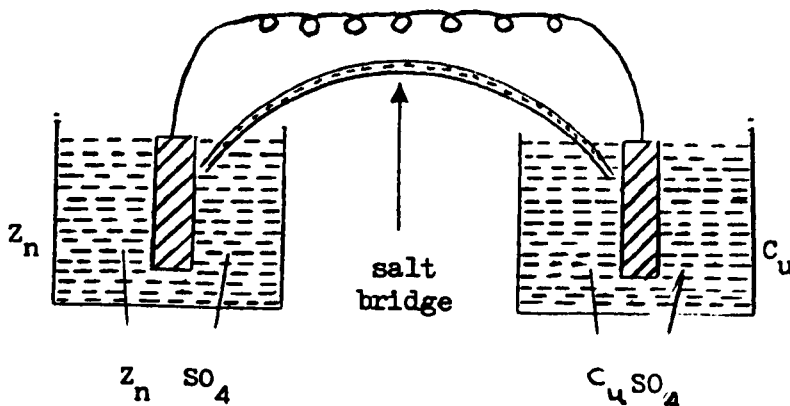
- a - Sulphite.
- b - Sulphide.
- c - Sulphate.
- d - Nitrate.

Q₁₀ - The mass of aluminium (relative atomic mass 27) which is deposited when passing an amount of electricity equal of (2) faradys in solution containing alumium cation (Al^{+3}) is:-

- a - 27 gm.
- b - 54 gm.
- c - 9 gm.
- d - 18 gm.

Q₁₁ - During the formation of galvanic cell (shown in the figure) if the standard electrode potential of Zn/Zn^{2+} is -0.76 V., and that of Cu/Cu^{+2} is +0.34 V., then:-

- a - Zn is reduced and Cu is oxidized.
- b - Zn^{+2} cation concentration is increased in the solution.
- c - Zn rod acts as the cathode.
- d - Cu is corroded and its weight decreased.



Q₁₂ - Given the standard electrode potential of $\text{Al}^{+3} + 3\text{e} \longrightarrow \text{Al}$, is - 1.66 volts and $\longrightarrow \text{Ag}^+ + \text{e}, \longrightarrow \text{Ag}$ is +0.79 volts, the electromotive force of a cell made up of silver and aluminium electrodes is:-

- a - + 0.87 Volt.
 - b - - 0.87 Volt.
 - c - + 2.45 Volt.
 - d - - 2.45 Volt.
-

Q₁₃ - At 400 °C, sodium nitrate (NaNO_3) is decomposed into:-

- a - NO_2 and Na_2O .
 - b - O_2 and NaNO_2 .
 - c - NO and NaNO_2 .
 - d - NO_2 and NaNO_2 .
-

Q₁₄ - In which of the following changes does neither oxidation nor reduction occur?

- a - $\text{H}_2\text{NOH} \longrightarrow \text{N}_2\text{O}$.
 - b - $\text{VO} \longrightarrow \text{V}_2\text{O}_3$.
 - c - $\text{AL} \longrightarrow \text{AL CL}_3$.
 - d - $\text{CrO}_4^{-2} \longrightarrow \text{Cr}_2\text{O}_7^{-2}$.
-

Q₁₅ - Of the following acids, the strongest one:-

- a - HOCL .
 - b - HOClO .
 - c - HOClO_2 .
 - d - HOClO_3 .
-

Q₁₆ - A nuclear chain reaction occurs when the mass of the radio-active element is:-

- a - Much greater than the critical mass.
 - b - Slightly greater than the critical mass.
 - c - Much less than the critical mass.
 - d - Less than the critical mass.
-

Q₁₇ - Which of following equations demonstrates the reaction between concentrated sulphuric acid and iron?

- a - $2\text{Fe} + 3\text{H}_2\text{SO}_4 \longrightarrow \text{Fe}_2(\text{SO}_4)_3 + 3\text{H}_2$.
 - b - $\text{Fe} + 2\text{H}_2\text{SO}_4 \longrightarrow \text{FeSO}_4 + 2\text{H}_2\text{O} + \text{SO}_2$.
 - c - $3\text{Fe} + 4\text{H}_2\text{SO}_4 \longrightarrow \text{FeSO}_4 + \text{Fe}_2(\text{SO}_4)_3 + 4\text{H}_2$.
 - d - $4\text{Fe} + 10\text{H}_2\text{SO}_4 \longrightarrow 2\text{FeSO}_4 + \text{Fe}_2(\text{SO}_4)_3 + 10\text{H}_2\text{O} + 5\text{SO}_2^{-5}$.
-

Q₁₈ - The emission of an alpha (α) particle followed by a beta ($-\beta$) particle transforms ${}_{92}^{238}\text{X}$ into:-

- a - ${}_{90}^{234}\text{Y}$.
 - b - ${}_{91}^{234}\text{Z}$.
 - c - ${}_{90}^{239}\text{Y}$.
 - d - ${}_{91}^{230}\text{Z}$.
-

Appendix - C.1

The following twenty seven items were removed on the basis of the initial judgement (i.e. the unclassified statements by the expert judges).

The Unclassified Statements

- 9 - Teacher who is interested in knowing how much pupils understand from the lesson.
- 14 - Teacher who takes into consideration the varying degrees of ability present in his class.
- 15 - Teacher who does not get upset at wrong answers.
- 17 - Teacher who does not punish pupils for giving wrong answers.
- 20 - Teacher who not only cares about classtime but who also cares about whether or not students understood the lesson.
- 21 - Teacher who gives the same kind of attention and help to every pupil in the class.
- 24 - Teacher who gives pupils a chance to catch up with work.
- 29 - Teacher who gives individual attention when needed.
- 30 - Teacher who makes pupils feel that he is one of them.
- 31 - Teacher who tries to clarify the subject matter when pupils ask him without embarrassing them.
- 35 - Teacher who praises pupils when they give the predetermined answers.
- 36 - Teacher who helps pupils to gain confidence in themselves.
- 41 - Teacher who does not waste classtime in repeating easy subject.
- 45 - Teacher who explains every lesson in a reasonable time.
- 52 - Teacher who gives examples from life to aid understanding.

Appendix - C.1 -Continued

- 56 - Teacher who welcomes pupils' questions.
- 61 - Teacher who answers pupils' questions carefully.
- 65 - Teacher who does not try to impose his opinion upon pupils without giving reasonable evidence.
- 70 - Teacher who mentions the main points of related subjects taken in the previous years.
- 72 - Teachers who gives different assignments on the bases of pupils' abilities.
- 73 - Teacher who gives pupils the impression that he is interested in their answers and ideas.
- 81 - Teacher who asks questions at the beginning of each lesson concerning previously discussed subject matters.
- 83 - Teacher who tries to answer most of the pupils questions if not all of them to help us understand the lesson.
- 88 - Teacher who invites challenging discussions.
- 92 - Teacher who provides adequate information.
- 101 - Teacher who uses teaching methods appropriate to pupils' aptitudes.
- 117 - Teacher who considers and allows new or alternative approaches to solve a problem.

Appendix - D.1-The Removed Forty Seven Items.

These items were removed on the basis of their correlation with the total subscales scores. (items' numbers are stated according to their allocations in the main scale).

- 5 - Teacher who does not allow pupils with low abilities to feel inferior.
- 6 - Teacher who is friendly with his pupils.
- 7 - Teacher who respects his pupils and treats them as adults.
- 8 - Teacher who has understanding and sympathy for his pupils.
- 16 - Teacher who is interested in the pupils.
- 23 - Teacher who devotes considerable time to helping pupils to overcome their problems.
- 25 - Teacher who is not inclined to talk down to his pupils.
- 34 - Teacher who is interested in the subject matter being discussed.
- 37 - Teacher who does not give the impression that he only teaches this course to earn his salary at the end of the month.
- 51 - Teacher who does not treat relatives, close friends or favourites differently.
- 58 - Teacher who prepares ideas and thoughts of the subject matter in an organized fashion before coming to the classroom.
- 94 - Teacher who has a thorough knowledge of the subject matter.
- 113 - Teacher who has enough experience in his field.
- 124 - Teacher who has a sufficient knowledge of the subject matter, by which he can answer any impromptu questions satisfactorily.
- 125 - Teacher who plans well and prepares every activity he intends to do in the classroom.
- 126 - Teacher who has a thorough understanding of his teaching field.

Appendix - D.1 -Continued

- 63 - Teacher who gives reasonable challenging assignments.
- 68 - Teacher who does not give work assignments to pupils in holiday periods.
- 103 - Teacher who encourages pupils to read subjects from outside sources related to the text-book materials.
- 1 - Teacher who has a strong personality by which he maintains an atmosphere of good feeling in the classroom.
- 13 - Teacher who does not allow students to misbehave and waste a great deal of classtime.
- 44 - Teacher who works all the time.
- 48 - Teacher who does not waste classtime on checking pupils' attendances.
- 55 - Teacher who does not waste classtime by talking to somebody else other than pupils.
- 112 - Teacher who feels sure and self confident and understands what he is talking about.
- 42 - Teacher who quotes personal examples to clarify ideas.
- 47 - Teacher who makes the lesson clear in the first few minutes so that nobody becomes confused.
- 54 - Teacher who uses excellent examples and illustrations to clarify the subject matter.
- 59 - Teacher who reviews the main points of previous lesson before starting a new one.
- 60 - Teacher who does not only give written exams.
- 62 - Teacher who uses as many examples as possible to clarify the subject matter.

Appendix - D. 1-Continued

- 82 - Teacher who listens to students' suggestions before deciding on any class activity.
- 85 - Teacher who does not leave any subject without sufficient explanations.
- 86 - Teacher who encourages pupils to take part in class activities.
- 89 - Teacher who gives clear and reasonable questions
- 90 - Teacher who welcomes accepts criticism of his own ideas.
- 93 - Teacher who states clearly what subject matters each exam will cover.
- 95 - Teacher who does not make the class discussion dull by repeating almost what the textbook says.
- 96 - Teacher who does the practical work on the spot and does not delay it until the time is convenient for him.
- 98 - Teacher who gives many exams.
- 99 - Teacher who suggests or allows new alternatives for doing any experiment.
- 105 - Teacher who gives exams correspondent to materials previous covered.
- 107 - Teacher who asks pupils about steps to be taken to solve a problem.
- 108 - Teacher who grades and returns results of the exams without too much delay.
- 110 - Teacher who has the ability of holding pupils' interest most of the time.
- 116 - Teacher who gives purposive type exams.
- 120 - Teacher who gives clear directions on any experimental work.

Appendix - D.2 -Table - 21 -Scale Item Characteristics of pupils' Perception Questionnaire

(i.e. the Removed 47 Items).

(N = 162)

Subscale	Item No.	Nature of Item	Pearson Correlation With Total Subscales' Score	Pupils' Responses Relative Frequency Percent				
				S.A.	A.	N.S.	D.	S.D.
I								
Category One	58	+	0.15	91.36	4.94	-	3.70	-
	94	+	0.18	61.73	25.93	4.94	3.70	3.70
	113	+	0.13	41.98	39.51	7.41	9.87	1.23
	124	+	0.15	80.25	16.05	-	-	3.70
	125	+	0.06	59.26	32.10	-	8.03	0.61
	126		0.04	66.67	22.22	4.94	6.17	-
II								
Category Two	42	+	0.12	75.54	18.52	-	2.47	2.47
	47	+	0.15	25.93	29.63	16.05	20.99	7.40
	54	+	0.08	87.65	12.35	-	-	-
	59	+	0.15	71.61	23.46	2.47	1.85	0.61
	60	+	0.10	92.59	7.41	-	-	-
	62	+	-0.14	69.14	27.16	-	1.23	2.47
	82	+	0.13	59.26	29.63	4.94	6.17	-
	85	+	0.12	48.15	30.86	16.05	-	4.94
	86	+	0.08	67.90	28.40	1.23	2.47	-
	89	+	0.07	46.91	27.16	12.35	6.79	6.79

Appendix - D.2 - ContinuedTable - 1 -

Subscale	Item No.	Nature of Item	Pearson Correl- ation With Total Scales' Score	Pupils' Responses Relative Frequency Percent.				
II				S.A.	A.	N.S.	D.	S.D.
Category <u>Two</u>	90	+	0.12	74.07	14.20	3.70	4.94	3.09
	93	+	0.06	43.83	22.84	11.11	17.28	4.94
	95	+	0.18	24.69	16.67	16.67	25.30	16.67
	96	+	0.00	79.01	18.52	-	2.47	-
	98	-	-0.04	4.94	10.49	8.02	28.40	48.15
	99	+	0.14	83.95	16.05	-	-	-
	105	+	0.06	22.22	40.74	8.64	12.35	16.05
	107	+	0.15	61.73	29.01	4.32	2.47	2.47
	108	+	0.03	86.42	7.41	3.70	2.47	-
	110	+	0.11	66.67	22.22	4.94	6.17	-
	116	+	0.06	72.84	19.75	2.47	1.85	3.09
	120	+	0.09	51.85	27.16	13.58	4.94	2.47
Category <u>Three</u>	1	+	0.05	80.25	11.11	3.70	2.47	2.47
	13	+	0.16	79.63	18.52	-	-	1.85
	44	+	0.11	88.89	6.17	-	4.94	-
	48	+	0.03	82.72	8.64	6.17	2.47	-
	55	+	0.05	80.25	11.11	-	-	8.64
	112	+	0.02	72.84	23.46	2.47	1.23	-

Appendix - D.2 - ContinuedTable - 1 -

Subscale	Item No.	Nature of Item	Pearson Correlation With Total Subscales' Score	Pupils' Responses				
				Relative Frequency Percent				
II				S.A.	A.	N.S.	D.	S.D.
Category	5	+	0.12	57.41	21.61	2.47	8.64	9.87
<u>Four</u>	6	+	0.12	80.80	9.87	5.56	2.47	1.20
	7	+	0.01	89.51	4.94	1.23	2.47	1.85
	8	+	0.13	80.25	13.58	-	2.47	3.70
	16	+	0.06	72.84	23.46	-	1.85	1.85
	23	+	0.14	86.42	12.35	-	1.23	-
	25	+	0.02	80.25	16.05	-	2.47	1.23
	34	+	0.07	77.78	16.05	2.47	2.47	1.23
	37	+	0.09	32.10	24.69	12.35	22.22	8.64
	51		0.01	74.07	12.35	3.70	4.32	5.56
III								
Category	63	+	0.03	70.37	18.52	4.94	6.17	-
<u>Five</u>	68	+	0.19	38.27	29.63	16.05	13.58	2.47
	103	+	0.03	45.68	35.80	4.94	11.11	2.47

KEY:

S.A. : Strongly Agree

A. : Agree

N.S. : Not Sure

D. : Disagree

S.D. : Strongly Disagree

Appendix - E.1 -

The Removed Six Items of the Subscale One (i.e., teachers' efforts before coming to the classroom) And Three (i.e., Pupils' required work as homework assignments).

These items were removed from the item pool because they were less than the minimum required items (six items) in each subscales category. These items are as follows and their allocation to scale is given in Table 2:-

- 102 - Teacher who does not prepare himself for any question pupils may raise in the class.
- 111 - Teacher who comes to the class well prepared.
- 57 - Teacher who does not give assignments that help pupils to understand the subject matter.
- 64 - Teacher who only explains the easy parts of the lesson and leaves the difficult parts to students as an assignment.
- 75 - Teacher who always asks students to read and prepare the lesson before he explains it.
- 76 - Teacher who does not give assignments all the time.

Appendix - E.2 -

Scale Item Characteristics of Pupils' Perception Questionnaire (i.e., the Removed 6 items).

Table - 1 -

Subscale	Item No.	Nature of Item	Pearson Correlation with Total Subscales' Score	Pupils' Responses Relative Frequency Percent				
				A.S.	A.	N.S.	D.	S.D.
Category One	102	-	0.45	1.23	4.94	4.94	25.93	62.96
	111	+	0.29					

Appendix - E.2 - ContinuedTable - 1 - Continued

Subscale	Item No.	Nature of Item	Pearson Correlation With Total Subscales' Score	Pupils' Responses				
				Relative Frequency Percent				
III				S.A.	A.	N.S.	D.	S.D.
Category Five	57	-	0.25	4.94	4.94	8.64	28.40	53.08
	64	-	0.24	-	1.23	-	32.10	66.67
	75	-	0.28	3.70	4.94	7.41	23.46	60.49
	76	+	0.24	51.85	23.49	11.11	11.11	2.47

where:

S.A.= strongly agree

A.= agree

N.S.= not sure

D.= disagree

S.D.= strongly disagree

APPENDIX F - I
Observed Reliability Data (R_a) of the STOS

R_a = $\frac{(a + b) - (c + d)}{(a + b + c + d)}$

- Where: a - the number of occasions when the category was judged to be used by the reliability check list as well as by the observer;
b - the number of occasions when both the reliability check list and the observer judged that the category was not used;
c - the number of occasions when the category was judged to be used by the observer; but not by the reliability check list;
d - the number of occasions when the category was judged to be used by the reliability check list, but not by the observer.

Table 1 : Observe Reliability Date for Individual Categories as well as of the Observed Total Categories

Category	Teacher Talk							Talk and Activity Initiated and/or Maintained by Pupils																Total Reliability	
	a ₁	a ₂	a ₃	a ₄	a ₅	a ₆	a ₇	b ₁	b ₂	b ₃	b ₄	c ₁	c ₂	c ₃	c ₄	d ₁	d ₂	d ₃	d ₄	e ₁	e ₂	e ₃	e ₄		
Physics	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	100%
Chemistry	1.00	1.00	1.00	1.00	1.00	0.88	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	99%
Biology	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86	1.00	1.00	1.00	1.00	1.00	1.00	0.86	1.00	98%

- N.B. 1) The first three minutes of the biology class were missing from the tape according to bad recording. Therefore, these three minutes were not recorded when using this tape to check reliability.
- 2) The above formula has been adopted from Hacker, R.G., 1980. (see also Appendix F, tables 2, 3, and 4 followed)

A SCIENCE TEACHING OBSERVATION SCHEDULE - form for student use

Name AMENA AL MAZAN. 16

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|----|----------------------------------------------------------------------------|----|
| 1 | TEACHER TALK | |
| 1a | Teacher asks questions (or invites comments) which are answered by: | |
| 21 | recalling facts and principles | a1 |
| 22 | applying facts and principles to problem solving | a2 |
| 23 | making hypothesis or speculation | a3 |
| 24 | designing of experimental procedure | a4 |
| 25 | direct observation | a5 |
| 26 | interpretation of observed or recorded data | a6 |
| 27 | making inferences from observations or data | a7 |
| 1b | Teacher makes statements: | |
| b1 | of fact and principle | b1 |
| b2 | of problems | b2 |
| b3 | of hypothesis or speculation | b3 |
| b4 | of experimental procedure | b4 |
| 1c | Teacher directs pupils to sources of information for the purpose of: | |
| c1 | acquiring or confirming facts or principles | c1 |
| c2 | identifying or solving problems | c2 |
| c3 | making inferences, formulating or testing hypotheses | c3 |
| c4 | seeking guidance on experimental procedure | c4 |
| 2 | TALK AND ACTIVITY INITIATED AND/OR MAINTAINED BY PUPILS | |
| 2d | Pupils seek information or consult for the purpose of: | |
| d1 | acquiring or confirming facts or principles | d1 |
| d2 | identifying or solving problems | d2 |
| d3 | making inferences, formulating or testing hypotheses | d3 |
| d4 | seeking guidance on experimental procedure | d4 |
| 2e | Pupils refer to teacher for the purpose of: | |
| e1 | acquiring or confirming facts or principles | e1 |
| e2 | seeking guidance when identifying or solving problems | e2 |
| e3 | seeking guidance when making inferences, formulating or testing hypotheses | e3 |
| e4 | seeking guidance on experimental procedure | e4 |

no presente.
o intervalo

Obtained 24 correct responses out of 29. — 95.8% agreement. 15

Name AVENA... ALMAZAN...

Class observed .. Biology.....

Teacher asks questions (or invites comments) which are answered by:

- recalling facts and principles
- applying facts and principles to problem solving
- making hypothesis or speculation
- designing of experimental procedure
- direct observation
- interpretation of observed or recorded data
- making inferences from observations or data

Teacher makes statements:

- b1** of fact and principle
- b2** of problems
- b3** of hypothesis or speculation
- b4** of experimental procedure

1c Teacher directs pupils to sources of information for the purpose of:

- c1 acquiring or confirming facts or principles
- c2 identifying or solving problems
- c3 making inferences, formulating or testing hypotheses
- c4 seeking guidance on experimental procedure

2 TALK AND ACTIVITY INITIATED AND/OR MAINTAINED BY PUPILS

2d Pupils seek information or consult for the purpose of:

- d₁** acquiring or confirming facts or principles
- d₂** identifying or solving problems
- d₃** making inferences, formulating or testing hypotheses
- d₄** seeking guidance on experimental procedure

2e *Pupils refer to teacher for the purpose of:*

- e1 acquiring or confirming facts or principles
- e2 seeking guidance when identifying or solving problems
- e3 seeking guidance when making inferences, formulating
- e4 seeking guidance on experimental procedure

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NOT TICKET

Rebuilding Check

A SCIENCE TEACHING OBSERVATION SCHEDULE - form for student use

Name.....AHENA AL MAZAN¹⁵.....

Class observed Chemistry.....

TEACHER TALK

Teacher asks questions (or invites comments) which are answered by:

- a1 recalling facts and principles
- a2 applying facts and principles to problem solving
- a3 making hypothesis or speculation
- a4 designing of experimental procedure
- a5 direct observation
- a6 interpretation of observed or recorded data
- a7 making inferences from observations or data

extra
refuse, subject
in this category

1b Teacher makes statements:

- | | |
|----------------|------------------------------|
| b ₁ | of fact and principle |
| b ₂ | of problems |
| b ₃ | of hypothesis or speculation |
| b ₄ | of experimental procedure |

Otherwise there was
complete agreement with
regulation et al. integrability

[illegible]

1c Teacher directs pupils to sources of information for the purpose of:

- c1 acquiring or confirming facts or principles
- c2 identifying or solving problems
- c3 making inferences, formulating or testing hypotheses
- c4 seeking guidance on experimental procedure

08/01/80

[illegible]

3. TALK AND ACTIVITY INITIATED AND/OR MAINTAINED BY PUPILS

24. Pupils seek information or consult for the purpose of:

- d₁** acquiring or confirming facts or principles
- d₂** identifying or solving problems
- d₃** making inferences, formulating or testing hypotheses
- d₄** seeking guidance on experimental procedure

[illegible]

2. Pupils refer to teacher for the purpose of:

- e1 acquiring or confirming facts or principles
- e2 seeking guidance when identifying or solving problems
- e3 seeking guidance when making inferences, formulating
- e4 seeking guidance on experimental procedure

[illegible]

SCHOOLS COUNCIL

160. Great Portland Street
London W1N 6LL
Telephone 01-580 0352

Your reference

Our reference

Dr. W.J. Wilkinson,
Department of Educational Studies,
Applied Science and Mathematics
Building,
Science Education Centre,
University of Hull,
Hull,
HU6 7RX

6 March, 1980.

Dear Dr. Wilkinson,

A Science Teaching Observation Schedule(Schools Council Project on the Evaluation of Science Teaching Methods)

Thank you for your letter of 7 February last. I enclose an order form, brief description and sample accompanying leaflet.

You will see that copy recordings are made for us by the Department of Audiovisual Media at the University of Salford, to which the order and blank tape stock should be sent. Twenty copies of the leaflet are automatically supplied with the recordings. I can send extras if required. As postage has recently risen, you may wish to check the price with Salford.

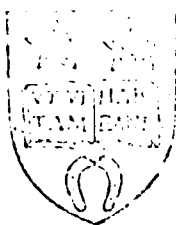
Please note that the original recording was not made to commercial standards, since it was initially intended only for use in the project team's own research. Unfortunately, it did not prove feasible to re-record for a wider audience. We recommend to all users that they stick to open reel tapes to ensure satisfactory reproduction.

As stated in the leaflet, the project's reliability data are stored at the School of Education, University of Leicester, although I have heard that Maurice Galton may no longer be organizing the training sessions there that are mentioned in our publication about the Schedule.

It may be helpful for you to know that both Professor Eggleston and Mr. Galton have a reference set of the tapes.

Yours sincerely,

Vivien M. Conrad (Miss)
Publications Section



University of Leicester School of Education

21 University Road, Leicester LE1 7RH Telephone 0533 551122

APPENDIX F,6

Our Ref: MG/JK

13th May, 1980.

Dr. B. Wilkinson,
University of Hull,
Science Education Centre,
Department of Educational Studies,
173 Cottingham Road,
Kingston upon Hull,
HU5 2EH

Dear Bill,

Thank you very much for your note about STOS. I am enclosing a set of corrected categories for the reliability tape. The observer merely checks off the individual ticks on that sheet against his own and calculates a simple coefficient of agreement. Remembering that STOS is used simply to differentiate between groups of teachers on the basis of aggregate totals, a 65 per cent agreement with 'God' (Jim Eggleston and myself as developers) is very satisfactory.

With best wishes,
Yours sincerely,

MAURICE GALTCH

SCHOOLS COUNCIL

180 Great Portland Street
London W1N 6LL
Telephone 01-580 0352

A SCIENCE TEACHING OBSERVATION SCHEDULE - videotapes

Each of the three tapes runs for about an hour. Tape One and the first part of Tape Two are devoted to an exposition of the divisions of the schedule, starting with the main division into *Teacher talk* and *Talk and activity initiated and/or maintained by pupils*. A number of classroom sequences are provided as illustrative material on which the trainee observer is asked to attempt a classification according to the instructions he has heard - the correct solution is then discussed.

In the exposition of the minor categories of the schedule, transcripts of sections of dialogue from a classroom episode that has just been shown are used to help the student further in discussion about classification. The latter part of Tape Two contains three practice episodes, and a correct classification is given in the accompanying leaflet.

Tape Three, the reliability trial, contains three long episodes for classification, and must not be shown more than once to any trainee. Data are available in the project files for those who wish to check their results; the relevant address is given in the leaflet.

Publications Section
November 1976

APPENDIX G.1 Example of the Data resulting from both the Perception of Physics Pupils to the Characteristics of their Physics Teachers (using the newly developed Pupil Perception Questionnaire) and the Pupil-Teacher Physics Classroom Interactions (using the Science teaching observation schedule) used in the Stepwise-Multiple Regression Analysis.

School 1	Dependent Variable	(School 1 - N = 21)									
		Independent Variables						Teacher's characteristics as perceived by pupils			
		Pupil-Teacher Classroom Interaction									
		No. of pupil	Pupil's Physics Achievement	Teacher's questions	Teacher's Statements	Teacher's Directions	Pupils' Consultations	Pupils' reference to Teachers	Teacher's personality	Teacher's attitude	Teacher's class- room behaviour
1	10	60	81	3	7	19	42	52	87		
2	13	60	81	3	7	19	39	47	98		
3	11	60	81	3	7	19	46	55	108		
4	10	60	81	3	7	19	33	46	105		
5	8	60	81	3	7	19	37	37	37		
6	7	60	81	3	7	19	40	46	84		
7	7	60	81	3	7	19	47	55	112		
8	10	60	81	3	7	19	36	48	99		
9	6	60	81	3	7	19	34	40	100		
10	5	60	81	3	7	19	47	44	105		
11	5	60	81	3	7	19	38	49	93		
12	10	60	81	3	7	19	50	58	102		
13	8	60	81	3	7	19	43	44	92		
14	7	60	81	3	7	19	39	47	93		
15	11	60	81	3	7	19	32	33	92		
16	9	60	81	3	7	19	43	52	110		
17	3	60	81	3	7	19	46	53	116		
18	3	60	81	3	7	19	25	38	91		
19	11	60	81	3	7	19	34	46	76		
20	13	60	81	3	7	19	43	52	95		
21	9	60	81	3	7	19	40	57	99		