

Open Research Online

The Open University's repository of research publications and other research outputs

The affective development of biology students in further education. The construction and evaluation of a test related to O- and A-level courses in biology, with particular reference to the affective domain. Use of the test to obtain diagnostic and predictive information.

Thesis

How to cite:

Bentley, Gerald Ian (1980). The affective development of biology students in further education. The construction and evaluation of a test related to O- and A-level courses in biology, with particular reference to the affective domain. Use of the test to obtain diagnostic and predictive information. MPhil thesis The Open University.

For guidance on citations see [FAQs](#).

© 1980 The Author

Version: Version of Record

Link(s) to article on publisher's website:
<http://dx.doi.org/doi:10.21954/ou.ro.0000f746>

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data [policy](#) on reuse of materials please consult the policies page.

UNRESTRICTED

THE AFFECTIVE DEVELOPMENT OF BIOLOGY STUDENTS
IN FURTHER EDUCATION

The construction and evaluation of a test related to
O- and A-level courses in biology, with particular
reference to the affective domain. Use of the test
to obtain diagnostic and predictive information.

Submitted by Gerald Ian Bentley, B.A.(Hons),
for the degree of Master of Philosophy
in Education

Date of submission: 4.3.80

Date of award: 25.9.80

March, 1980

The Open University

ProQuest Number: 27777418

All rights reserved

INFORMATION TO ALL USERS

The quality of this reproduction is dependent on the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if material had to be removed, a note will indicate the deletion.



ProQuest 27777418

Published by ProQuest LLC (2020). Copyright of the Dissertation is held by the Author.

All Rights Reserved.

This work is protected against unauthorized copying under Title 17, United States Code
Microform Edition © ProQuest LLC.

ProQuest LLC
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 - 1346

ACKNOWLEDGMENT

I would like to record my gratitude to Dr.W.R.Hallows,
for encouraging me throughout my period of study and
for helpful suggestions during the preparation of the
thesis.

The Affective Development of Biology Students

in Further Education

Submitted by Gerald Ian Bentley, B.A.(Hons),

for the degree of Master of Philosophy

in Education

The Open University, 1980

ABSTRACT

The thesis is divided into three parts. In Part One, the literature relating to affective characteristics and science education is reviewed. In Part Two, the theory and measurement of affective characteristics are discussed.

Part Three describes the design and use of a questionnaire to measure the affective development of further education students in the biological sciences. A taxonomic model of affective development forms the basis of the instrument.

The results provide evidence that supports the validity of a taxonomic model of affective development. Students studying for GCE A-level in the biological sciences are shown to have reached higher states of affective development than GCE O-level students.

'Affective Profiles' can provide a useful graphic representation of the level of affective development reached by individual students and such profiles can, in conjunction with cognitive data, aid in the prediction of academic success.

The level of affective development reached by groups of students is found to be related to gender and vocational grouping. Females obtain

higher scores at the lower levels of the taxonomy, but males are more likely to obtain high scores at the higher levels. Students tend to reach higher levels of affective development if they are following courses which are vocationally related to biology.

The study has not identified any clear pattern of relationship between affective development and cognitive development, which would allow academic success to be predicted from a knowledge of affective development alone.

TABLE OF CONTENTS

Acknowledgment

Abstract

Table of Contents

List of Tables

List of Figures

List of Appendices

Part 1. Affective characteristics and science education.
Review of the literature.

	Page
Chapter 1. The arousal and early development of science interest.	2
Chapter 2. Girls and science.	6
Chapter 3. Science image and career aspirations.	13
Chapter 4. The 'Swing from Science'.	23
Chapter 5. Teaching styles.	30
Chapter 6. Official statements.	36

Part 2. The theory and measurement of affective characteristics.

Chapter 7. The nature of attitudes.	41
Chapter 8. The importance of attitudes.	48
Chapter 9. Attitude acquisition and change.	50
Chapter 10. Developing attitude to learning.	58
Chapter 11. A taxonomic approach.	64
Chapter 12. Affective and cognitive relationships.	76

Part 3. Survey of the affective development of further education students in the biological sciences. Relationship to academic success.	Page
Chapter 13. Attitude measurement.	82
Chapter 14. Introduction to the survey.	89
Chapter 15. Pilot survey.	
15.1 Development of the affective instrument.	90
15.2 Administration of the affective instrument.	92
15.3 Analysis of the affective instrument.	93
15.4 Reliability of the affective instrument.	96
Chapter 16. The affective survey.	
16.1 Development of the second affective instrument.	97
16.2 Administration of the second affective instrument.	98
16.3 The survey.	99
16.4 Description of courses used in the survey.	99
Chapter 17. Cognitive variables.	103
Chapter 18. Analysis of the affective instrument	
18.1 Introduction.	105
18.2 Analysis of individual respondents.	105
18.3 Affective profile.	107
Chapter 19. Analysis of sub-groups.	115
Chapter 20. Analysis of individual questions.	121
Chapter 21. Multiple correlation analysis.	125
Chapter 22. Summary	
22.1 Affective profiles.	130
22.2 Affective development.	132
22.3 Prediction of examination success.	134
22.4 Affective development and vocational grouping.	135
22.5 Affective development and gender.	135
22.6 Development of the project.	136

	Page
Bibliography	138
Appendices	147

LIST OF TABLES

	Page
Table 1. Indices of favourability for pilot study.	95
Table 2. Mean favourability weightings for sub-groups in the survey.	116
Table 3. Differences between AL and OL mean favourability weightings.	117

LIST OF FIGURES

		Page
Figure 1.	Ratings of mean positions of eight professions and 'self' from data supplied by 96 High School Physics students.	17
Figure 2.	The two main dimensions of behaviour.	44
Figure 3.	An attitude continuum indicating attitude direction.	44
Figure 4.	The range of meaning of common affective terms as defined by the taxonomy of educational objectives.	47
Figure 5.	Pupils' rating of three figures relative to 'ideal self'.	52
Figure 6.	The nature of the taxonomic hierarchy.	64
Figure 7.	Subdivisions of the affective domain.	70
Figure 8.	Proposed cognitive-affective development relationship.	79
Figure 9.	Example of an item from a semantic differential instrument.	83
Figure 10.	Distribution of questions in the pilot instrument.	92
Figure 11.	Administrative details for the pilot study.	93
Figure 12.	A typical item analysis record card.	94
Figure 13.	Distribution of students in the survey by course.	100
Figure 14.	Distribution of students taking a biological science, by gender.	101
Figure 15.	Dates of administration of the second affective instrument.	102
Figure 16.	Conversion of raw scores into test scores on the Mill Hill vocabulary scale.	104
Figure 17.	Relationship of Likert weighting, percentage score and interpretation.	105
Figure 18.	Relationship of questionnaire sections to taxonomy subdivisions.	106
Figure 19.	Affective profile of student 'A'.	108
Figure 20.	Affective profile of student 'B'.	109

	Page
Figure 21. Affective profile of student 'C'.	110
Figure 22. Affective profile of student 'D'.	111
Figure 23. Affective profile of student 'E'.	112
Figure 24. Affective profiles for student 'F' before embarking on a)Science pre-entry course and one year subsequently on b)A-level course.	113
Figure 25. Variables used in multiple correlation analysis.	125
Figure 26. Graphs of mean favourability weightings against taxonomy subdivisions for all A-level and O-level students in the survey.	132

LIST OF APPENDICES

	Page
Appendix 1. Pilot affective instrument : Sub-scales.	147
Appendix 2. Pilot affective instrument : Final form.	150
Appendix 3. Pilot affective instrument : Score sheet.	153
Appendix 4. Indices of favourability for pilot items.	154
Appendix 5. Affective II instrument : Sub-scales.	157
Appendix 6. Student attitudes in biology. No. 2. Questionnaire.	162
Appendix 7. Score sheet for Affective II instrument.	169
Appendix 8. Student attitudes in biology. Notes for the supervisor.	170
Appendix 9. Specimen data sheet.	171
Appendix 10. Data sheet for student 'A'.	172
Appendix 11. Data sheet for student 'B'.	173
Appendix 12. Data sheet for student 'C'.	174
Appendix 13. Data sheet for student 'D'.	175
Appendix 14. Data sheet for student 'E'.	176
Appendix 15. Affective profiles of student 'F'.	177
Appendix 16. Sample question analysis sheet for 1977-1978 group.	179
Appendix 17. Correlation matrix for O-level Human Biology.	180
Appendix 18. Correlation matrix for O-level Biology.	181
Appendix 19. Correlation matrix for Science Pre-entry group.	182
Appendix 20. Correlation matrix for Home Economics Pre-entry group.	183
Appendix 21. Correlation matrix for Pre-nursing group.	184
Appendix 22. Correlation matrix for first year A-level biology group.	185

	Page
Appendix 23. Correlation matrix for second year A-level biology group.	186
Appendix 24. Correlation matrix for first year A-level botany/zoology group.	187
Appendix 25. Correlation matrix for second year A-level botany/zoology group.	188

We shall not cease from exploration,
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.

T.S.Eliot
Little Gidding

PART 1

AFFECTIVE CHARACTERISTICS AND SCIENCE EDUCATION

REVIEW OF THE LITERATURE

CHAPTER ONE

THE AROUSAL AND EARLY DEVELOPMENT OF SCIENCE INTEREST

There is a body of evidence, adequately summarised by Ormerod and Duckworth¹ to suggest that pupils begin to develop attitudes to science at around the age of eight years and that these attitudes become fixed at about thirteen or fourteen years of age. In a study of 117 thirteen year old boys from an East London Grammar School, Kelly² found that the pupils who had chosen to pursue their science studies further, had long-standing favourable attitudes to science which were formed at least two years earlier. The non-scientists, on the other hand, did not make up their minds about future studies until nearer the time of choice.

Eight years later, Butcher³ was able to support these findings in a study of 1, 000 Scottish pupils. He found that by the age of thirteen years clear patterns of differential aptitude and interests were evident. This was while the pupils were still following a general curriculum and before they had begun to specialise. Also, using American instruments to measure personality and interest patterns, it proved possible, at the same age, to distinguish potential pure scientists from applied scientists or technologists. It further transpired from this study that

¹Ormerod, M.B. with Duckworth, D., Pupils' Attitudes to Science : A Review of Research, (Slough : N.F.E.R., 1975), p.39-43.

²Kelly, P.J.(1961), 'An Investigation of the Factors which Influence Grammar School Pupils to Prefer Scientific Subjects', Br.J.Ed.Psy., 31,44.

³Butcher, H.J.(1969), 'An Investigation of the "Swing from Science"', Res.in Educ., 1, 38-57.

science students at universities had, in general, when at school, decided on their future specialisation about a year earlier than students of arts subjects and two years earlier than social science students⁴.

In 1971 the Association for Science Education entered the debate with a report entitled 'Science for the Under-Thirteens'⁵. It suggested that science activities between the ages of five and nine should arise out of the spontaneous interests of the children and should not be imposed upon them with the aim of laying down foundations. Whatever was done, however, should not be dilettante but should be carried on in the spirit of the initial stages of the scientific process. The children should learn the importance of good and thorough observation using their unaided senses. Later on the children should be encouraged to look for simple patterns in their observations, using discovery methods. It was suggested that by the time they were nine years old, children could have been introduced in a simple but sound way to the three basic notions of matter, energy and life. From the teaching point of view no attempt should be made at specialist teaching, although the employment of at least one member of staff with qualifications in science would benefit the development of a curriculum.

Beyond the age of eight years the following objectives were suggested : ⁶

a. To identify more patterns and to use the generalisations arising out of them for the beginning of explanations of why there is a pattern. This may involve the examination of alternative explanations (hypotheses).

b. To achieve the realisation that once an explanation (perhaps

⁴Ibid., p.56

⁵Association for Science Education, Science for the Under-Thirteens, (Hatfield, Herts. : A.S.E., 1971).

⁶Ibid., p.13.

better to call it a rationalisation) is chosen it makes possible the extension of the pattern, both as it exists in that the more phenomena are seen to fall within the pattern, and as an 'artefact' in the sense that we can now create components of the pattern to meet our needs and wishes.

- c. To give some understanding of the role of science in decision making, both personal (whether to smoke or not) and corporate (whether to farm rather than preserve; whether or not to build a reservoir).
- d. To encourage an increasing use of, and also invention and making of, apparatus and equipment- the tool-making capability. It is important that pupils have personal experience of devising and constructing equipment needed for a planned purpose. This kind of activity will contribute to the linking of science with technology and thus to an appreciation of some of the major causes of change in human societies.
- e. To give a reasonable familiarity with a range of simple techniques (such as timing, weighing, heating, magnifying and measuring length, volume and area) essential to successful experimentation.
- f. To give an appreciation of the need for control experiments in practical investigations and for making separated observations.
- g. To give first hand experience of causality by a study of suitable examples.

By this stage, where pupils were progressing towards a more formally structured kind of science, the Association believed it to be essential to have a suitably qualified science teacher, responsible for providing a suitable foundation for later, more advanced study.

The developments, which desirably would take place in the early years of secondary education, were presented in a policy statement 'Science and General Education'⁷. It was noted that attitudes, which may determine choices at a later stage of education, were formed very early in the child's life and that therefore, from the earliest years, children should be exposed to the ideas and methods of science. The best science teachers should have contact with pupils in the early years of secondary education and should not be solely concerned with the

⁷Association for Science Education, Science and General Education, 1971, (Hatfield, Herts.; A.S.E., 1971).

education of the older (16+) students.

Finally the Association recommended that pupils below the age of fifteen or sixteen years should not be segregated into 'arts' and 'science' groups. Neither was too much specialisation within the science subjects recommended since it was felt that this could lead to the exclusion of a study of biology or chemistry or physics.⁸

⁸Ibid., p.4.

CHAPTER TWO

GIRLS AND SCIENCE

Most research studies in the affective domain reveal differences in interests and attitudes that are related to gender. These differences are established in the early years of secondary education. In their study of factors associated with interest in science, Meyer and Penfold¹ sampled 150 pupils from a large coeducational bilateral school on the fringe of East London. The sample included roughly equal numbers of boys and girls, who were tested in the first year and then fifteen months later in the third year. The study showed that the girls started with less interest than the boys. Butcher² in an investigation of 1,000 Scottish pupils has shown that a sex difference in attitude towards all kinds of scientific career is very marked by the age of thirteen years with boys showing more positive attitudes.

An 'Attitude to Science' scale for 12-14 year olds, developed by Brown and Davis³ and administered to 3,000 pupils in Scottish secondary schools, has shown that boys score significantly higher than girls on the sub-scale 'Interest and Enjoyment in Science'. Brown⁴ has found that this difference increased over the first two years of secondary education

¹Meyer, G.R. and Penfold, D.M.E.(1961), 'Factors Associated with Interest in Science', Br.J.Ed.Psy., 31, 1,36.

²Butcher, H.J.(1969), 'An Investigation of the "Swing From Science"', Res. in Educ., 1, 38-57.

³Brown, S.A. and Davis, T.N.(1973), 'The Development of an "Attitude to Science" Scale for 12-14 Year Olds', Scottish Educ.Stud., 5, 2, 85.

⁴Brown, S.A., Attitude Goals in Secondary School Science, (Stirling : Department of Education, University of Stirling, 1976), p.51.

suggesting that " school science may not only have done little to improve the image of science for girls but may have added a further antipathetic element".

In an American study, using the 'Scientific Interest Scale' of the Kuder Preference Record with 325 pupils from junior and senior classes, Wynn and Bledsoe⁵ detected this same sex difference and commented that it appeared to be a characteristic of our western culture.

The reasons for the differences in interests and attitudes in the early years of secondary school are complex and often subtle. In the primary schools the ethos is characteristically feminine. Men are rarely employed in nursery and infant schools. In junior schools they form a minority. In primary schools, therefore, girls are perceived by their teachers as being better adjusted to the values of the school. In a study of 150 primary school teachers, about one third of whom were men, Clift and Sexton⁶ obtained teacher ratings of pupils on twenty different constructs. For sixteen of these constructs the difference in means between the scores for boys and girls was significant at $p < 0.05$ or higher. The teachers saw girls as being more sensible, more obedient, more hard working, more co-operative, needing less attention, being quieter, more mature, better adjusted to school, more sensitive to criticism, more likeable, needing less supervision, being intellectually brighter, less excitable, less talkative, possessing a greater measure of leadership and being more self-assured than boys.⁷ It is, therefore,

⁵Wynn, D.C. and Bledsoe, J.C.(1967), 'Factors relating to Gain and Loss of Scientific Interest During High School', Sci.Educ., 51, 70.

⁶Clift, P. and Sexton, B.(1969), '.....And All Things Nice', Educ.Res., 21, 3, 194-199.

⁷Ibid., p.197.

not too surprising to find that in reading, writing, English and spelling, the average eleven year old girl is superior in ability to the average eleven year old boy. In the secondary schools girls maintain their superiority in these basic subjects, but fall behind the boys in many others, notably arithmetic, geography and science.⁸

In the secondary school, the odds are that the science teacher will be male. This may act as a subtle influence, in which science is perceived by pupils as being a male activity. In terms of staffing, this influence can generate a 'vicious circle', for with fewer girls training to be science teachers, science becomes even more male dominated.

A study of some of the educational influences on the choice of a science career by grammar school girls was published by Brown⁹ in 1953. The investigation was occasioned by an increasing shortage of women science teachers and surveyed 705 girls from twelve grammar schools in Sheffield, who were taking Northern Universities Joint Matriculation Board School Certificate Examinations at midsummer, 1947. The number of girls taking up a science career was found to be influenced by ability as measured by the School Certificate examinations. Girls who engaged in science careers gained a significantly greater proportion of marks over fifty percent in all their School Certificate subjects than girls who engaged in non-science careers. Thus it appeared to be only the most able girls who sought a science career. A home influence was also apparent in that girls taking up science careers tended to have fathers who had intellectually demanding jobs.

The subtlety of influence can also extend to teaching aids such as

⁸Douglas, J.W.B., The Home and the School, (London : Panther Books, 1967), p.99.

⁹Brown, N.M.(1953), 'Some Educational Influences on the Choice of Science Career By Grammar School Girls', Br.J.Ed.Psy., 23, 188-195.

textbooks. In an American study, Gaetano¹⁰ confronted the problem that, in spite of a need for more scientists, only eleven percent of the scientists were women. It was felt that this imbalance might be due to attitude rather than aptitude restrictions. The purpose of the study was to determine if there was a significant difference between the number of masculine and feminine figures presented in six science textbook series published since 1960. The t statistic was computed using the combined totals of masculine and feminine figures in thirty-six text books. Of the total number of discernable figures, 4338 were male and 2155 were female. The difference is significant at $p < 0.005$. The author concludes : ¹¹

"There is no empirical evidence to demonstrate the influence of the disproportionate number of male figures in science text books on the career choice of females, but on logical grounds one might suspect that females are not positively reinforced on the appropriateness of a science career for the female sex."

A similar conclusion is reached by Hutchings and Clowsley¹² in their survey of 541 boys and 581 girls, who were in their last week of formal schooling in the sixth form. The sample was drawn from representative types of school in Lancashire, Yorkshire, Gloucestershire, London and Coventry. It was concluded that girls were being deflected from science despite ability and motivation comparable to boys. A possible interpretation of this would be that the science that is taught is cast in masculine interests and is therefore alien to the kinds of interests that attract girls in our culture.

The authors also suggest that girls whose scholastic achievements

¹⁰Gaetano, M.A.K.(1966), 'A Study to Determine the Distribution of Male and Female Figures in Elementary Science Textbooks', J.Res.Sci.Teach., 4, 178-179.

¹¹Ibid., p.179.

¹²Hutchings, D. and Clowsley, J.(1970), 'Why do Girls Settle for Less?', Further Education, (Autumn), 6-7.

are comparable with boys' are more susceptible to social pressures, which have the effect of making them lower their sights. This problem is related to the practicalities of career development, particularly in relation to problems of reconciling career and family life.

A 'Feminine Image Factor' often emerges from factor analytic studies. Hallworth and Waite¹³ surveyed 155 boys and 128 girls in the fourth year of secondary schooling. They used a semantic differential technique for thirty-six concepts, followed by factor analysis. In general the results confirmed expectations. The boys' attitudinal associations were with ambition and study, whereas the girls' were with self and home. Boys had a cluster of concepts identified with authority, girls with security. Less expected was the girls' association of school with men and boys.

In a larger survey involving 265 boys and 248 girls, aged 12-14 years, drawn from seventeen classes in nine secondary modern schools in Lancashire, Slee¹⁴ used a new Thurstone-type general attitude scale of twenty-five items, which was subjected to factor analysis. Again a 'Feminine Image Factor' emerged, associated with a liking for housecraft, art, English and music, which was particularly strong among the older girls.

In a factor analytic study of 261 boys and 264 girls from seventeen schools stratified according to type, Ormerod¹⁵ found that a 'Social Implications Factor' arose by the third year of secondary education. Although 'social' topics had been appearing in some modern science syllabuses, there had been little reason to believe they should be studied in the 11-14 age range. Ormerod suggests that teachers of this

¹³Hallworth, H.J. and Waite, G.(1966), 'A Comparative Study of the Value Judgements of Adolescents', Br.J.Ed.Psy., 36, 202-209.

¹⁴Slee, F.W.(1968), 'The Feminine Image Factor in Girls' Attitudes to School Subjects', Br.J.Ed.Psy., 38, 212-214.

¹⁵Ormerod, M.B.(1971), 'The "Social Implications Factor" in Attitudes to Science', Br.J.Ed.Psy., 41, 3, 335-338.

age range would be justified in experimenting with courses which had a balanced view of the social implications of science as a major objective and evaluating the effect on the choice of science options by girls.

Education has for a long time promoted the male-female image dichotomy, by providing a curriculum in which the girls study the arts, domestic science and needlework, whilst the boys study the sciences, woodwork and engineering. This is further reinforced by the old divisions of labour, which have resulted in prevailing attitudes in the adult population against the employment of girls (and boys) in certain jobs.¹⁶ However, recently the role expectations of the two sexes are becoming increasingly diffuse and are moving from a male-female distinction to one tailored to the individual's interest irrespective of sex.¹⁷

When one considers science in terms of its major components of biology, chemistry and physics it is found that girls turn in their greatest numbers towards biology. The usual reason advanced to explain this is that biology is concerned with people, whereas the other sciences are concerned with inanimate matter. However, Kelly¹⁸ has shown this view to be too simplistic. It is true that girls do exhibit a greater desire to work with people than do boys, but this desire manifests itself not only when they are contrasted in the biological sciences, but also the physical sciences, social sciences and arts.

Other factors may be that girls are introduced to the subject content of biology in the primary school, often in the guise of 'Nature Study', whereas they are unlikely to make such an early contact with the

¹⁶Newton, D.P. (1975), 'Attitudes to Science', Sch.Sci.Rev., 57, 199, 368.

¹⁷Reich, B. and Adcock, C., Values Attitudes and Behaviour Change, Essential Psychology Series, ed. Herriot, P. (London: Methuen, 1976), 46.

¹⁸Kelly, A. (1975), 'Why do Girls Study Biology?', Sch.Sci.Rev., 56, 196, 628-632.

physical sciences. By the time they reach secondary school they may prefer to remain with a subject they feel is familiar to them rather than to try out a new subject which they may feel has dubious social connotations.

Ingle and Shayer¹⁹ and Shayer^{20,21,22} have shown that the early years of the Nuffield chemistry and physics syllabuses are at a conceptual level beyond that of most pupils, whereas biology tends to be more descriptive and less abstract in the early years. It may be that girls are more susceptible to anticipated difficulties in the physical sciences.

¹⁹Ingle, R.B. and Shayer, M. (1971), 'Conceptual Demands in Nuffield O-level Chemistry', Educ. in Chem., 8, 5, 182-183.

²⁰Shayer, M. (1970), 'How to Assess Science Courses', Educ. in Chem., 7, 5, 182-186.

²¹Shayer, M. (1972), 'Conceptual Demands in Nuffield O-level Physics Course', Sch.Sci.Rev., 186, 54, 26-34.

²²Shayer, M. (1974), 'Conceptual Demands in Nuffield O-level Biology Course', Sch.Sci.Rev., 195, 56, 381-388.

CHAPTER THREE

SCIENCE IMAGE AND CAREER ASPIRATIONS

The decision to take science subjects in the school or college and to pursue careers in science is very much tied up with the image the pupils have of science and scientists. Over the years this image has become tarnished with a fair amount of myth and ignorance. Pupils who opt for science courses because they are attracted by the media image of the scientist may experience genuine disillusionment in their science lessons.

Using an open-ended response technique, Mead and Metraux¹ attempted to discover the image of the scientist among American high school students. 35,000 students completed statements, which were analysed and synthesised into pen portraits. The following picture emerged :

"The scientist is a man who wears a white coat and works in a laboratory. He is elderly or middle aged and wears glasses. He is small, sometimes small and stout, or tall and thin. He may be bald. He may wear a beard, may be unshaven and unkempt. He may be stooped and tired. He is surrounded by equipment : test tubes, bunsen burners, flasks and bottles, a jungle gym of blown glass tubes and weird machines with dials. The sparkling white laboratory is full of sounds : the bubbling of liquids in test tubes and flasks, the squeaks and squeals of laboratory animals, the muttering voice of the scientist. He spends his days doing experiments. He pours chemicals from one test tube into another. He peers raptly through microscopes. He scans the heavens through a telescope[or a microscope!]. He experiments with plants and animals, cutting them apart, injecting serum into animals. He writes neatly in black note books.²

[link words underlined]

¹Mead, M. and Metraux, R. (1957), 'Image of the Scientist among High-School Students', Science, 126, 384-390.

²Ibid., p. 386-387.

The image then diverges. On the positive side :

"He is a very intelligent man-a genius or almost a genius. He has long years of expensive training-in high school, college, or technical school, or perhaps even beyond-during which he studied very hard. He is interested in his work and takes it seriously. He is careful, patient, devoted, courageous, open-minded. He knows his subject. He records his experiments carefully, does not jump to conclusions, and stands up for his ideas even when attacked. He works for long hours in the laboratory, sometimes day and night going without food and sleep. He is prepared to work for years without getting results and face the possibility of failure without discouragement; he will try again. He wants to know the answer. One day he may straighten up and shout : "I've found it! I've found it!"

He is a dedicated man who works not for money or fame or self-glory but-like Madam Curie, Einstein, Oppenheimer, Salk-for the benefit of mankind and the welfare of his country. Through his work people will be healthier and live longer, they will have new and better products to make life easier and pleasanter at home, and our country will be protected from enemies abroad. He will soon make possible travel to outer space.

The scientist is a truly wonderful man. Where would we be without him? The future rests on his shoulders."³ [link words underlined]

The negative side of the image abounds with a lack of realism :

"The scientist is a brain. He spends his days indoors, sitting in a laboratory, pouring things from one test tube into another. His work is uninteresting, dull, monotonous, tedious, time consuming and, though he works for years, he may see no results or may fail, and he is likely to receive neither adequate recompense nor recognition. He may live in a cold-water flat; his laboratory may be dingy. If he works by himself, he is alone and has heavy expenses. If he works for a big company, he has to do as he is told, and his discoveries must be turned over to the company and may not be used; he is just a cog in a machine. If he works for the government he has to keep dangerous secrets; he is endangered by what he does and by constant surveillance and by continual investigations. If he loses touch with people, he may lose the public's confidence-as did Oppenheimer. If he works for money or self-glory he may take credit for the work of others-as some tried to do with Salk. He may sell secrets to the enemy.

His work may be dangerous. Chemicals may explode. He may be hurt by radiation, or may die. If he does medical research, he may bring home disease, or may use himself as a guinea pig, or may accidentally kill someone.

He may not believe in God or may lose his religion. His belief that man has descended from animals is disgusting.

He is a brain; he is so involved in his work that he doesn't know what is going on in the world. He has no other interests and neglects his body for his mind. He can only talk, eat, breathe, and sleep science.

³Ibid., p.387.

He neglects his family-pays no attention to his wife, never plays with his children. He has no social life, no other intellectual interest, no hobbies or relaxations. He bores his wife, his children and their friends-for he has no friends of his own or knows only other scientists-with incessant talk that no-one can understand; or else he pays no attention or has secrets he cannot share. He is never home. He is always reading a book. He brings home work and also bugs and creepy things. He is always running off to work in his laboratory. He may force his children to become scientists also. A scientist should not marry. No-one wants to be such a scientist or to marry him."⁴ [link words underlined]

Many of the sentiments expressed in this study are echoed in more recent work. In 1967, Hudson⁵ used a semantic differential technique on 390 English schoolboys of high academic ability in the age range 13-17 years. He found that "adult scientists are seen by both future arts and science specialists as leading dull personal lives." The same stereotyped image was as easy to elicit from an unspecialised thirteen year old as a specialised seventeen year old. One can only speculate on the origin of these images.

Selmes⁶ tape recorded responses of 12/13 year old pupils, who were encouraged, in small groups, to talk about their reactions to science and scientists. The tapes were then analysed for recurring phrases and expressions, the frequencies of which were converted to a percentage.

The following stereotype of the scientist emerged :

"Scientists spend their time inventing things or messing about with chemicals(8%). They may invent good things like new drugs and..... well, other things I can't name but also things that are not very good(8%) like H-bombs and other weapons, giving diseases to animals; and the thousands of scientists breeding germs. They are usually menwell, there's more scope for them and anyway ladies aren't wanted(8%). They have to be very brainy or clever(7%) but I think they're mad or eccentric because of it or because they don't care what they do(7%).....in fact they have to devote their whole life

⁴Ibid., p.387

⁵Hudson, L.(1967), 'The Stereotypical Scientist', Nature, 213, 228-229.

⁶Selmes, C.(1969), 'The Attitudes of 12/13-year-old Pupils', Sch.Sci. Rev., 51, 174, 7-14.

to it(7%) and do nothing else..... it must be grim to be disconnected from the world. No, I don't read magazines about science.....they're too complex and difficult to understand. We aren't given enough information or programmes about scientists but I've enjoyed the T.V. programmes I've seen out of school.(10%) I suppose we never see scientists doing normal kind of work but I think they do too much as they like(7%) and there ought to be more control over them by a non-scientific body, or they could be limited to specific problems, eg.curing of cancer. No, I'm not thinking of becoming a scientist (9%)."⁷

Parts of the stereotype bear a striking resemblance to the American study.⁸ In the sixth form, misconceptions still arise. Ashton and Meredith⁹ analysed the answers to a question set in the General Studies paper of a G.C.E. Examination Board at A-level. The question asked candidates to "try to account for the fact that the number of students wishing to study arts and social sciences at universities is increasing more rapidly than the number wishing to study the natural sciences." The popular image of the scientist was of a drab, bespectacled, overalled figure bending over a bunsen burner in a back room or of a "dishevelled and wildly excited man dancing around, waving a test tube and talking to himself." He was also regarded as uncultured, lacking in the ability to converse socially, whereas a training in arts or social sciences(partly because they were seen as the study of people rather than things) enabled one to converse with anyone(except a scientist) in any situation, and in general, fitted one much better for life. There was also a disenchantment with society implicit in many essays. One candidate wrote:"The twentieth century has seen many developments in science which are not only horrific in their powers of destruction but in their ability to reduce 'human life' to the level of mere existence."

⁷Ibid., p.11.

⁸Mead, M. and Metraux, R., op.cit., p.387.

⁹Ashton, B.G. and Meredith, H.M.(1969), 'The Attitudes of Sixth Formers', Sch.Sci.Rev., 51, 174, 15-19.

In America the number of High School students taking Physics had declined from 25% in 1950 to under 20% in 1970. Ahlgren and Walberg¹⁰ devised a method of rating high school physics students using a series of semantic differential scales the results of which were subjected to factor analysis. The image of 'physicist' was found to be the most remote of a number of professions from 'me', i.e. physics student. The ratings are shown in Figure 1.

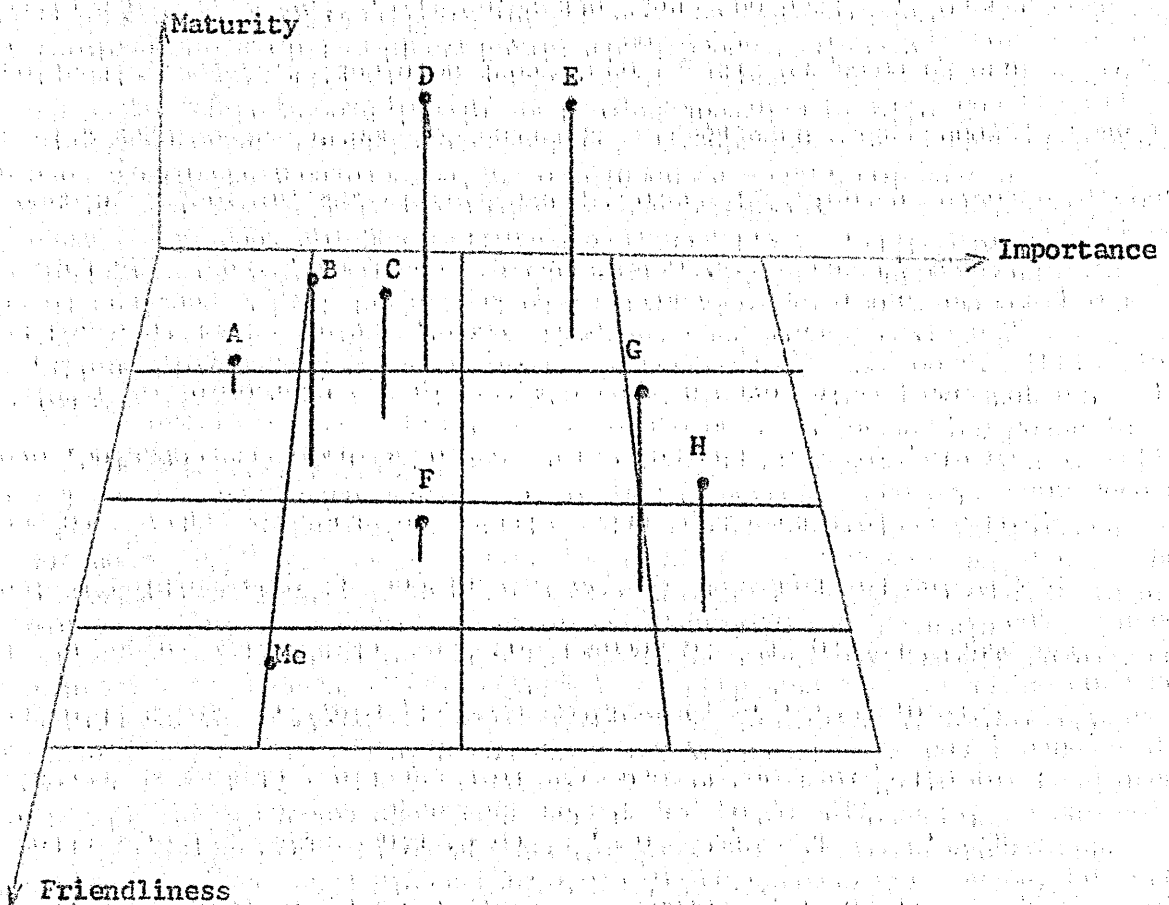


Fig.1. Ratings of mean positions of eight professions and 'self' from data supplied by 96 High School Physics students. (Adapted from Ahlgren and Walberg, 11)

Key : A-artist, B-plumber, C-biologist, D-businessman, E-physicist, F-secretary, G-teacher, H-doctor.

¹⁰Ahlgren, A. and Walberg, H.J. (1973), 'Changing Attitudes to Science among Adolescents', Nature, 245, 187-190.

¹¹Ibid.

The Association for Science Education was obviously cognisant of the poor image of the scientist when preparing its policy statement on 'Science and General Education'.¹² In referring to the functions of the science teacher, the Association refers to the need to "help the majority of pupils and parents to overcome any existing prejudice against science" and to "help pupils to understand the thinking of the scientist and to provide some knowledge of the kind of problems which are capable of solution by scientific means, thereby avoiding misconceptions prevalent among non-scientists today."¹³

A more realistic image of the scientist was detected by Bradley and Hutchings¹⁴ in a recent study of two thousand third-year pupils, drawn from seventeen secondary schools in England and Wales. They used a questionnaire designed as a semantic differential with a four-point scale, with four sub-sections, one of which related to the character of the scientist. The following picture emerged :

"Our findings have tended to present a much more encouraging picture of the scientist as a quietly efficient person who is more in the centre of things than locked away in the back room. He is not the eccentric, solitary figure devoting himself to his work but much more society-orientated, working in a team and dealing with the world of politics and big business that we have come to recognise through the media.

The 'absent-minded professor' is certainly becoming outdated. Only 18 percent of the overall sample described the scientist as very or quite absent-minded and only 24 percent of those least interested in science as a subject. Similarly, around 50 percent of the sample described him as enjoying company, being a family man and being kindly and cheerful. He was also described as an interesting person and was not seen as especially dowdy and unfashionable."¹⁵

¹²Association for Science Education, Science and General Education, (Hatfield, Herts. : A.S.E., 1971)

¹³Ibid., p.7.

¹⁴Bradley, J. and Hutchings, D.(1973), 'Concepts of Science and Scientists as Factors Affecting Subject Choice in Secondary Schools', Sch.Sci.Rev., 55, 190, 8-15.

¹⁵Ibid., p.12.

Two possible sources can be suggested for a more enlightened image of the scientist. One is a possibly more realistic presentation of the scientist in the media, particularly television, and children's literature. The second is the introduction of new teaching styles, in the wake of the curriculum projects founded by the Nuffield Foundation, which may give the pupils a more accurate model of the scientist than can be achieved by a more rigid, didactic approach.

The school performs many functions, one of which is to prepare pupils for the world of work. H.M. Inspectorate drew attention to this aspect of the curriculum in a recent working paper.¹⁶ In a section titled 'Schools and Preparation for Work : Pupils' Attitudes', they said :

"The development of a sense of values and of responsible attitudes to work itself and towards individuals with whom they deal are as important to young employees as the development of skills. It is essential that pupils have experience at school of what it is to work individually and in groups, to work sometimes individually and sometimes under supervision. Many attitudes traditionally valued in schools, such as the appreciation of quality, a pride in work, a concern for accuracy, a willingness to co-operate, to take responsibility and to sustain the effort needed to complete a task are equally relevant to the world of work. The links must be self-evident. Similarly schools can educate pupils to value punctuality and neatness and to be sensitive to safety requirements."¹⁷

Although all school subjects can play a part in meeting this ideal, the sciences are particularly important because of their direct vocational significance. If a pupil wishes to pursue a science career there is evidence that the process begins before or during the early years of secondary education. Meyer and Penfold¹⁸ refer to the importance of parents in the making of career decisions and to the need to make such decisions at an early age :

¹⁶Department of Education and Science, Curriculum 11-16, Working Papers by H.M. Inspectorate : a Contribution to the Current Debate, (London : H.M.S.O., 1977)

¹⁷Ibid., p.16.

¹⁸Meyer, G.R. and Penfold, D.M.E. (1961), 'Factors Associated with Interest in Science', Br.J.Ed.Psy., 31, 1, 37.

".....if the home is democratic, and the parents give an impression of their own interest in science, the child will probably respond with an interest. Ambition for prosperity on the part of the parents will probably act as a stimulant. If the parents are to take a part in deciding what careers their children are to follow, they should be encouraged to discover their interests and to realise that the age of 14,, may be quite late enough."

It is particularly important therefore, that in the early years of secondary education, pupils are encouraged to develop an authentic image of the scientist's job for there is a general assumption that boys and girls who choose science subjects will, probably opt for a career in science.¹⁹ It is also important to inculcate suitable attitudes to science before specialisation begins, for as Laughton and Wilkinson²⁰ have shown in a study of 215 pupils drawn at random from the first three years of a G.C.E. course in three different schools, attitudes play an important role in pupils' selection of science subjects for further study.

The context of the situation in which scientific subjects are chosen is also important. In his survey of thirteen year old grammar school boys in East London, Kelly²¹ found that there were three main features :

1. The choice was the pupil's own. There was little evidence that anyone else had any direct influence.
2. The pupil's choice was a product of the school environment. Influences outside the school were vague and few. The home was neutral.
3. Within the school environment it was the nature of the subjects rather than teachers or fellow pupils that had the greatest effect.

¹⁹Bradley, J. and Hutchings, D., op.cit., p.18.

²⁰Laughton, W.H. and Wilkinson, W.J. (1970), 'The Science Opinion Poll', Educ. in Sci., VIII, 37, 25-27.

²¹Kelly, P.J., op.cit., p.44.

The general ethos of the school is seen to be an important determinant of career aspiration. This view is supported by the work of Sumner and Warburton²² in their study of the four most and four least industrious pupils drawn from twenty-eight schools of five types. They found that the "more ambitious and educationally reliant vocational aspirations run parallel to favourable outlooks on school, its organisation, the work it generates and the teachers who staff it."

In a study of 120 boys and girls in a County Durham Grammar School, Angus²³ was concerned with the advice given to pupils in the middle forms about specialising in science. The dilemma was that the most intelligent pupils were equally good at most school subjects and therefore internal examinations had little predictive value. Angus therefore devised a questionnaire of science interest and obtained a teachers' interest estimate, which, together with cognitive measures, were used in an effort to determine whether a pupil's interest in a subject could predict future success in that subject. He concluded that "although the investigation showed that further research is needed to establish a really reliable criterion of scientific interest, it also showed that tests of scientific interest should be included in any battery of tests used for predicting scientific achievement and thus for educational guidance.....".

Kelly²⁴ found that the performance of A-level students related to their career aspirations and was in step with the level of entry requirements. The students performed best when their choice required a

²²Sumner, R. and Warburton, F.W., Achievement in Secondary School : Attitudes, Personality and School Success, (Slough : N.F.E.R., 1972).

²³Angus, L. (1950), 'A Comparative Study of the Methods of Measuring Interest in Science and its Relation to Ability and Achievement', Br.J.Ed.Psy., 20, 63-65.

²⁴Kelly, P.J., 'Curriculum Development and Curriculum Mechanism', (Unpublished Ph.D. thesis, Chelsea College, 1971).

university education. This was thought to be due in part to motivation and also to students' accuracy in sensing their own capabilities.

Butcher²⁵ attempted to determine at an early age and before specialisation, which pupils were potential university graduates. A range of criteria were used on a sample of 1,150 thirteen year old children from twenty Scottish schools, who were likely to go to either Edinburgh or Heriot-Watt university. Using factor analysis, ten major factors were identified as having strong predictive value :

- Temperamental stability
- Interest in and aptitude for science
- Practical-mechanical interest
- General scholastic achievement
- Introversion-extraversion
- Verbal reasoning
- Mathematical-computational aptitude
- Literary interest
- Interest in social work
- Aesthetic interest

The Association for Science Education is certainly aware of the need to make it easier for pupils to relate their science education to employment opportunities. In a recent consultative document²⁶ the Association urges science educators to "include in their schemes of work and syllabuses a greater awareness of industry" and looking to the future points to the "urgent need to scrutinize science curricula in order to consider their relevance in the changing industrial and social contexts."²⁷

²⁵Butcher, H.J.(1969), 'The Structure of Abilities, Interests and Personality in 1,000 Scottish School Children', Br.J.Ed.Psy., 39, 2, 154-165.

²⁶Association for Science Education, Alternatives for Science Education, (Hatfield, Herts. : A.S.E., 1979).

²⁷Ibid., p.36.

CHAPTER FOUR

THE 'SWING FROM SCIENCE'

In the 1950's there was a marked increase in the proportion of pupils studying pure science courses in the sixth form. During the 1960's this proportion declined and generated an official concern which led to the setting up of the Dainton Committee. It reported in 1968.¹ The committee coined the term 'swing' to denote the process whereby fewer pupils were following a pure science course in the sixth form and an increasing number were following either a mixed course, containing both arts and science subjects, or a pure arts course. Their interpretation of this was that students who would formerly have been expected to take a pure science course in the sixth form, were in fact opting for courses with an arts bias. A number of explanations of the 'swing' were offered. One was that the children were having to specialise in biology, chemistry or physics too early, with little opportunity for opting in at a later stage in their education. Hall², in 1969, advanced the argument that separate sciences should not be taught prior to O-level, but instead General Science should be a compulsory subject for all pupils. A second reason was that science teaching was claimed to be far too formal and too related to historical tradition. At the time the Dainton Report was

¹Council for Scientific Policy, Inquiry into the Flow of Candidates in Science and Technology into Higher Education. [Dainton Report]., (London : H.M.S.O., 1968)

²Hall, W.C. (1969), 'General Science to O-level', Sch.Sci.Rev., 51, 175, 433-437.

was being produced however, major science curriculum projects were being introduced under the auspices of the Nuffield Foundation. The main reason advanced for the swing from science though, was alleged changes in pupils' attitudes to science.

Following the publication of the Dainton Report, the Association for Science Education had the opportunity to discuss the situation at its 1968 Education Conference in Nottingham.³ The main reason advanced to explain the swing was given in terms of subject complexity and the use of syllabuses which had their origins in the 1930's. The matter of subject complexity was aptly described by a headmaster in a letter to the A.S.E. :

"Two boys returned to school for a day last week after their first term at the same university. One is doing physics, mathematics and chemistry and is "killed" by hard mathematics and lengthy afternoon and evening labs. The other is doing Italian, averages one or two lectures a day and an agreeable Italian club session on one evening a week. The rest of the time he has available for all that London offers, Is it any wonder that the one is already thinking of switching over to social science and an easier life so that he can enjoy a little time with the other?"⁴

At the same time the A.S.E. published two studies on attitudes to science.^{5,6} Selmes collected tape recordings of groups of children, who were encouraged to talk freely about their attitudes to science. The recordings were then analysed for recurring phrases and expressions. Frequencies were expressed as percentages. By using only items with a frequency in excess of five percent, the following picture of school biology for 12/13 year olds emerged :

"Some parts of biology are interesting(7%), eg.work on animals, but a

³Newall, A.B.(1969), 'The Views of Science Teachers', Sch.Sci.Rev., 51, 174, 20-22.

⁴Ibid., p.21.

⁵Selmes, C.(1969), 'The Attitudes of 12/13-year-old Pupils', Sch.Sci.Rev., 51, 174, 7-14.

⁶Ashton, B.G. and Meredith, H.M.(1969), 'The Attitudes of Sixth-Formers', Sch.Sci.Rev., 51, 174, 15-19.

lot of it is boring and monotonous(15%), eg. all that stuff we're doing on broad beans and onions. There is little practical work (5%) but we enjoy it and would like to have more of it(20%), particularly work which involves keeping and studying animals. Much of the work is a waste of time or quite useless(18%), eg. finding out things we already know, or learning about photosynthesis. There is a lot of writing in biology(7%), pages and pages of it, as well as a lot of drawing(9%), but it is possible to learn it without understanding it(9%), ie. parrot-fashion."⁷

This is hardly a description that would allow of complacency on the part of biology teachers. Taken together with the poor image these pupils had of scientists⁸ the 'image factor' is one which almost certainly plays a part in influencing later subject choices.

The second investigation⁹ of sixth formers used the answers to a G.C.E. A-level General Studies question, which asked candidates to account for the fact that the number of students wishing to study arts and social sciences at university was increasing more rapidly than the number wishing to study natural sciences. Candidates described the sciences as lacking in the opportunity for freedom of thought, excluding creative ability and being a 'slog'. A disenchantment with society was blamed on science. Science lessons were described as "boring and uninteresting in the extreme, with little to do except amass notes and learn innumerable, incomprehensible laws and formulae". Career opportunities for the science graduate were also regarded as limited, unattractive, often with poor pay and working facilities.

In 1969, Butcher¹⁰ conducted an investigation on the 'Swing from Science' using measures on 1,150 Scottish pupils. He found that the pupils' interests and aptitudes in science had crystallised by the age

⁷Selmes, C., op.cit., p.9.

⁸see pages 15-16.

⁹Ashton, B.G. and Meredith, H.M., loc.cit.

¹⁰Butcher, H.J.(1969), 'AN Investigation of the "Swing from Science"', Res.in Educ., 1, 38-57.

of thirteen years, before any specialisation had occurred. Butcher found that the dimensions were more readily assessable than had previously been supposed and that besides general arts-science orientation it was possible to obtain a clear identification of particular vocational interests. Examining social factors, no association was found between interest and ability measures and socio-economic status, although this may have operated earlier in determining entry to selective secondary schools. There was some evidence that childrens' interest in science was related to the number of their relatives who were scientists. This accords with the work of Brown¹¹, who in a study of 705 girls from twelve Sheffield Grammar Schools, found that girls taking up a science career more often had fathers who were engaged in intellectually demanding careers. From the retrospective accounts of students it appeared that expectation of higher earnings plays some part in the decision to specialise in scientific subjects. The career of science teacher was found to be not at all highly regarded, either by the most scientifically oriented pupils or girls, who are usually attracted to teaching in general.

The importance of interest has been studied by Houghton¹² in a questionnaire survey of 54 boys and 53 girls from a West Riding grammar school. She concluded that interests were very important, more so than achievement, in forming the basis on which children make decisions about the subjects they will study at school.

More recently, the whole phenomenon of the 'swing from science' has

¹¹Brown, N.M. (1953), 'Some Educational Influences on the Choice of a Science Career by Grammar School Girls', Br.J.Ed.Psy., 23, 194.

¹²Houghton, E.M., 'Attitudes to Biology', (Unpublished M.A. thesis, University of Leeds, 1972)

been scrutinised by Duckworth and Entwistle.¹³ They define the swing in terms of the proportion of passes obtained in specific A-level subjects compared with the total number of passes in all subjects. In these terms the swing is not just away from science, but also the foreign languages. The gains appear to be made by English Literature and the social sciences. The authors point to three major changes in the sixth form which may have had an effect :

1. Widening the choice of subject options in the sixth form has the effect of drawing 'less committed students' away from a pure science curriculum.
2. An increasing proportion of girls entered the sixth form between 1963 and 1970 and they were less likely to follow a heavily science-based curriculum.
3. With more students staying on at school, pupils of lower ability entered the sixth form and were less likely to opt for science subjects.

Thus in real terms there may not have been a swing from science, but the new category of pupil entering the sixth form after 1963 may have been less likely to choose science subjects.

Duckworth¹⁴ has drawn attention also to the fact that the sciences exemplify a group of subjects which require cumulative learning. With less rigid O-level requirements to enter the sixth form, more pupils were likely to enter without an O-level science background and thus A-level science was precluded for them. A further factor was that students who had a science biased course in the fifth form could turn to the arts and

¹³Duckworth, D. and Entwistle, N.J. (1974), 'The Swing from Science : A Perspective from Hindsight', Educ. Res., 17, 1, 48-53.

¹⁴Causes of the Swing from Science, review of The Continuing Swing? Pupils Reluctance to Study Science by Duckworth, D., Education, March 30, 1979, p.373.

humanities in the sixth, whereas a student with an arts biased course in the fifth form would experience extreme difficulties in turning to science at that stage.

Duckworth and Entwistle¹⁵ thus found it 'arguable' that the sciences had lost recruits because of a change in pupils' attitudes to science. They found it much more probable that " some have been attracted away by the welcome diversification of sixth-form courses while others, the 'new' sixth-formers, have never been serious candidates for science(or language) courses because they find these subjects particularly difficult."

Pell¹⁶ in a study of the swing from physics, used a questionnaire to sample the attitudes of fifth formers, who were studying physics and sixth formers, some of whom were studying physics and some of whom had given up physics after O-level. The survey suggested four main factors which may have been producing a negative physics swing :

- 1.The poor image of O-level physics;
- 2.the considerable difficulty of the O-level subject;
- 3.unattractive teaching methods;
- 4.the expansion of the range of available A-level subjects.

The perceived difficulty of chemistry and physics as a factor in deciding A-level subjects, was also remarked upon by Gaskell¹⁷ in a study of 1200 secondary school pupils.

At university there appears to be very little opportunity to change specialisms after matriculation. Keele University is unique in offering a Foundation Year, which allows students to sample a number of subject

¹⁵Duckworth, D. and Entwistle, N.J., op.cit., p.53.

¹⁶Pell, A.W.(1977), 'Subject Swings at A-level : Attitudes to Physics', Sch.Sci.Rev., 53, 205, 763-770.

¹⁷Gaskell, D.C.(1975), 'The Flow of Chemists', Educ.in Sci., 62, 23.

disciplines and select their honours subjects subsequently. Iliffe¹⁸ produced evidence to support the hypothesis that the weaker science students were more likely to change their intended specialisms to the arts side. The subjects most likely to attract such students were economics, politics, psychology, American Studies-subjects which were not likely to have been studied at school.

The belief that science courses are more intellectually demanding than arts courses, however ill founded, still prevails at university level.

¹⁸Iliffe, A.H., The Foundation Year in the University of Keele-
A Report, Soc.Rev.Monograph 12, (Keele University : 1968), p.101.

CHAPTER FIVE

TEACHING STYLES

In their review of research connected with the teaching of affective responses, Khan and Weiss¹ end with the statement that education cannot afford the luxury of having its most important affective outcomes occur as accidents or unintended effects of the curriculum and of school life in general. Evans² has pointed out that we can arrange for our children to acquire particular information and to learn particular skills, so in the same way we can arrange for them to acquire particular attitudes and interests.

An important factor in bringing about affective development within the school or college is the teaching method or style. Within the sphere of higher education Hornsby-Smith³ has shown that, at the University of Surrey, students taking the Human and Physical Sciences degree show a good deal of dissatisfaction with the Physical Science part of the degree, largely because of its expository teaching style. The Physical Science component is taught in a didactic style. The human ideas and social science or philosophy option, on the other hand, are taught heuristically with no rigid stratification between the teacher and the taught. The students claimed more interest, enjoyment and involvement in the part of the course which used heuristic methods, whereas the didactic

¹Khan, S.B. and Weiss, J., 'The Teaching of Affective Responses', in Second Handbook of Research on Teaching, ed. Travers, R.M.W. (Chicago : American Educational Research Association, 1973), p.789.

²Evans, K.M., Attitudes and Interests in Education, (London : Routledge and Kegan Paul, 1965), p.141.

³Hornsby-Smith, M.P. (1973), 'Styles of Teaching and their Influence on the Interest of Students in Science, Durham Research Rev., 7, 31, 807-815

approach of the physical science course produced unfavourable attitudes. Indeed, the study suggested that a possible reason for higher wastage rates in the sciences than the humanities may be the didactic teaching style.

A useful technique, which encompasses affective as well as cognitive qualities in the student, is the method of small group discussion. Groups are important in affective development, because they serve as an important reference for the student providing a set of social roles, norms, values and attitudes for their members. In group discussion the teacher can withdraw some authority and allow students to be exposed to a variety of views from their peers. Beard⁴ has noted that a new experience combined with free discussion is crucial in changing attitudes, particularly where prejudice and misconception are involved. When students experience cognitive dissonance⁵ they like to be aware of how other members of the group are responding as an assurance that their response is appropriate. Indeed, there is evidence⁶ to suggest that individuals in a class are influenced in their reactions to the persuasive message by clues as to how others are responding.

Part of the task of assisting the attitude development of individuals, therefore, has to do with managing the 'ethos' of the group to which they belong. Aversion tendencies⁷ are much easier to reverse in individuals than in groups. It is a most difficult task for a teacher to properly teach a group, which has developed a hostility to the subject.

⁴Beard, R., Teaching and Learning in Higher Education, (Harmondsworth, Middlesex : Penguin, 1970), p.127.

⁵ see page 53.

⁶Newcomb, T.M., Turner, R.H., and Converse, P.E., Social Psychology, rev.edn., (London : Routledge and Kegan Paul, 1966), p.103.

⁷ see page 59.

Another way of promoting the development of a particular attitude is to get the student to actively support it or to behave in such a way as to endorse it. Some of the evidence supporting the validity of such a method is cited in Bem.⁸ To promote positive attitudes towards the importance of following safe procedures in laboratory work, for example, an essay might be set on 'The importance of safety rules for practical work' or a pupil might be asked to talk to the class on the same topic. Dinkele⁹ has remarked upon the value of simulated role-playing exercises in Geography lessons for helping to reveal value systems and philosophies of life. Role-playing exercises have been less important as teaching strategies in science in the last decade, since they are, in many respects, the antithesis of the more fashionable discovery-learning approaches.

Discovery methods can also be important in promoting positive attitudes. This is particularly the case in the sciences, where practical work lends itself to this strategy. In the United States, Charen^{10,11} has described the use of a set of open-ended chemistry experiments produced by the Manufacturing Chemists' Association in developing positive attitudes. He found that the majority of students preferred the open-ended experiments to the traditional 'closed' experiments. The chemistry teachers reported that the MCA experiments were a useful tool in providing motivation and the development of positive scientific attitudes.

⁸Bem, D.J.(1967), 'Self-Perception : An Alternative Interpretation of Cognitive Dissonance Phenomena', Psy.Rev., 74, 188-200.

⁹Dinkele, G., 'The Affective Domain', T.E.S., Jun.11, 1976, p.30.

¹⁰Charen, G.(1963), 'The Effect of Open-Ended Experiments in Chemistry on the Achievement of Certain Objectives in Science Teaching', J.Res.Sci.Teach., 1, 184-190.

¹¹Charen, G.(1966), 'Laboratory Methods Build Attitudes', Sci.Educ., 50, 1, 54-57.

Plewes¹², investigating the attitudes and interests generated by the introduction of the Scottish Integrated Science scheme at a British Forces school in Germany, found that the pupils were largely in favour of discovery methods and that 94% of his sample enjoyed the individual practical work.

However, it should not be assumed that discovery methods are appropriate for all students. Dunham¹³ has shown that for some of the university students he investigated, discovery methods led to confusion, apathy, antagonism and failure. The students performed best in teaching situations where they were directed and organised.

It is possible that the success of a particular teaching style may be related to the personality of the student. Entwistle¹⁴ used scales developed by Eysenck and Cattell to investigate the relationship between introversion/extraversion and academic success at school and university. The results suggested that the style of teaching might affect the relationships between personality and attainment.

Meyer and Penfold¹⁵ in their study of 150 pupils from a large co-educational bilateral school on the fringe of East London offer suggestions about maintaining interest in science. In the first year at secondary school interest is present in most pupils, but needs to be fostered if it is not to deteriorate. They suggest that interest can be

¹²Plewes, J.A.(1975), 'An Attempt to Evaluate Attitudes and Interest Towards the End of a Modern Introductory Course in a British Forces School in Germany', Sch.Sci.Rev., 56, 197, 796-800.

¹³Dunham, J., 'Attitudes and Motivation', in New Movements in the Study and Teaching of Biology, ed. Selmes, C., (London : Temple Smith, 1974), p.244.

¹⁴Entwistle, N.J.(1971), 'Personality and Academic Attainment', Br.J.Ed.Psy., 42, 2, 137.

¹⁵Meyer, G.R. and Penfold, D.M.E.(1961), 'Factors Associated with Interest in Science', Br.J.Ed.Psy., 31, 36.

increased by allowing pupils to work with suitable classmates and that pupils who are encouraged to look up things for themselves will probably become more interested than those who merely receive information from the teacher. This raises the question of the importance of ancillary equipment in promoting affective development.

The Association for Science Education¹⁶ in its policy statement on 'Science and General Education', makes the point that good science teaching makes special demands on supportive provisions. Khan and Weiss¹⁷ comment that "in addition to the teacher and the classroom environment, other major sources of influence on the development of affective behaviours are communication materials (such as textbooks and other software)...."

Pupils will only be motivated to use textbooks which they find attractive. In biology the most successful books tend to have a large format, enabling the use of large diagrams and type. Pages are made attractive by balancing blocks of type with diagrams and photographs. Readability is also an important factor. In a survey of Physics books intended for use with C.S.E. and G.C.E. O-level pupils, Johnson¹⁸ found that the majority required reading ages in excess of the chronological age of the pupil and Carrick¹⁹ has found that similar problems can exist for biology books.

An alternative method of presenting information is programmed learning, which permits a 1:1 ratio between 'instructor' and instructed. Such a desirable ratio can only be achieved for brief periods in a

¹⁶Association for Science Education, Science and General Education, (Hatfield, Herts : A.S.E., 1971), p.4.

¹⁷Khan, S.B. and Weiss, J., op.cit., p.779.

¹⁸Johnson, R.K. (1979), 'Readability', Sch.Sci.Rev., 60, 212, 562-568

¹⁹Carrick, T. (1978), 'Problems of Assessing Readability of Biology Textbooks for First Examinations', J.Biol.Ed., 12, 2, 113-122.

conventional classroom lesson. The apparent absence of the human element, however, may be inhibiting for some pupils. Okunrotifa²⁰ has investigated the effectiveness of programmed learning in Geography for Nigerian secondary school pupils and found that programmes can produce more favourable attitudes towards map reading in Geography than conventional texts.

There is no real substitute, however, for a good teacher, who provides for his pupils a model, that they would wish to emulate. Mace²¹ has stated the simple truth that, "Likings for subjects are often derived from likings for people who teach these subjects."

²⁰Okunrotifa, P.O.(1975), 'Attitudes of Nigerian Secondary School Children to Programmed Instruction in Geography', Educ.Res., 17, 2, 110-114.

²¹Mace, C.A., The Psychology of Study, (Harmondsworth : Penguin, 1968) p.103.

CHAPTER SIX

OFFICIAL STATEMENTS

In the last ten years a number of official bodies with responsibilities for the curriculum in schools, have included statements about the affective domain in their objectives.

In 1970, the Schools Council¹ defined the scientific method, not in terms of a formal set of procedures which can be systematically applied to solve a problem, but in affective terms :

"Methods of inquiry used in science, commonly called "scientific method", are intrinsically elusive and difficult for the layman to grasp. It is a method neither in the sense of a formal procedure nor an infallible prescription; rather, it is a set of attitudes [*italics mine*], springing from the philosophy of the discipline, which provide a basis for action."

To assess whether pupils had developed such a set of attitudes was a declared function of the 'Assessment of Performance Unit' set up by the Department of Education and Science in 1974. The A.P.U.'s terms of reference are to "promote the development of methods of assessing and monitoring the achievement of children at school, and to seek to identify the incidence of under-achievement."² To monitor development in science, two teams have been set up based at the University of Leeds and Chelsea College, University of London. The aim of the teams is to develop assessment instruments which will provide insight into scientific development at eleven, thirteen and fifteen years of age. The teams will

¹Schools Council Bulletin No.3, Changes in School Science Teaching, (London : Evans/Methuen Education, 1970), p.7.

²Department of Education and Science, (1978), 'Assessing the Performance of Pupils, D.E.S. Report on Education, No.93, p.1.

" focus their range of test instruments on the relevant processes and skills such as observation, selection, pattern seeking, explanation (or hypothesis construction), experimentation, communication; and on attitudes to science and its applications [italics mine]; in the context not only of the subject matter commonly dealt with in science but also in other lessons."³

Similar aims are to be found in other subjects. The mathematics team, for example, are developing instruments to assess the "power of generalisation and proof, capacity for investigation and 'creative thought', and attitudes towards and about the subject.... [italics Mine]"⁴

The attitudes that one might expect to find developing in a science student were elaborated in a D.E.S. Consultative Paper⁵ on assessing scientific development. The paper suggests six main qualities :

1. Openmindedness- paying attention to several points of view, considering all evidence, changing one's ideas if evidence is convincing.
2. Self-criticism- appraising one's own work and ideas, pointing out strengths and weaknesses, making suggestions for improvement and acting on them.
3. Independence of Thought- making up one's own mind and producing evidence for one's own judgement.
4. Responsibility- working without supervision, according to the demands of the task; not allowing personal preference to be the criterion of action.
5. Perseverance- persisting despite difficulties, whilst seeing the need to try different ways rather than persist in a fruitless way.
6. Co-operation- working with others, contributing ideas and accepting counter-suggestions and criticism.

³Ibid., p.3.

⁴Marjoram, T., 'Patience Rewarded', T.E.S., October 14, 1977, p.2.

⁵Assessment of Performance Unit, 'Assessment of Scientific Development' D.E.S. Consultative Paper, October 1977.

In addition to measuring these 'scientific attitudes' the monitoring team was also recommended to consider producing assessment items on attitudes towards science, exploring the development of interest, enjoyment and commitment. The main theme of this thesis is to explore the development of interest, enjoyment, commitment and related affective qualities, using a taxonomic approach.

The most recent curriculum development project, which has included the expression of affective objectives is that of the 'Schools Council 18+ Research Programme'.⁶ A number of bodies with strong educational links were commissioned to prepare syllabuses in the main subject areas of science and to include statements of aims and objectives, details of assessment material and procedures.

The Institute of Biology Commissioned Group on biology did not produce an inspiring set of affective objectives and confined itself to the affective aspect of the scientific method already referred to.⁷ Amongst the objectives cited was the need to apply the scientific method to the investigation of biology by :

1. developing a critical approach to all evidence;
2. the recognition and appreciation of patterns and relationships within biology as a whole.⁸

Some of the other groups were more explicit in stating their affective objectives. The Welsh Joint Education Committee Commissioned Group on Physics, for example, referred to the need :

1. To enable students to derive interest, enjoyment and some sense

⁶Schools Council, Schools Council 18+ Research Programme : Studies Based on the N and F Proposals : Report of the Science Syllabus Steering Group to the Joint Examinations Sub-Committee of the Schools Council, (Schools Council, April 1977).

⁷Schools Council Bulletin No.3., loc.cit.

⁸Schools Council, op.cit., Report of the Biology Commissioned Group Based on the Institute of Biology, p.2.

- of achievement from their study of physics.
2. To appreciate the way physics is used to solve practical problems in everyday life.⁹

A similar statement was made by the Association for Science Education Commissioned Group on physics, which has amongst its aims :

1. To create an awareness of the applications of physics and of the influences and consequences of scientific and technical development on society and the environment.
2. To develop an interest in physics as a satisfying intellectual discipline.¹⁰

The fullest statement of affective objectives, however, was given by the Joint Matriculation Board Commissioned Group on chemistry, which devoted a special section to this aspect :

Attitudes, interests and values

Courses developed from the syllabus should help the student to :

1. value chemistry both for its intrinsic value and for its contribution to society;
2. develop and maintain a continuing curiosity and desire to know;
3. enjoy generating knowledge which is new to the student;
4. recognise and conduct honest and unbiased evaluation of data and theories;
5. respect and consider the ideas of others;
6. be flexible and open-minded and willing to seek information;
7. recognise the applications and implications of the chemist's knowledge in society, thereby helping the student to an understanding of life in a technological society;
8. realise that many everyday decisions are at best a compromise between conflicting interests and also that many decisions are necessarily taken on incomplete evidence.¹¹

⁹Schools Council, op.cit., Report of the Physics Commissioned Group based on the Welsh Joint Education Committee, p.2.

¹⁰Schools Council, op.cit., Report of the Physics Commissioned Group based on the Association for Science Education, p.2.

¹¹Schools Council, op.cit., Report of the Chemistry Commissioned Group based on the Joint Matriculation Board., p.3.

PART 2

THE THEORY AND MEASUREMENT OF AFFECTIVE CHARACTERISTICS

CHAPTER SEVEN

THE NATURE OF ATTITUDES

In science there are a number of terms which are common to everyday speech and specialist communication. The word 'fruit', for example, in popular parlance denotes a part of the plant which is fleshy and edible. When the botanist uses the word 'fruit', it encompasses a wider range of structures, which may or may not be fleshy and which may or may not be edible.

The term 'attitude' possesses similar features which have been summarised by Selmes.¹ It was derived from everyday language; it is still shared between the technical language of social scientists and the everyday language of common sense; in both languages it has a long history of useage and has undergone changes in meaning; and it has developed as an interdisciplinary term, equally acceptable to both psychologists and sociologists.

However, unlike most scientific terms, the word 'attitude' is capable of different definitions within different areas of the field of social psychology. Allport² summarised the literature in 1935 and proposed his own definition : "An attitude is a mental and neural state of readiness, organised through experience, exerting a directive or dynamic influence upon the individual's response to all objects and

¹Selmes, C., 'Attitudes Towards Science. The Design, Construction, Validation and Use of an Attitude Scale', (Unpublished Ph.D. thesis, University of Bath, 1971), p.8.

²Allport, G.W., 'Attitudes', in Attitudes and Behaviour, ed. Thomas, K (Harmondsworth, Middlesex : Penguin, 1971), p.17-20.

situations with which it is related." This definition is still highly influential.

A more recent review of definitions by DeFleur and Westie³, places them into one of two categories.

1. Probability conceptions

Definitions within this category tend to emphasise the consistency of attitudinal response. If an individual is presented with an attitude stimulus, it would be possible to predict the subsequent response with a high probability of success.

2. Latent process conceptions

This type of definition extends beyond response consistency and postulates a 'hidden' or 'latent' variable, within the individual, producing particular responses to particular stimuli. Allport's classic definition, quoted above, is of this second type since it refers to an attitude as "exerting a directive or dynamic influence".

It is a fashion amongst social psychologists to produce personal definitions of terms, but such a practice is not desirable since it can introduce difficulties of communication. Brown⁴ has commented that, in general, the study of attitudes is "characterised by diverse theories, complex concepts and, frequently, ill-defined terminology." Khan and Weiss⁵ have attempted to express the communality amongst the various definitions by noting that "attitudes are selectively acquired and integrated through learning and experience; that they are enduring

³DeFleur, M.L. and Westie, F.R., 'Attitude as a Scientific Concept', in Attitudes and Behaviour, ed. Thomas, K., (Harmondsworth, Middlesex : Penguin, 1971), p.295-311.

⁴Brown, S., Attitude Goals in Secondary School Science, (Stirling : Department of Education, University of Stirling, 1976), p.5.

⁵Khan, S.B. and Weiss, J., 'The Teaching Of Affective Responses', in Second Handbook of Research on Teaching, ed. Travers, R.M.W., (Chicago : American Educational Research Association, 1973), p.759-804.

dispositions indicating response consistency; and that positive and negative affect toward a social or psychological object represents the salient characteristic of an attitude."

Components of Attitudes

In general, attitudes can be shown to possess three components :

1. A Cognitive Component.

A person must hold some belief about or have some knowledge of an attitude object. It is clear that a student who does not have the concept of conservation, for example, would not be able to have any attitudes towards conservation.

2. An Affective Component.

A person must have some feeling or emotion towards the attitude object. If the concept of conservation does not raise any feelings or emotions in the student, then no attitudes will have been formed.

3. A Behavioural Component.

A person must be predisposed to respond in a particular way to an attitude object. Thus a student may seek to inform himself about conservation matters by reading books on the topic or, alternatively, a student may deliberately avoid books on conservation.

Triandis⁶ has claimed that any behaviour can be conceived as involving a certain amount of seeking or avoiding contact and a certain amount of positive or negative affect, as shown in Figure 2.

⁶Triandis, H.C., Attitude and Attitude Change, (New York : John Wiley, 1971), p.12.

	POSITIVE AFFECT	NEGATIVE AFFECT
SEEK CONTACT	Going toward	Going against
AVOID CONTACT	Revering	Going away

Fig.2. The two main dimensions of behaviour.
(Modified from Triandis)

Properties of Attitudes

Among the many complex properties inherent in attitudes it is possible to describe two, which are of major importance. These are the direction of the attitude and its degree of centrality.

1. Direction of the attitude.

By 'direction' of an attitude, is meant whether the feelings and emotions towards the attitude object can be described as positive or negative. If positive, the attitude object would engender feelings of pleasure and gratification and the person would be predisposed to seek some kind of contact with it. If negative, the attitude object would engender feelings of displeasure and frustration, which would lead to avoidance.

In the present study a Likert scale technique is used to measure attitude direction. The subject is asked to respond to an attitude statement by marking a position on a scale, from which the attitude direction can be immediately inferred.

STRONGLY DISAGREE	DISAGREE	UNCERTAIN	AGREE	STRONGLY AGREE
-------------------	----------	-----------	-------	----------------

Fig.3. An attitude continuum indicating attitude direction.

2. Centrality of the attitude object

The centrality of the attitude object is a measure of the importance of the attitude object to the individual. Objects

that confront the person frequently are likely to show a high degree of centrality and more remote objects a lower degree of centrality. Thus a person preparing for an examination should show a high degree of centrality for attitude to study and a lower degree of centrality for, say, attitudes to the fortunes of the local football club.

The centrality of an attitude object for the individual has important implications for attitude formation and stability. Newcomb, Turner and Converse⁷ state that "the general rule is that we are more likely to form attitudes towards objects that have some centrality for us, and are less likely to form attitudes towards objects that are peripheral or psychologically remote."

Functions of Attitudes

Perhaps the most influential recent study of attitude functions is that of Katz⁸, who ascribes them to four classes.

1. The instrumental, adjustive or utilitarian function.

This function describes the tendency to maximize the rewards in the external environment and to minimize the penalties. This class is the first to be developed by the child, who develops favourable attitudes toward objects that support his needs and unfavourable attitudes toward those that oppose them. Objects thus attain a utilitarian status, in the sense that they are associated with success or failure in satisfying needs. The behavioural component is reflected in the development of approach

⁷Newcomb, T.M., Turner, R.H. and Converse, P.E., Social Psychology, rev.edn, (London : Routledge and Kegan Paul, 1966), p.61.

⁸Katz, D.(1960), 'The Functional Approach to the Study of Attitudes', Pub.Opin.Quart., 24, 163-204.

and avoidance habits.

2. The ego-defensive function.

Many attitudes are directed towards the defence of a person's self-image as he attempts to protect himself from seeing basic truths about himself or the realities of the external world.

A student who has been brought up as a fundamentalist Christian may, for example, have strong negative attitudes towards a study of the theory of evolution.

3. The knowledge function.

The individual needs to be able to perceive stability, organisation and structure in the world or it would appear to be chaotic. Knowledge and related attitudes help to provide standards and frames of reference for understanding the world.

4. The value-expressive function.

Attitudes may be the vehicle by which an individual reveals his values and self-identity to others. In so doing, the person derives a measure of satisfaction, since he is able to control the projection of a positive self-image.

Attitudes and the Affective Domain

In the present study an attempt is made to measure the developmental stage reached by further education students in the affective domain as delineated by Krathwohl, Bloom and Masia.⁹ The domain encompasses not only attitudes, but other constructs such as interests and values. These terms suffer from the same problems of definition as do attitudes and throughout this work the suggestions of Krathwohl, Bloom and Masia will be used.

⁹see page 69.

Stanley and Hopkins¹⁰ have adapted a diagram from Krathwohl, et.al., to show the relationship between the meaning of common affective terms and the affective domain. It is reproduced as Figure 4.

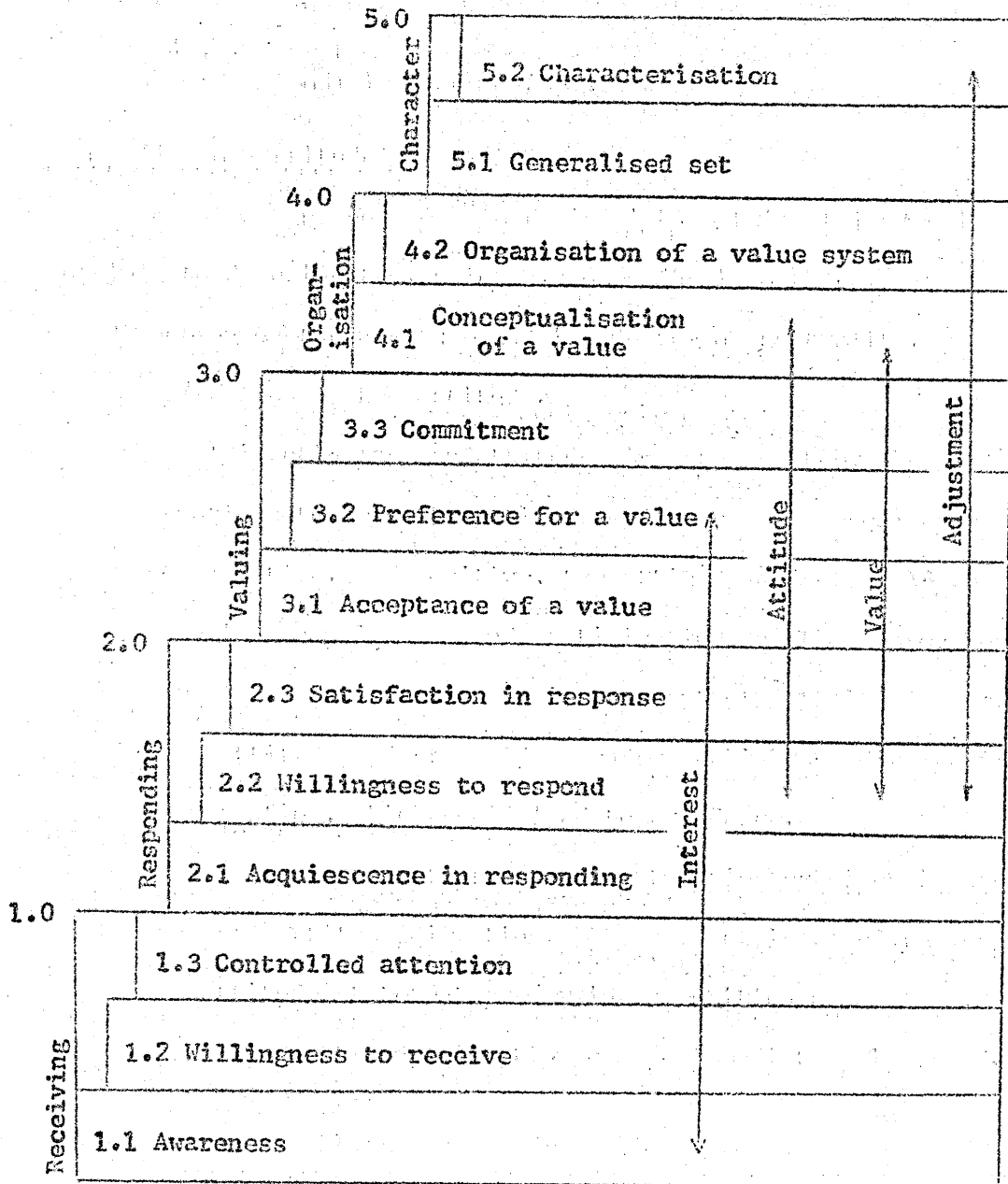


Fig.4. The range of meaning of common affective terms as defined by the taxonomy of educational objectives. (Adapted from Stanley and Hopkins)

¹⁰Stanley, J.C. and Hopkins, K.D., Educational and Psychological Measurement and evaluation, (New Jersey : Prentice-Hall, 1972), p.283.

CHAPTER EIGHT

THE IMPORTANCE OF ATTITUDES

Education should be concerned with the affective, cognitive and psychomotor development of pupils. However, whereas cognitive and psychomotor skills are usually developed within the highly structured framework of a curriculum, affective development is often allowed to happen consequentially. It is a central tenet of this present study that affective development should be accorded a similar status to cognitive and psychomotor development within the curriculum of the school and that affective objectives should be pursued in a systematic manner.

The importance of attitudes is stated simply but potently by Allen¹:

"Pupils must be willing as well as able if we are to expect them to succeed in school work. Whether they are willing or not depends a lot on their attitude to school work; putting it bluntly, on whether they are favourably inclined or not.

Why should it matter so much whether pupils are favourably inclined? The answer is that of the two things, ability and willingness, willingness is what you can do more about. And it is remarkable how able people become once they are willing. If pupils have wrong attitudes, this can easily persist, anyway, until you do do something about it. Putting it another way, a reason for studying attitudes is that you can give the customer what he wants. In business this is essential. In education it is not very different."

For older adolescents, exemplified by students in further and higher education, there is evidence of the importance of positive attitudes in academic achievement. Vernon² has said that "a g-factor

¹Allen, E.A., 'A New Look at Adolescents' Attitudes to School', in The Psychology of Adolescence. Nine Lectures. (Swansea : Faculty of Education, University College of Swansea, 1966), p.7.

²Vernon, P.E., The Measurement of Abilities, 2nd edn., (London : University of London Press, 1956), p.146.

can still be extracted from their mental test results, but it seems to play a decreasingly important part in educational or vocational achievement, and interests, work attitudes, and temperamental traits become more influential."

More recently, Rowntree³ has examined the correlations between G.C.E. A-level results and success in final university examinations. He has found that less than eleven percent of variance in university success can be explained by variation in academic achievement at the time of entry and that "perhaps such factors as personality and motivation may have as much or more influence in higher education."

However, attitudes should not merely be seen as a possible factor in cognitive success but should be prized in their own right. Any educational establishment, which attaches no importance to the development of positive interests, attitudes and values, does its students a disservice.

³Rowntree, D., Assessing Students. How Shall we Know Them?, (London : Harper and Row, 1977), p.17.

CHAPTER NINE

ATTITUDE ACQUISITION AND CHANGE

Few social psychologists would hold the view that we are born with attitudes or that they may be attributed to physiological maturation.¹ Rather, attitudes are acquired or learnt.

Soon after birth an infant is capable of making affective responses in the sense that it will approach objects, persons and situations that provide interest or amusement and avoid objects, persons and situations that appear threatening.² By the time the child enters school it will therefore have acquired a repertoire of attitudes, some educationally and socially desirable and some undesirable. One of the roles of the school should be to strengthen desirable attitudes, reduce the strength of undesirable attitudes and provide an appropriate environment for the development of new, positive attitudes. Such a process should occur throughout the education of the individual, but if it is to be effective it should be properly structured. Khan and Weiss³ make a clear statement of the case :

"The belief that a student will develop positive attitudes towards subject matter, school, education, the teacher and others just by coming to school and interacting with the curriculum materials,

¹McGuire, W.J., 'Innate and Physiological Aspects of Attitudes', in Attitudes, ed. Warren, N. and Jahoda, M., 2nd. edn., (Harmondsworth, Middlesex : Penguin Books, 1973), p.49-58.

²see page 45.

³Khan, S.B. and Weiss, J., 'The Teaching of Affective Responses', in Second Handbook of Research on Teaching, ed. Travers, R.M.W., (Chicago : American Educational Research Association, 1973), p.760.

other students, etc., is an untenable assumption.....If desirable affective goals are to be realised as a result of the educational process, relevant formal learning situations have to be developed and systematically appraised."

The development of attitude to learning is discussed in a separate chapter.⁴ The remainder of this chapter is devoted to the theoretical basis of attitude acquisition and change.

9.1 Attitude Acquisition

Allport⁵ has postulated four conditions for the formation of attitudes :

1. Attitudes are developed from the accumulation and integration of the experiences of childhood. Thus the child builds up a pattern of approach and avoidance tendencies. By this method the child may gradually develop a strong liking for biology say, but a dislike for geography.
2. Attitudes may be developed through differentiation. A child who has a general dislike of practical investigations in biology, may, over a period of time, refine his attitude and just have a dislike of those investigations which use live animals. The attitude has become more specific as the individual has matured.
3. Attitudes may be formed in response to a single dramatic or traumatic experience. If the child experiences revulsion on seeing an animal dissected, this may develop into an aversion for all biological investigations.
4. Attitudes may be adopted ready-made from others by imitation or identification. Children may model their affective responses on

⁴ see page 58.

⁵Allport, G.W., 'Attitudes', in A Handbook of Social Psychology, ed. Murchison, C., (Worcester, Mass. : Clarke University Press, 1935), p.810-812.

their parents, teachers and friends. Although this places a strong responsibility on the teacher to portray the standard of behaviour expected of his pupils, Wright⁶ found, in a study of secondary modern school adolescents, that parents were more influential models than teachers. Figure 5 shows how pupils rated themselves relative to their teachers, parents and 'ideal self'.

Teachers -----> Me -----> Parents -----> Ideal Self

Fig.5. Pupils' rating of three figures relative to 'ideal self'.
(Adapted from Wright).

Two further suggestions have been made by Dunham.⁷

5. Attitudes may be formed as a result of behaviour being reinforced by appropriate rewards and punishment. If a desired response is reinforced by rewards when it is made, the behaviour of the pupil can gradually be shaped in a specified direction. Controlled use of verbal praise can, for example, act as strong reinforcement.

6. Attitudes may be developed in the pupils' search for self-identity.⁸ Thus if a pupil is consistently given classwork beyond his conceptual level, this may lead to the self-concept 'I am no good at biology', and lead to avoidance behaviour.

Attitudes have cognitive, affective and behavioural or conative components.⁹ Generally the cognitive and affective components are acquired as a result of some direct experience with the attitude object,

⁶Wright, D.S., (1962), 'A Comparative Study of the Adolescent's Concepts of his Parents and Teachers', Educ.Rev., 14, 226-232.

⁷Dunham, J., 'Attitudes and Motivation', in New Movements in the Study and Teaching of Biology, ed. Selmes, C. (London : Temple Smith, 1974), p.234-246.

⁸see page 46.

⁹see page 43.

whereas the behavioural component is learned as a result of interaction with people, who bear some relevance to the attitude object.

9.2 Attitude Change

Students enter schools and colleges with a vast repertoire of attitudes, some desirable and some not. Part of the affective education of the student therefore becomes concerned not so much with the development of new attitudes as with the modification of existing ones and the elimination of undesirable ones.

Of the many theories in social psychology on how attitudes change, the most firmly established is the 'Theory of Cognitive Dissonance' developed by Festinger.¹⁰ Attitude change depends generally on the receipt of new information, which to the holder of the attitude is relevant to the attitude object. Compared with the cognitive components of attitudes already held, the new information may be consonant, dissonant or irrelevant. If the new information is dissonant with respect to an attitude already held, then the individual will experience a 'tension' or 'frustration', which will motivate him to reduce the dissonance. The magnitude of the dissonance is a function of the following variables :

1. The centrality of the attitude object for the holder.¹¹

Dissonant information is less likely to create tension if it relates to an attitude of low centrality for the holder.

Dissonance is greatest for attitude objects which have a high degree of centrality for the holder or are related to the self-identity of the holder.

¹⁰Festinger, L., A Theory of Cognitive Dissonance, (Stanford : Stanford University Press, 1957)

¹¹see page 44.

2. The ratio of consonant to dissonant elements.

If an individual is presented with an array of information relating to an attitude object, the amount of dissonance will be a function of the ratio of dissonant to consonant elements.

3. The communality of the elements represented by each cognition.

More dissonance would be created, for example, if a student had to choose between studying biology or chemistry than if he had to choose between animal or plant biology.

Supposing that a student experienced dissonance as a result of exposure to new information, there are three main ways in which this may be reduced.

1. By changing one or more of the elements involved in the dissonant relationship.
2. By seeking further information which is consonant with the attitude held.
3. By decreasing the importance of the dissonant elements.

The theory has many corollaries of importance to education. One of these is forced compliance or coercion. Suppose, for example, that a student is averse to animal dissection. If forced to perform a dissection by the teacher dissonance is created. The student may rationalise 'I don't agree with what I am doing, but I am justified in behaving this way because they are forcing me', which has the effect of diminishing the dissonance and thus the likelihood of attitude change.

With respect to the methodology of attitude change, Hovland, Janis and Kelley¹² suggest that three elements are important. These are :

¹²Hovland, C.I., Janis, I.L. and Kelley, H.H., 'A Summary of Experimental Studies of Opinion Change', in Attitudes, ed. Warren, N. and Jahoda, M., 2nd. edn., (Harmondsworth, Middlesex : Penguin Books, 1973), p.115-128.

1. The Communicator.
2. The Communication.
3. The Audience.

To these may be added the 'channel' through which the communication is delivered.¹³

The Communicator

The characteristics of the person wishing to bring about the attitude change are an important variable in achieving the change. The usual characteristics mentioned in the literature are the expertise, or competence of the communicator and his credibility. Hovland, et.al.¹⁴ have investigated the importance of the credibility of the source and present four main results :

1. Communications attributed to low credibility sources tended to be considered more biased and unfair in presentation than identical ones attributed to high credibility sources.
2. High credibility sources had a substantially greater immediate impact on the audiences opinions than low credibility sources.
3. The positive effect of high and negative effect of low credibility sources tended to disappear after a few weeks.

Triandis¹⁵ has tried to analyse the characteristics of the source, which determine the assessment of credibility and proposes five main variables. Sources may differ in the degree of competence or expertise shown towards the subject. They differ in their degree of familiarity.

¹³Triandis, H.C., Attitude and Attitude Change, (New York : John Wiley, 1971), p.145.

¹⁴Hovland, et.al., op.cit., p.115-116.

¹⁵Triandis, H.C., op.cit., Ch.VII.

Sources differ in their attractiveness (appearance and personality). In certain situations sources may show hostility. Finally, sources differ in the extent of their power of persuasion.

The Communication

Communication techniques are very important in bringing about attitude change. Some of the more important strategies are mentioned below :

1. Fear appeal followed by reassurance.

If one wished to develop positive attitudes towards laboratory safety, for instance, one might induce a mild state of fear about laboratory accidents followed by reassurance that no accident would occur if laboratory safety rules were always followed.

Mild fear appeals are more effective than severe ones, where reassurance may not counteract the initial effect.

2. Conclusion drawing.

When dealing with complex issues it is better to be explicit about conclusions. With less complicated issues, however, the individual is best left to draw his own conclusions.

3. Pleasant communications first.

If the pleasant elements of the communication are presented first the individual is reinforced for listening to the subsequent elements.

4. One or two sides of an issue.

In general, if the individual is intelligent and likely to favour the position advocated, it is best to present both sides of an argument. Otherwise it is best to present only information supporting the position advocated.

The Audience

The student has attitudes which relate to him as an individual

together with attitudes which are related to his membership of a specific group, eg. biology class. It is generally easier to change attitudes which are held as an individual than attitudes held by virtue of group membership. In the latter case the attitudes of the group as a whole must be changed.

It is, for example, more difficult to help students who have a poor attitude to work if the class they belong to has a poor attitude to work, than if they were working as individuals and did not belong to such a class.

The Channel

Generally, face-to-face communications are most likely to be effective in bringing about attitude change. They allow the source to monitor the progress being made and adapt if necessary. The audience also has the opportunity to freely question the source and open dialogue is possible.

Other channels, such as television and films, do not usually allow free dialogue but can provide strong visual persuasion. For example, local television news films on the gassing of badgers on Dartmoor, shown in the summer of 1979, did more to develop negative attitudes towards the method, than a long period of discussion.

A combination of visual presentation and face-to-face communication provides a very potent opportunity for bringing about attitude change.

CHAPTER TEN

DEVELOPING ATTITUDE TO LEARNING

"We [the inspectorate] see the common curriculum as a body of skills, concepts, attitudes and knowledge, to be pursued, to a depth appropriate to their ability, by all pupils in the compulsory years of secondary education....."¹

"Above all, the [social] objectives must be realised through the general ethos of the school, through the nature of the personal relationships in the classroom, through a match between the aims of the school and its organisation and through the daily example of all adults with whom the pupils are in contact. Attitudes cannot be taught, but teachers who are both caring and challenging, tolerant of error but consistent in setting high standards, and skilful in getting pupils to participate in their learning, will, whatever their specialisms, substantially contribute to all the social objectives that are a proper part of education."²

The above statements are taken from a recent working paper of Her Majesty's Inspectorate and represent explicitly the view that attitude development is an appropriate concern of the secondary school curriculum. One of the early curricula to include attitude objectives was the Scottish Education Department's 'Curriculum Paper 7'³, which has been studied extensively by Brown.⁴

¹Department of Education and Science, Curriculum 11-16, Working Papers by H.M. Inspectorate : a Contribution to the Current Debate, (London : H.M.S.O., 1977), p.6.

²Ibid., p.13.

³Scottish Education Department, Consultative Committee on the Curriculum, Curriculum Paper 7 : Science for General Education, (Edinburgh : H.M.S.O., 1969).

⁴Brown, S.A., Attitude Goals in Secondary School Science, (Stirling : Department of Education, University of Stirling, 1976).

Having recognised that it is a proper concern of education to assist in the affective development of students, it is necessary to express such aims in operational form. In this respect, the most important guidelines have been suggested by Mager⁵ and the following exposition is largely based on his work.

In order to assess the attitude of a student, it is necessary to use a parameter based on visible behaviour. Such a parameter may be to 'approach' or 'avoid' particular subject matter. Thus a student with positive attitudes to biology would tend to display 'subject matter approach tendency', whereas a student with negative attitudes would show 'subject matter aversion tendency'. A suitable teaching objective would therefore be to ensure that for each student, the frequency of approach responses made would be at least as great as when the student first joined the class. Indications of approach tendencies can be a good record of attendance and punctuality in biology lessons, belonging to a biology club, asking questions in class, seeking advice about opportunities in biology, etc. Aversion tendencies are recognised by poor attendance and punctuality, failure to hand work in on time, claiming disinterest in the subject, etc. Once aversive patterns of behaviour develop they are extremely difficult to reverse.

Whenever contact with the subject is followed by positive consequences, the subject will act as a stimulus for further approach responses. Similarly, if contact with the subject causes, or threatens to cause, physical or mental discomfort, or a loss of self-respect or dignity, then the student is likely to develop avoidance responses.

There are a number of aversions which are universal, in the sense

⁵Mager, R.F., Developing Attitude to Learning, (Belmont, California : Fearon, 1968).

that they do not just relate to specific subjects but to any educational contact. They include pain, fear and anxiety, frustration, humiliation and embarrassment, boredom and physical discomfort. To take just one example, frustration may be caused by presenting information beyond the conceptual ability of the student⁶; presenting information too quickly; speaking too quietly to be heard; providing badly duplicated material; providing an obscure text; not answering students' questions; not relating tests to classwork; not returning work promptly, etc. The key to correcting this problem is to develop awareness in the teacher, that certain poor practices are likely to lead to student aversion.

In contrast, universal positives lead to stimulation and approach. Examples would include pacing work relative to the students' ability; acknowledging correct or incorrect responses as attempts to learn; respecting the student as an individual; using motion, colour, contrast, variety and personal reference in lessons; expressing genuine delight when the student succeeds. As before, the key to the development of approach tendencies is awareness and deliberation on the part of the teacher. Stones and Anderson⁷ suggest that an appropriate behavioural objective for courses in teacher education would be : "At the end of the course the student will be committed to an approach to teaching based on the general principles of educational psychology."

In Science Education it is necessary to go one stage beyond developing attitude to learning, for potential science students need to

⁶Shayer, M. (1974), 'Conceptual Demands in the Nuffield O-level Biology Course', S.S.R., 195, 56, 381-388. Shayer claims that for many biology topics, the time of presentation is inappropriate to the level of conceptual development of the child.

⁷Stones, E. and Anderson, D., Educational Objectives and the Teaching of Educational Psychology, (London : Methuen, 1972), p.160.

cultivate, in addition, attitudes that are appropriate to science as a process. Such attitudes include curiosity, rationality, suspended judgement, open-mindedness, critical-mindedness, objectivity, honesty and humility.⁸

Curiosity is a desire to find explanations. Properly channelled it can act as a stimulus to enquiry and is strongly motivational. The Nuffield Science schemes, developed in the 1960's, sought to emphasise this particular aspect. In the preface to the Nuffield Biology O-level scheme, a number of aims are given, one of which is "to develop an attitude of curiosity and enquiry."⁹ The Nuffield Advanced Biology scheme proclaims similar aims. The emphasis is on "learning rather than being taught, on understanding rather than amassing information, on finding out rather than being told...."¹⁰ However, curiosity is learned and the teacher must be particularly careful not to allow the demands on time and energy, associated with curious students, to lead to its repression.

Rationality is the application of reason and logic to explain phenomena. It must stem from a belief that natural phenomena have a non-mythical explanation, which can be discovered by controlled experimentation and disciplined reasoning.

Willingness to suspend judgement implies that judgements should not be made impulsively but only after all available evidence has been

⁸Haney, R.E. (1964), 'The Development of Scientific Attitudes', The Science Teacher, Dec. 1964, 33-35.

⁹Nuffield Foundation, Nuffield Biology Teachers' Guide 1, Introducing Living Things, (Harmondsworth, Middlesex : Penguin Books, 1966), p. ix-x.

¹⁰Nuffield Foundation, Nuffield Advanced Science, Teachers' Guide to the Study Guide : Evidence and Deduction in Biological Science, (Harmondsworth, Middlesex : Penguin Books, 1970), p. vii.

gathered. Although students may be used to drawing 'conclusions' at the end of single experiments, they should realise that, in reality, evidence can only be substantiated after an exhaustive programme of experimentation.

Open-mindedness is a willingness to consider all available evidence and interpretations of a phenomenon before forming an opinion. It also calls for a willingness to revise an opinion in the light of fresh evidence and embodies the concept that knowledge is not static, but is capable of refinement and modification.

Critical-mindedness refers to the necessity to challenge the authenticity of the evidence and interpretations, before allowing them to form a part of the students' own strategies. In the classroom critical-mindedness can be developed by encouraging students to ask questions of the "How do you know?" type and by providing evidence for the generalisations made in lessons.

Objectivity involves removing personal and emotional factors from the scientific process to the extent that the same evidence and interpretations could be obtained by any other individual with a different set of personal traits. Although all students and scientists have personalities, these play no part directly in providing explanations for phenomena.

Intellectual honesty involves accepting observations at their face value, whether or not they fulfill expectations. It involves the presentation of all evidence for a phenomenon, rather than a selected portion which fits a favoured explanation. In the classroom it means that the teacher should reward the students for an honest record of data, regardless of whether the data fulfill the teaching aim or not. Indeed the investigation of 'wrong' answers can be rewarding.

Finally, humility is a desirable attitude. In this context it is used to mean the ability to recognise both personal limitations and the

limitations of science. It embodies a willingness to work for the common good rather than for personal glory.

The eight attitude traits discussed could be called 'attitudes of scientists' and as such are different in kind to the 'attitudes towards science', which form the main theme of the present study. In the context of the taxonomy of the affective domain¹¹ 'attitudes of scientists' fit into the higher level categories of valuing, organisation and characterisation. At the lowest level they imply 'acceptance of a value' and at the highest level 'characterisation'.

¹¹ see page 69

CHAPTER ELEVEN

A TAXONOMIC APPROACH

It is of little use, for diagnostic purposes, to specify a range of educational objectives and outcomes, unless there exists some underlying pattern or rationale to relate them. The search for patterns is very much a part of the process of science and is no less worthwhile an activity in the field of education.

In biology, a very high-level pattern is represented in a structure of relationships called a 'taxonomy'. In such a classification objects are not merely assigned to a particular category, but the categories are themselves related in an hierarchical sense. Thus in Figure 6, item 'A' is assigned to Category One, which forms a subset of Category Two, which in turn forms a subset of Category Three.

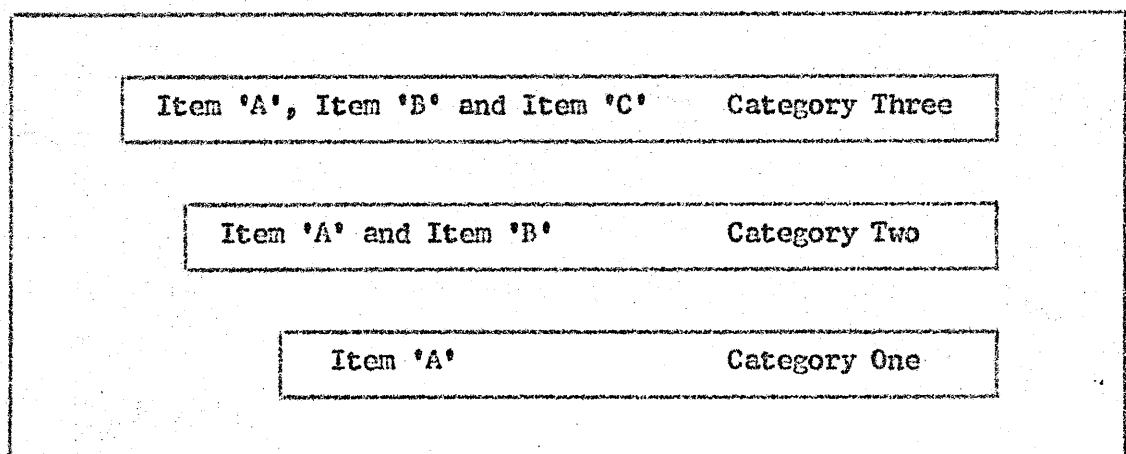


Fig.6. The nature of the taxonomic hierarchy.

It is possible to apply such taxonomic models to the main areas or domains of educational interest, namely the affective, cognitive and psychomotor. The first model for the classification of educational

goals in the cognitive domain was published by a committee of American college and university examiners under the editorship of Bloom, in 1956.¹ Eight years later, the same principles were applied to the affective domain.² More recently, a taxonomy of the psychomotor domain has been put forward by Harrow.³

11.1 The Cognitive Domain

The cognitive domain represents the field of knowledge and the development of intellectual abilities and skills. The majority of activities within schools and colleges relates to this domain. Bloom⁴ has proposed a model with six major classes ;

1.00 Knowledge

2.00 Comprehension

3.00 Application

4.00 Analysis

5.00 Synthesis

6.00 Evaluation

Knowledge : This is the basic level on which all others depend. It involves the recall or bringing to mind of facts, methods processes, etc.

Comprehension : This is the lowest level of understanding and involves, at a simple level, the translation, interpretation and extrapolation of information.

¹Bloom, B.S., ed., Taxonomy of Educational Objectives. Book 1 ; Cognitive Domain, (New York : McKay, 1956).

²Krathwohl, D.R., Bloom, B.S. and Masia, B.B., Taxonomy of Educational Objectives. Book 2 : Affective Domain, (New York : McKay, 1964)

³Harrow, A.J., A Taxonomy of the Psychomotor Domain, (New York : McKay, 1972).

⁴Bloom, B.S., loc.cit.

- Application : This is the ability to apply concepts and generalisations to new, practical or unfamiliar situations.
- Analysis : This is the ability to identify the elements of a structured whole.
- Synthesis : This is the ability to construct a novel structure or pattern from basic elements and parts.
- Evaluation : This is the ability to make judgements about the value or accuracy of presented materials against specified criteria.

Metfessel, Michael and Kirsner⁵ have suggested a scheme for translating the taxonomy into behavioural terms by supplying lists of infinitives and direct objects relating to each subdivision of the taxonomy.

It is now the practice of a number of C.S.E. and G.C.E. examination boards and the Technician Education Council (TEC) to include lists of 'Aims and Objectives' with their syllabi. These objectives will fit the appropriate subdivisions of the taxonomy. At the ordinary level of the General Certificate in Education in biology, for example, the University of London Schools Examinations Board include the following cognitive objectives for the syllabus⁶ :

1. To develop an understanding of basic biological principles based upon an elementary knowledge of living organisms. [Knowledge].
2. To recognise the interrelationships between various areas of

⁵Metfessel, N.S., Michael, W.B. and Kirsner, D.A. (1969), 'Instrumentation of Bloom's and Krathwohl's Taxonomies for the Writing of Educational Objectives, Psychology in the Schools, 6, 3, 227-231.

⁶University of London, General Certificate in Education Examination : Regulations and Syllabuses : June 1981 and January 1982, (London : University of London, 1979), p.67-68.

biology and, in particular, the relationship between structure and function. [Comprehension].

At the advanced level of the General Certificate in Education higher level cognitive abilities are stressed. Amongst the objectives of the A-level Biology syllabus for the University of London Schools Examinations Board are⁷ :

1. The knowledge and application of important biological facts and principles. [Application].
2. The ability to assess and critically evaluate scientific information and to present coherent and logical written arguments. [Evaluation].

In the last decade curriculum innovators have become very practised at expressing cognitive objectives in precise behavioural terms and this has spurred the development of equally sophisticated assessment techniques, which enable the measurement of cognitive curriculum objectives with great precision.

11.2 The Psychomotor Domain

The psychomotor domain represents the field of observable voluntary human motion. Harrow⁸ asserts the importance of the domain by claiming that "movement is incorporated in all life and is actually a pre-requisite for life.....The educator understands that all behaviour involves movement of some type, internal and external.....all behaviours delve into the cognitive areas to some degree and since man is a gregarious animal, many of his observable behaviours are modified by his affective self."

⁷Ibid., p.78.

⁸Harrow, A.J., op.cit., p.14.

The model proposes six levels of classification :

- 1.00 Reflex movements
- 2.00 Basic-Fundamental movements
- 3.00 Perceptual abilities
- 4.00 Physical abilities
- 5.00 Skilled movements
- 6.00 Non-discursive communication

Reflex movements : Reflex movements or actions are elicited in response to a stimulus without conscious volition. They are functional at birth and develop through maturation. Although not voluntary, they are the precursors of voluntary movement.

Basic-Fundamental movements : These occur during the first year of life and are built on a foundation of reflex movements. They include visual tracking, grasping, manipulating, crawling, walking. Some develop innately, others are taught.

Perceptual abilities : These are the abilities to receive a stimulus, process it in the higher brain centres and bring about an appropriate movement response. It includes visual, auditory, kinaesthetic and tactile discrimination as well as eye-hand and eye-foot co-ordination.

Physical abilities : These are an important part of the foundation for the development of skilled movements and can be limiting factors to the development of highly skilled movement.

They include endurance, strength, flexibility and agility.

Skilled movements

: These are complex movements involving a high degree of efficiency. They include sports, dance, recreational and manipulative skills.

Non-discursive communication

: This is communication by means of movement and may range from facial expressions, postures, and gestures to highly complex dance routines.

Because motor movements constitute behaviours, no additional step is needed for translating objectives in this taxonomy into behavioural terms. It is already fully operationalised.

11.3 The Affective Domain

The affective domain represents the field of interests, attitudes, values and adjustment. The model proposed by Krathwohl et.al.⁹ contains five classification levels, each divided into sub-levels, as shown in Figure 7 (overleaf).

Since the affective domain forms the basis of the present work, it will be discussed in more detail.

Receiving (attending)

This level consists of three sub-levels :

- 1.1 Awareness
- 1.2 Willingness to receive
- 1.3 Controlled or selected attention

Awareness is the lowest affective state and simply implies that the

⁹Krathwohl, D.R., Bloom, B.S. and Masia, B.B., loc.cit.

CATEGORY	SUBDIVISION
1.00	Receiving(attending) 1.1 Awareness 1.2 Willingness to receive 1.3 Controlled or selected attention
2.00	Responding 2.1 Acquiescence in responding 2.2 Willingness to respond 2.3 Satisfaction in response
3.00	Valuing 3.1 Acceptance of a value 3.2 Preference for a value 3.3 Commitment
4.00	Organisation 4.1 Conceptualisation of a value 4.2 Organisation of a value system
5.00	Characterisation by a value or value complex 5.1 Generalised set 5.2 Characterisation

Fig.7. Subdivisions of the affective domain.

student is conscious or aware of a situation, phenomenon or object. Unless the student is, for example, aware of biology as a field of knowledge or enquiry, he can have no feelings towards it.

The next stage is willingness to receive, in which the student is prepared to take notice of a phenomenon and give it his attention. The physiological basis of attention forms an important area of enquiry in experimental psychology.

Treisman¹⁰ and Moray¹¹ have each suggested a list of distinct subdivisions of the concept, which include :

1. Mental concentration - the subject tries to exclude all incoming stimuli, which might interfere with the performance of a specified task.
2. Vigilance - nothing is happening, but the observer is paying attention in the hope of detecting some event when it does happen.
3. Search - a set of signals is presented and the observer hunts for a sub-set or single signal.
4. Activation - preparing to deal with whatever happens next-"Sit up and pay attention".
5. Expectation - the subject is set to receive particular stimuli.

All of these definitions include some flavour of the taxonomic meaning of the term.

The highest state within this first level is 'Controlled or selected attention', in which the student is prepared to attend to a relevant stimulus despite the presence of distractant stimuli. The phenomenon has been called 'The Cocktail Party Problem', signifying the difficulty of following two concurrent conversations.¹² In the classroom there will be many distractant stimuli ranging from the physical environment (eg.the

¹⁰Treisman, A., 'Human Attention', in New Horizons in Psychology 1, ed. Foss, B.M., (Harmondsworth, Middlesex : Penguin Books, 1966), p.97-117

¹¹Moray, N., Attention. Selective Processes in Vision and Hearing, (London : Hutchinsen, 1969).

¹²Treisman, A., op.cit., p.101.

view out of the window) to the sociological environment (eg. the behaviour of another student). Broadbent¹³ has suggested a filter model of selective attention. The body receives through its sense organs a variety of stimuli, one of which is selected or 'filtered' for response. The non selected stimuli are stored in a short-term memory for a few seconds before they are degraded. Experiments show that it takes one sixth of a second to change attention from one stimulus to another. It seems that the filter has a built in bias to select signals that change or are novel. The response will wane if the same stimulus is repeatedly presented (habituation), but will be restored if some quality of the stimulus is varied slightly (dishabituation).

Responding

This level represents a graded series of behaviours, which begin with acquiescence in the sense of compliance. The student will respond in order to acquiesce with an instruction or suggestion from the teacher, rather than having generated the response independently.

The next stage, 'willingness to respond', involves the students in voluntary responses, which come from within. The responses are made because the student wishes to make them and not because they are prompted by a third party. Willingness to respond implies that two-way communication has been established between student and teacher. The student does not merely act as a passive receiver of instruction, but becomes involved in dialogue. Once this process has begun, the student is able to gain pleasure or satisfaction from participation and this is defined in the third stage, 'satisfaction in response'.

¹³Broadbent, D.E., Perception and Communication, (Oxford : Pergamon Press, 1958).

'Satisfaction in Response' forms an important landmark in affective development. It should be the aim of all teachers to structure their courses in such a way that all students are able to gain satisfaction in responding to their subjects. Only when students have reached this stage can they make an informed choice about continuing to follow a particular subject. After leaving school or college, students are unlikely to seek further contact with a subject unless they have reached this stage.

Teachers should also be aware that for many students, 'satisfaction in response' is the highest level of affective development likely to be reached in their particular subject, for the next level of the taxonomy is concerned with the development of values. If students are following a pattern of general education, with subjects drawn from the sciences and humanities, then if they develop a set of values related to their science studies, it is unlikely that the same level of affective development will be reached in the humanities. Teachers who do not understand, or accept, this view often vent their frustrations about students who have not developed a commitment to their particular subject and may regard themselves as failing. It should be appreciated that, before specialisation takes place, only a few students in a particular subject class, will continue their level of affective development beyond the level of 'Responding'.

Valuing

Students who do proceed to the level of 'valuing' will be recognised firstly by their acceptance of values associated with a particular subject. They will have developed a set of beliefs which indicate that they attach some degree of importance to the subject. Further development will indicate that they have come to express some preference for the subject's values. The final stage of 'commitment' is reached

when the student consistently adopts the subject's values for himself. He may seek to convince others of the validity of his value system.

A type of student likely to become committed to science has been described by Box and Ford¹⁴ as a marginal student. This is a person who has biographical roots in one social world, but who currently operates in another. An example would be a working class student who finds himself in the predominantly middle class social milieu of the university. This can lead to hostility, isolation and a crisis of identity, which causes the student to seek a new ego-identity enabling him to re-integrate. One such ego-identity is that of the dedicated scientist. In a study of 83 freshers and 139 finals or doctorate candidates in three English university chemistry departments, Box and Ford reach the conclusion that in the case of the working class chemistry students, the most attractive available role in which the individual can become immersed is that of the dedicated scientist. They propose that for such students the process of professional socialisation may be understood as a response to marginality.¹⁵

Organisation and Characterisation

The final two levels of the taxonomy represent an increasing internalisation of values until finally they form a philosophy of life which characterises the individual completely. Whilst it might be considered the legitimate concern of education to assist students to reach the stage of commitment, the higher levels, which involve the organisation of values and characterisation, are much more sensitive

¹⁴Box, S. and Ford, J. (1967), 'Commitment to Science : A Solution to Student Marginality?', Sociology, 1, 225-238.

¹⁵Ibid., p.234.

areas and deeply personal. They would not generally be part of the formal aims of an educational curriculum.

As with the cognitive domain, Metfessel, Michael and Kirsner¹⁶ have provided a list of infinitives and direct objects which enable the affective domain levels to be translated into behavioural terms.

An influential attempt to take the affective taxonomy and make it operational has been made by Klopfer.¹⁷ He has developed a series of specifications for science education, which come under the main headings of knowledge and comprehension, processes of scientific enquiry, application of scientific knowledge and methods, manual skills, attitudes and interests, and orientation.

The 'Attitudes and Interests' group has six subdivisions :

1. Manifestation of favourable attitudes toward science and scientists.
2. Acceptance of scientific inquiry as a way of thought.
3. Adoption of 'scientific attitudes'.
4. Enjoyment of science learning experiences.
5. Development of interests in science and science-related activities.
6. Development of interest in pursuing a career in science.

Examples of items which test each subdivision are presented.¹⁸ They embrace a variety of different testing techniques such as the Likert scale, semantic differential, equal appearing intervals scale and forced choice questionnaire.

¹⁶Metfessel, N.S., Michael, W.B. and Kirsner, D.A., loc.cit.

¹⁷Klopfer, L.E., 'Evaluation and Learning in Science' in Handbook of Formative and Summative Evaluation of Student Learning, ed. Bloom, B.S., Hastings, J.T. and Madaus, G.F., (New York : McGraw-Hill, 1971), p.559-641.

¹⁸Ibid., 618-623

CHAPTER TWELVE

AFFECTIVE AND COGNITIVE RELATIONSHIPS

Traditionally, formal schooling has been concerned with the pursuit of academic excellence and assessment procedures have been directed to cognitive outcomes. Indeed, by using objective tests, particularly of the multiple choice type, it is possible to make measurements of the cognitive development of students to a high degree of precision.

Despite this strong cognitive component in the curriculum, schools have also declared affective objectives and in the last century schools purported to train for character development, leadership, etc.¹ However, affective education has often been regarded merely as a corollary of cognitive education and usually no serious attempts to assess the affective progress of students have been made. Stanley and Hopkins² comment that "the appraisal of feelings, interests and attitudes has been grossly neglected in education, even though affective objectives are implicit, if not explicit, in every educational endeavor."

Affective development is important in its own right. It should not be seen as a poor sideshoot of a cognitive curriculum. When students finish their formal education, they will have developed not only cognitive skills but also opinions, attitudes, interests and values. In a plea for General Science to be taught as a compulsory subject to all

¹Mathews, J.C., 'The Assessment of Attitudes', in Techniques and Problems of Assessment, ed. Mackintosh, H.G., (London : Arnold, 1973), p.174.

²Stanley, J.C. and Hopkins, K.D., Educational and Psychological Measurement and Evaluation, (New Jersey : Prentice-Hall, 1972), p.301.

secondary school pupils, Hall³ draws attention to the fact that most pupils will not use their scientific knowledge or laboratory skills after leaving school. They could, though, have developed a set of attitudes towards explaining phenomena that can be used in their work, leisure, cultural and family lives.

Although it is claimed that affective education does not depend on cognitive education for its justification, certain relationships do exist between the two domains. Attitudes can, for example, distort reasoning. Thistlethwaite⁴ constructed a number of short deductive items based on emotive topics such as sex roles, ethnic attitudes and nationalistic attitudes. Subjects were asked to state whether or not the items were logically consistent. It was found that items with strongly emotive statements were less likely to engender objective reasoning than items with a content judged to be emotively neutral.

Rubin⁵ also claims that feelings condition cognitive thought and that by adding an affective dimension to the present, cognitively orientated curriculum, learning can be enhanced so that feelings support, rather than distort, thinking skills.

Considering the topic from a different viewpoint, it is equally clear that affective development is conditioned by cognitions. Attitudes have a cognitive component.⁶ Rosenberg⁷ has stated that "when a person

³Hall, W.C.(1969), 'General Science to O-level', S.S.R., 51, 175, 433-437.

⁴Thistlethwaite, F.(1950), 'Attitude and Structure as Factors in the Distortion of Reasoning', J.Ab.Soc.Psy., 45, 442-458.

⁵Rubin, L.ed., Facts and Feelings in the Classroom, (London : Ward Lock, 1973).

⁶see page 43.

⁷Rosenberg, M.J.(1956), 'Cognitive Structure and Attitudinal Affect', J.Ab.Soc.Psy., 53, 367-372.

has a relatively stable tendency to respond to a given object with either positive or negative affect, such a tendency is accompanied by a cognitive structure made up of beliefs about the potentialities of that object for attaining or blocking the realisation of valued states."

Because of the pre-eminence of cognitive objectives in the curriculum, numerous investigations have been made of the importance of attitudes in determining cognitive success. The present study is also concerned with this problem. So far, no clear pattern is shown by research studies. Khan and Weiss⁸ give examples of studies showing significant correlation coefficients between affective and achievement tests, but point out that other workers have found no such correlations. Brown⁹ also states that although some researchers have found significant correlations, others have found that cognitive learning is unrelated or only weakly related to affective learning.

One study which suggested that affective development could be used to predict scientific achievement was conducted by Angus¹⁰ and has already been discussed.

Selmes¹¹ found that students who had passed three O-level science subjects had higher attitude to science scores than students with no O-level science subjects.

Some studies, notably those of Laughton and Wilkinson¹² and Schock¹³

⁸Khan, S.P. and Weiss, J., 'The Teaching of Affective Responses', in Second Handbook of Research on Teaching, ed. Travers, R.M.W., (Chicago : American Educational Research Association, 1973), p.794.

⁹Brown, S.A., Attitude Goals in Secondary School Science, (Stirling: Department of Education, University of Stirling, 1976), p.10.

¹⁰see page 21.

¹¹Selmes, C., Attitudes Towards Science. The Design, Construction, Validation and Use of an Attitude Scale, (Unpublished Ph.D. thesis, University of Bath, 1971), p.118.

¹²Laughton, W.H. and Wilkinson, W.J. (1968), 'Pupils' Attitudes to Science Teaching', Educ. in Sci., Feb. 1968, 31-33.

provide evidence that, whilst cognitive development improves during secondary education, affective development deteriorates. Pupils usually start their secondary education with a high level of curiosity and interest in the subjects they study. Unless it is carefully nurtured, however, this interest can gradually disappear. Figure 8, adapted from Schock, shows the proposed relationship between cognitive and affective development at the three main phases of formal schooling.

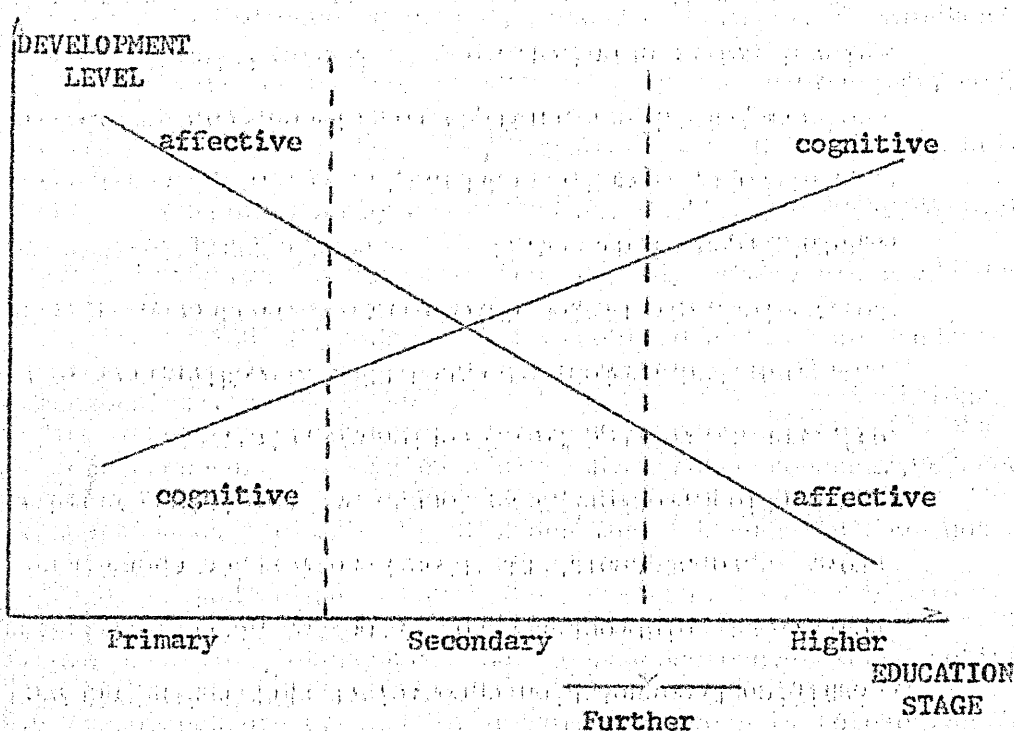


Fig.8. Proposed cognitive-affective development relationship.
(adapted from Schock¹⁴)

In primary school, pupils are interested and eager to learn even though they are at a low cognitive state of development, whereas in further and higher education students have reached a high state of cognitive development, yet may have lost their initial interest and

¹³Schock, N.H. (1973), 'An Analysis of the Relationship which Exists Between Cognitive and Affective Educational Objectives', J.Res.Sci.Teach., 10, 4 299-315.

¹⁴Ibid., p. 314.

enthusiasm for the subject.

Cognitive and affective development must be seen as essentially complimentary. The question is not whether we should teach for cognitive or affective objectives, but how we can best promote the cognitive and affective development of the student. Bell¹⁵ cites the paradox of the excellent mathematician, whose poor attitudes prevent his knowledge from being effectively applied. An equally dismal failure is represented by a pupil with an excellent positive attitude towards mathematics, but a very poor knowledge.

The goals of education are concerned with the development of the total person. Rubin¹⁶ has stated that "we are complex creatures, who, in seeking to satisfy our urges, are driven in part by our reason and knowledge, and in part by our passions, anxieties and our convictions as to what in life is important and unimportant." As educationalists, we fail if we emphasise one to the detriment of the other.

¹⁵Bell, A., 'A Consideration of Objectives', T.E.S., Nov.28, 1977, p.17.

¹⁶Rubin, L., op.cit., p.29.

PART 3

SURVEY OF THE AFFECTIVE DEVELOPMENT OF FURTHER
EDUCATION STUDENTS IN THE BIOLOGICAL SCIENCES.

RELATIONSHIP TO ACADEMIC SUCCESS

CHAPTER THIRTEEN

ATTITUDE MEASUREMENT

Observation of the overt behaviours of students is rarely a satisfactory method of discerning attitudes. Zinberg¹ used anthropological techniques to study the attitudes of staff and first-year students in the chemistry department of an English University. As well as questionnaires and interviews, the method of participant observation was used. However, such methods can lead to misinterpretation and are not yet sufficiently well developed for general use.

Various alternative methods are available and include :

Essays

Semantic differential

Projective techniques

Teachers' ratings

Rating scales

1. Essays

This technique has the advantage that it is simple to prepare and administer. The teacher asks students to write, for example, an open-ended essay giving their views about science.

The information obtained can be interesting and useful. However, it is extremely difficult to obtain any objective measurements of attitudes, for it is impossible to devise a rigorous marking scheme.

¹Zinberg, D.(1971), 'The Widening Gap : Attitudes of First Year Students and Staff Towards Chemistry, Science Careers and Commitment', Sci.Stud., 1, 287-313.

2. Semantic Differential

This is a form of rating scale developed by Osgood, Suci and Tannenbaum.² The student is presented with a word or statement representing an attitude object, followed by several bipolar adjectives lying at the ends of a five or seven point scale. An example is given in Figure 9.

<u>Experiments involving dissection</u>	
Good	Bad
Interesting	Dull
Cruel	Kind

Fig. 9. Example of an item from a semantic differential instrument.

The responses may be subjected to factor analysis and the three factors, evaluation, potency and activity are frequently identified.

The theoretical framework of the semantic differential has been extended by Kelly³ and others in the repertory grid technique, where respondents supply, under guidance, their own bipolar adjectives.

3. Projective Techniques

Projective techniques involve a relatively unstructured task, with open responses. The respondent is not aware of the interpretation that will be placed on the responses, which can reveal covert, latent or

²Osgood, C.E., Suci, G.J. and Tannenbaum, P.H., The Measurement of Meaning, (Urbana, Ill. : University of Illinois Press, 1957)

³Kelly, G.A., The Psychology of Personal Constructs, (New York : Norton, 1955)

unconscious affects. The technique is particularly useful in personality research.

Two of the best known instruments are the Rorschach Inkblots Test and the Thematic Apperception Test. In the former, the respondent is shown a series of ten inkblots and is asked what each one could represent. In the latter, which is more structured, the respondent is shown a series of picture cards and is asked to make up a story about each one, stressing what the characters think and feel.

4. Teachers' Ratings

The teacher rates the attitudes of the student on a suitable scale, eg. Excellent, Good, Average, Fair, Poor. Difficulties arise from the teacher's willingness to rate honestly and conscientiously and from his ability to rate consistently and correctly.⁴ Generally, where the technique has been used in educational research, as for example by Brown⁵, there has been a poor correspondence between teacher ratings and the students' own assessments of their attitudes.

5. Rating Scales

Of a number of rating scales which have been developed, two of the most influential in educational research are Differential Scales and Summated Rating Scales.

⁴Thorndike, R.L. and Hagen, E.P., Measurement and Evaluation in Psychology and Education, 3rd edn., (New York : Wiley, 1969), p.424-436.

⁵Brown, S.A., Attitude Goals in Secondary School Science, (Stirling: Department of Education, University of Stirling, 1976), p.59-60.

A. Differential Scales (Thurstone-Type)^{6,7,8}

The aim of this technique is to produce a scale with equal appearing intervals. A large number of attitude statements are devised and given to a group of people, who are asked to act as judges. Each judge is asked to imagine a rating scale with eleven equal intervals and to assign each statement to a scale position. Items are rejected if the spread of scale positions from different judges is too large. Each suitable item is given a scale value, which is the mean or median of the judges' ratings.

Respondents are asked to select items which most closely resemble their own attitudes and receive a score, which is the mean of the selected item scores.

In practice, a differential scale involves a lot of preparative work and it is often difficult to find an adequate panel of judges.

B. Summated Rating Scales (Likert-Type)^{9,10,11}

This is the type of scale used in the present study and so will be described in greater detail. The aim of the technique is to produce a scale which is unidimensional, i.e. a scale in which all of the items measure the same dimension. To eliminate the need for judges, as

⁶Gardner, P.L.(1975), 'Attitudes to Science : A Review', Stud.Sci, Educ., 2, 4-5.

⁷Oppenheim, A.N., Questionnaire Design and Attitude Measurement, (London : Heinemann, 1966), p.125-133.

⁸Burroughs, G.E.R., Design and Analysis in Educational Research, 2nd edn., (Birmingham : School of Education, University of Birmingham, 1975), p.120-124.

⁹Gardner, P.L., op.cit., p.5-7.

¹⁰Oppenheim, A.N., op.cit., p.133-142.

¹¹Burroughs, G.E.R., op.cit., p.118-120 and 123.

required in the production of a differential scale, the respondents place themselves on an attitude continuum for each attitude statement. The continuum is usually divided into five positions ranging from strongly agree to strongly disagree, although more or fewer positions may be used. Each position is given a weighting and the respondent's score is the sum of the weightings for all items. To accommodate statements phrased unfavourably, the direction of the weighting can be reversed. Statements reflecting neutral attitudes, which are acceptable on a differential scale, are of no value in a summated rating scale. The items are most useful when they elicit responses at the extremities of the attitude continuum.

The reliability of Likert scales is often better than corresponding differential scales, because of the greater range of answers. The number of items in a scale is arbitrary and may be small. Less preparative work is involved in producing a summated rating scale than a differential scale.

A major drawback of summated rating scales is their lack of reproducibility, in the sense that the same score may be obtained in different ways. Two students with the same total score, may have very different attitude response patterns. The scale is normally used, therefore, to measure attitudes of groups and attitude change.

Chanan¹² has challenged the use of attitude scales on philosophical grounds, claiming that they have an analogy with bad teaching techniques. Determination of the terms on which the interaction takes place is one-sided and the respondent is only allowed to make forced choices. However, the scale is not designed to be educative to the respondent and any interaction, other than that permitted, would be such as to reduce the

¹²Chanan, G., 'Science or Ideology?', T.E.S., 5.3.1976, p.21.

objectivity and thus validity of the instrument.

Techniques of measurement in the affective domain are different in kind to those in the cognitive domain. Cognitive measures usually represent an attempt to assess the maximum performance of the student, whereas affective measures attempt to reflect typical performance.¹³ The difference is between what a student can do and what he does do. Thus in a cognitive test the student can fake lower scores than those which represent his true attainment but not higher scores, whereas in affective tests it is possible to fake scores in either direction.

There are a variety of types of faking on affective measures, which produce atypical scores. These are called response sets.

Response Set

This is the conscious or unconscious tendency in a student to respond to a questionnaire in such a way as to show himself in a good light by making responses he believes to be socially desirable or by making responses he believes will impress the investigator.

Some respondents will acquiesce and produce agreement responses to all items, regardless of content. Others show a tendency to centrality and in an effort to be absolutely fair about each item, always choose a response close to the middle of the scale.

All such responses obscure the true state of attitude development. One can never be sure, when administering an affective test, that respondents will not show some degree of response set. It can be reduced by earning the confidence of respondents and administering the

¹³Stanley, J.C. and Hopkins, K.D., Educational and Psychological Measurement and Evaluation, (New York : Prentice-Hall, 1972), p.282.

test in such a way that they see no incentive to be untruthful.

Recently, Gardner¹⁴ has written a critique of some research in attitude measurement. He has found a number of instruments with scales that lack any discernable underlying theoretical construct, together with scales in which various theoretical constructs are confounded.

In the present work it is suggested that a taxonomic approach to affective development forms a valid theoretical construct. In such an approach, the different levels of the taxonomic hierarchy form discreet unidimensional variables, each of which can form the basis of a sub-scale of an instrument designed to measure affective development.

¹⁴Gardner, P.L.(1975), 'Attitude Measurement : A Critique of Some Recent Research', Educ.Res., 17, 2, 101-109.

CHAPTER FOURTEEN

INTRODUCTION TO THE SURVEY

The survey was made in circumstances which differed from those normally encountered in educational research. It was conducted in a single Further Education College, where the author was employed as a full-time lecturer. The schools, which sent students to the college, were predominantly selective and the majority of students were from a secondary modern school background. The catchment area was semi-rural, with limited opportunities for employment in science-based industry.

The decision to use a single college was made on practical grounds. The survey was not funded and was conducted by the author alone. A larger survey would have required a prohibitive investment of time and funds. However, any disadvantage in using a single establishment was partly offset by the fact that the author, being an employee, was immersed in the social milieu of the college. Such an advantage is not often enjoyed in educational research, for surveys are usually conducted by educational researchers from external establishments.

CHAPTER FIFTEEN

PILOT SURVEY

15.1 Development of the Affective Instrument

It was decided that the most appropriate method of obtaining data would be to devise a summated rating scale of the 'Likert' type. This would enable an instrument to be designed as a collection of sub-scales, each possessing a high degree of unidimensionality.¹

Each item on a Likert-type scale should elicit a favourable or unfavourable reaction to the attitude object being studied. The response, which on a five-choice scale would commonly be Strongly Agree/Agree/Uncertain/Disagree/Strongly Disagree, is given a weighting so that the respondent's score is the sum of the weightings for all items on a particular sub-scale.

The sub-scales were designed to correspond to the first three categories of the affective domain² together with a section on career attitudes. The categories and subdivisions of the affective domain are given in Figure 7.³

It was felt that at Category 1.0(Receiving), the subdivision 1.1 (Awareness) was not amenable to assessment by means of a questionnaire

¹Oppenheim, A.N., Questionnaire Design and Attitude Measurement, (London : Heinemann, 1966), p.133.

²Krathwohl, D.R., Bloom, B.S. and Masia, B.B., Taxonomy of Educational Objectives, Handbook II : Affective Domain, (New York : David McKay Co., 1964), p.95

³see page 70.

and was thus omitted. At this early stage in the development of the instrument, it was also felt that Category 3.0 (Valuing) could only be assessed in general terms and that the higher categories were not suitable for assessment by means of a self-rating questionnaire. Such a conclusion was also reached by Lewy⁴, who noted that difficulties were encountered in formulating test items to measure the higher levels of internalisation.

For each of the sub-scales, items were devised to be as simple as possible and therefore to have a high degree of face validity. By constant reference to the Taxonomy of Educational Objectives⁵ and to biology colleagues, items were devised which, it was hoped, would imbue the instrument with a high degree of content validity. This method was used successfully by Lewy⁶, who commented that it was necessary to have a high degree of agreement in the classification of affective test items if the taxonomy was to be employed practically "for without such a consensus, communication in terms of its categories will not be possible."

In an attempt to reduce 'response set', in which the respondent may try to answer all of the items with a consistently favourable (or unfavourable) response, some of the items were worded to give maximum weighting for an agreement response, whilst others were given a maximum weighting for a disagreement response.

The final instrument contained fifty questions distributed as follows :

⁴Lewy, A.(1968), 'The Empirical Validity of Major Properties of a Taxonomy of Affective Educational Objectives', J.Exp.Educ., 36, 3, 76.

⁵Krathwohl, D.R., Bloom, B.S. and Masia, B.B. ,loc.cit.

⁶Lewy, A., op.cit., p.72.

Affective subdivision	Subscale	No. of questions
1.2	Willing to receive	7
1.3	Selected attention	8
2.1	Acquiescence in response	6
2.2	Willing to respond	11
2.3	Satisfaction in response	7
3.0	Valuing	7
C	Career attitudes	4
Total		50

Figure 10. Distribution of questions in the pilot instrument.

The questions forming each sub-scale are given in Appendix 1.

In order to further reduce response set within each sub-scale, the question sequence was scrambled using a random number table. The final form of the instrument consisting of fifty questions, with no differentiation into sub-scales is given in Appendix 2.

A score sheet was prepared (Appendix 3) for the respondents to record their answers on and transparent templates were prepared, to overlay the score sheets, for subsequent scoring of the sub-scales.

15.2 Administration of the Affective Instrument

The instrument was administered to all of the full time students taking biological sciences in the first and second years of an advanced-level G.C.E. course at the college. The first year students had entered the course only one week previously, whilst the second year students were just embarking on their final year of study.

The questionnaire was administered by the author. The nature and purpose of the study was explained to the respondents in an effort to

reduce anxiety and gain the correct level of motivation. It was particularly important, since the author was a member of staff at the college, to give assurances about the confidentiality of the responses.

The questions were read to the students to prevent the possibility of cross-referencing. Each question was read out twice and students were given ample time to circle their responses on the score sheet.

Each session extended over a period of about forty-five minutes. Details of dates and numbers of students are given in Figure 11.

Year	Subject	No. of Respondents	Date of Test
First	Biology	8	24 Sept. 1975
First	Botany and Zoology	6	24 Sept. 1975
Second	Biology	14	15 Sept. 1975
Second	Botany and Zoology	4	17 Sept. 1975

Fig.11. Administrative details for the pilot study.

Each group was retested using the same protocol approximately five months later in order to calculate test-retest reliability coefficients.

15.3 Analysis of the Affective Instrument

The answer sheets were scored by awarding points as follows :

Strongly agree	- 5 points
Agree	- 4 points
Uncertain	- 3 points
Disagree	- 2 points
Strongly disagree	- 1 point

In the case of items which had been framed for a disagreement response, the scoring was reversed.

Each item was given an 'Index of Favourability', which was

calculated as the sum of the actual scores obtained by respondents, divided by the maximum possible score obtainable if all respondents had chosen a 'Strongly agree' response. For items requiring a disagreement response, the scoring was reversed. The index was quoted as a percentage.

For each of the two A-level year groups, the frequency of response to each item and the 'Index of Favourability' was recorded. Figure 12 shows the format of a typical record card.

Qu. 16						Subdivision 2.3
<u>I enjoy talking about biological problems with people</u>						
Second Year. Tested 15.9.75	A(5)	B(4)	C(3)	D(2)	E(1)	
	6	8	2	2	0	frequency
	33%	45%	11%	11%		
Index of Favourability = $\frac{72}{90}$ raw = 80%						
First Year. Tested 24.9.75	A(5)	B(4)	C(3)	D(2)	E(1)	
	0	4	8	1	1	frequency
		29%	57%	7%	7%	
Index of Favourability = $\frac{43}{70}$ raw = 61%						

Figure 12. A typical item analysis record card.

Record cards were prepared for all items.

The Favourability Indices for each item are given in Appendix 4, together with Pearson product moment correlation coefficients for the first and second year groups within each sub-scale. With the exception of the sub-scales 'Willing to Receive' and 'Career Attitudes', the coefficients of correlation are high and significant at a minimum level

of $p < 0.05$. Thus large proportions of the variance in second year scores can, for most sub-scales, be explained by variance in first year scores.

The mean Favourability Indices for each sub-scale are given in Table 1.

Subscale	Favourability Index	
	First Year	Second Year
1.2	78.5	86.2
1.3	50.1	62.3
2.1	86.4	85.7
2.2	72.6	73.9
2.3	77.8	84.0
3.0	77.8	81.3
C	66.1	70.3
<u>Total</u>	72.8	77.3

Product moment correlation coefficient, $r = 0.95$ ($p < 0.01$)

Table 1. Indices of Favourability for pilot study.

A number of interesting features emerge from this table. The first is the high correlation coefficient, indicating that ninety percent of the variance in the second year indices can be explained by variance in the first year indices. The second is that for all sub-scales except 2.1 (Acquiescence in response) and for the total average index, the second year students have produced higher favourability indices than the first year students. Within the limited framework of the pilot study this gave grounds for cautious optimism that the instrument was capable of detecting affective development between the first and second year of the A-level biology course.

15.4 Reliability of the Affective Instrument

Two sources of variation in performance that will tend to reduce the precision of a particular score as a description of an individual are :

1. Variation in response to the test at a particular moment in time.
2. Variation in the individual from time to time.⁷

A test-retest reliability coefficient can be used to indicate the size of these sources of variation. Consequently, the first and second year groups were retested with the same instrument after approximately twenty weeks, on 25.2.1976 and 29.2.1976 respectively.

The coefficients obtained were as follows :

First Year Group $r_{tt} = 0.85$

Second Year Group $r_{tt} = 0.99$

Both of these figures can be considered highly satisfactory. The second year group showed a surprisingly high level of stability over the twenty week period, but these affects had been built up over the previous twelve months at the college. One might expect a smaller degree of stability in the scores of the first year students, since the first test was taken before they had been exposed to the rigour of A-level study, whilst the retest was taken after they had settled in to an A-level work pattern.

⁷Thorndike, R.L. and Hagen, E.P., Measurement and Evaluation in Psychology and Education, 3rd edn., (New York : Wiley, 1969), p.181.

CHAPTER SIXTEEN

THE AFFECTIVE SURVEY

16.1 Development of the Second Affective Instrument

From the experience gained with the pilot study, it was decided to restructure and improve the Affective Instrument in order to meet the following criteria :

1. In order to detect affective development prior to the A-level stage and to increase the number of students in the survey, it was decided to produce an instrument suitable for use with both O-level and A-level students. To this end it was necessary to make the style of some of the questions easier.
2. The questions would be framed to be as appropriate to students who were not studying biology as to those who were, since the former would be used as a control group.
3. There was a need to try to extend the area tested in the higher levels of the domain, to subdivisions 3.1, 3.2 and 3.3¹. A greater confidence was achieved, after experience with the pilot instrument, that these levels were suitable for assessment by a self-rating questionnaire technique.
4. The sub-scales needed to be more balanced in terms of numbers of items.
5. It was found to be difficult to frame some of the items for a disagreement response, since it often tended to make the

¹see page 70.

statement sound cumbersome or ambiguous. The proportion of such items would remain the same as in the pilot instrument.

6. The final instrument, consisting of seventy items, would be produced in the form of a booklet.

As with the pilot instrument, the new items were discussed with biology colleagues before incorporation into the instrument, thus maintaining high face validity. Ten questions were used for each of the subdivisions 1.2 to 3.1. Producing items for subdivisions 3.2 and 3.3 proved more difficult and so only five items were included for each.

The final series of questions, together with indications of agreement or disagreement responses, are given in Appendix 5. The questions were then collected into a booklet, together with an introduction to the project and a set of instructions on the recording of responses on the answer sheet. The booklet is reproduced as Appendix 6.

A score sheet was prepared (Appendix 7) together with a set of transparent overlays to act as scoring templates.

16.2 Administration of the Second Affective Instrument

The larger numbers of students involved in the survey over two years of college intake meant that a uniform method of data collection had to be devised. The large survey size also meant that it was not possible for the author personally to supervise the gathering of data from every group. In order to achieve this uniformity two strategies were adopted :

1. A questionnaire booklet was prepared to replace the verbal presentation of the questions. This ensured that the introduction to the project and information on how to fill in the score sheet

would be the same for all respondents. The method also removes the variable of voice intonation as a factor in causing response bias.

2. A small number of interested teachers agreed to assist with data collection. They were briefed individually about developing rapport and provided with notes to remind them of the procedure to be followed. (Appendix 8)

After the collection of data, all materials were returned to the author for collation.

16.3 The Survey

The questionnaire was administered to students taking a biological science at the college, together with a small control group of non-biologists. Although students were given the choice not to participate, no-one exercised this option, thus giving a one hundred percent response rate. However the survey does not include students who may have been absent on the date the questionnaire was administered.

The distribution of students in the survey, by course, is given in Figure 13.(overleaf)

16.4 Description of Courses Used in the Survey

Human biology and biology(O-level)

Human biology and biology are offered in a list of subjects, from which all full time students select five to study for one year.

Science Pre-Entry

This is a course offering five O-levels - Biology, Chemistry, English Language, Mathematics, Physics - together with the City and Guilds of London Institute 'Science Laboratory Technicians(C.& G. 733) Part 1 Examination'. It is intended for students who show a strong

Course	G.C.E. Level	Number
Human Biology	O	59
Biology	O	32
Science Pre-Entry	O	34
Home Economics Pre-Entry	O	15
Pre-Nursing	O	70
Non Biologists(control)	O	26
Biology(Year 1)	A	18
Biology(Year 2)	A	14
Botany/Zoology(Year 1)	A	9
Botany/Zoology(Year 2)	A	9
<u>Total</u>		<u>286</u>

Fig.13. Distribution of students in survey by course.

vocational bias towards the sciences.

Home Economics Pre-Entry

This is a practically based course offering O-levels in English Language, Human Biology, Nutrition and Cookery; The Royal Society of Health Food Handling Certificate; St. John's First Aid, Child Care and Nursing Certificates.

Non-Biologists(Control)

These were the residue of full time O-level students, who had not chosen a biological science from the list of options.

Biology(A-level)

This subject may be selected from a list, offered to full time students on a two-year course.

Botany/Zoology(A-level)

These two subjects, usually taken together, may be selected from a list offered to full time students on a two-year course. They would be selected by students with a definite vocational bias towards the biological sciences.

The distribution of students taking a biological science, by gender, is given in Figure 14.

G.C.E. Level	Female	Male
O	138(66%)	72(34%)
A	28(56%)	22(44%)

Fig.14. Distribution of students taking a biological science, by gender.

The large imbalance in favour of females, at O-level, is largely due to the Home Economics Pre-Entry and Pre-Nursing courses, which attract very few males. If the full time O-level course is considered alone the sexes are almost evenly balanced at forty-four males and forty-seven females.

The dates of administration of the questionnaire are given in Figure 15.(overleaf)

Course	1976	1977
Human Biology(6)	8. Oct.	17. Oct.
Biology(0)	8. Oct.	20. Oct.
Science Pre-Entry(0)	5. Oct.	19. Oct.
Home Economics Pre-Entry(0)		18. Oct.
Pre-Nursing(0)	14. Oct.	21. Oct.
Non-Biologists(0)	8. Oct.	
Biology Year 1(A)		28. Oct.
Biology Year 2(A)		4. Nov.
Botany/Zoology Year 1(A)		19. Oct.
Botany/Zoology Year 2(A)		20. Oct.

Fig. 15. Dates of administration of the second affective instrument.

CHAPTER SEVENTEEN

COGNITIVE VARIABLES

In addition to the affective data collected, four cognitive variables were recorded for each respondent. The first three variables were determined as part of the procedure of application to full time courses at the college and were placed at the disposal of the author.

1. Figure Reasoning Test(Daniels)

This is a thirty minute test giving a mean quotient of one hundred and a standard deviation of fifteen. It is designed to measure Spearman's general ability(g) factor.

2. Graded Arithmetic-Mathematics Test(Vernon)

This is a twenty minute test of seventy-five items graded for degree of difficulty. The test score is converted into a 'Mathematics Age' by use of the formula :

$$\text{Mathematics Age} = 6 + \frac{2 \times \text{Test score}}{10}$$

3. Mill Hill Vocabulary Scale, Form 1 Senior

This is a test of approximately fifteen minutes duration. Candidates are required to write down the meaning of thirty-four words and to select the synonym, from a choice of six words, for a further thirty-four words.

The raw scores are converted into test scores as indicated in Figure 16.

Raw Score	Test Score
<20	V-
20-23	V
24-25	V+
26-30	IV
31-32	IV+
33-35	III-
36-39	III
40-44	III+
45-47	II-
48-50	II
51-55	II+
>56	I

Fig.16. Conversion of raw scores into test scores on the Mill Hill vocabulary scale.

4. Sessional Examination Mark

Each course had a series of internal examinations held shortly before the end of the session. Because the tests were set by different teachers and had different marking schemes, the means and standard deviations for each group varied. The marks for each group were therefore converted into normalised T scores, using the graphical method described by Guilford and Fruchter¹, to give a mean of fifty and a standard deviation of ten.

¹Guilford, J.P. and Fruchter, B., Fundamental Statistics in Psychology and Education, 5th edn., (New York : McGraw-Hill, 1973), p.468.

CHAPTER EIGHTEEN

ANALYSIS OF THE AFFECTIVE INSTRUMENT

18.1 Introduction

The data collected over the two years was used for :

1. Analysis of individual respondents.
2. Analysis of specific courses with a biological component.
3. Analysis of each question in the instrument.
4. Multiple correlation analysis.

18.2 Analysis of Individual Respondents

For each student, the scores for each sub-scale were expressed as a percentage of the maximum scores that could be obtained for that sub-scale. Each percentage score thus relates directly to the Likert weighting as shown in Figure 17.

Likert Weighting	Percentage	Interpretation
5	100	Strongly agree
	90	Tend to strongly agree
4	80	Agree
	70	Uncertain with tendency to agree
3	60	Uncertain
	50	Uncertain with tendency to disagree
2	40	Disagree
	30	Tend to strongly disagree
1	20	Strongly disagree

Fig.17. Relationship of Likert weighting, percentage score and interpretation.

Percentage scores were obtained for each questionnaire section, which relate to the subdivisions of the affective taxonomy as indicated by Figure 18.

Questionnaire Section	Taxonomy Subdivision	Description
1	1.2	Willing to receive
2	1.3	Selective attention
3	2.1	Acquiescence in response
4	2.2	Willing to respond
5	2.3	Satisfaction in response
6	3.1	Acceptance of a value
7	3.2	Preference for a value
8	3.3	Commitment

Fig.18. Relationship of questionnaire sections to taxonomy subdivisions.

For each student in the survey a data sheet was kept with the following information :

1. Scores from standardised tests obtained on application to full time college courses.¹
2. Examination passes for the Certificate of Secondary Education and the General Certificate in Education in a biological science and/or general science, obtained by the student prior to joining a full time college course.
3. The raw mark obtained in college end of session examinations and the normalised T score derived from it.²

¹see page 103.

²see page 104.

4. The percentage scores obtained for each section of the affective instrument.
5. An 'Affective Profile' of the student obtained by graphing the percentage scores on the ordinate and the questionnaire section on the abscissa.

A specimen data sheet is given in Appendix 9.

18.3 Affective Profile

The affective profile is a device for providing a visual representation of the respondent's percentage score for each subdivision of the taxonomy. It is easier to interpret quickly than a rank of numbers.

A percentage score of sixty may be taken as a datum point, since it represents a balance between a positive and negative response to each subdivision of the taxonomy. Respondents with scores over sixty percent have shown a net positive response to a particular subdivision, whilst respondents with scores below sixty percent have shown a net negative response.

Used together with the standardised cognitive data, the affective profile can provide a useful extra dimension in predicting how a prospective student is likely to cope with a study of the biological sciences. The normalised T scores, obtained in the college sessional examinations, provide an indication of cognitive ability after one year's work in the biological sciences. It is important to recall that the affective profiles appertain to the affective state of the student at the start of the course.

The properties of the Affective Profiles are illustrated below in a number of case studies. The students' names have been omitted to preserve anonymity.

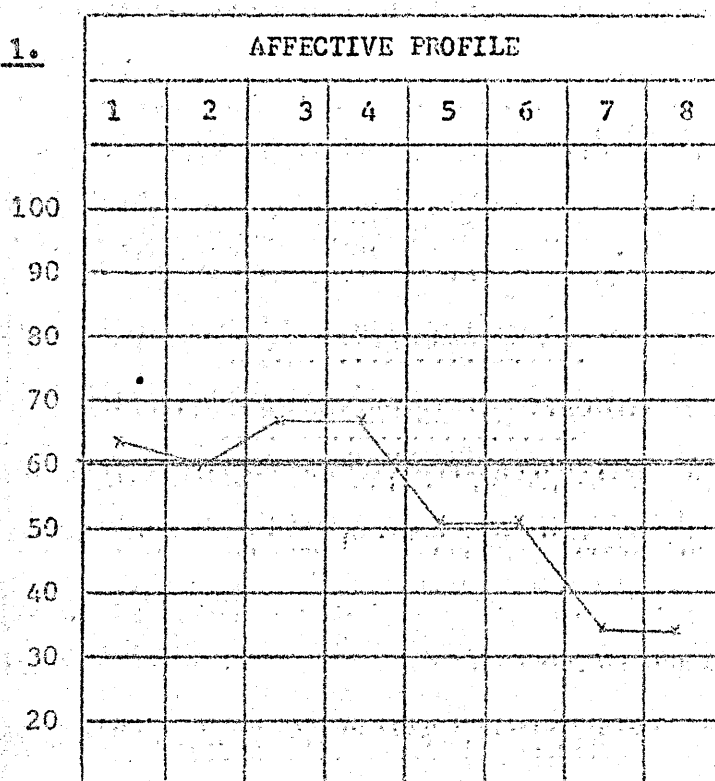
Case Study 1.

Fig.19. Affective Profile of Student 'A'.

Full data sheet is given in Appendix 10.

Student 'A' is a sixteen year old female student on the Home Economics Pre-Entry course. She has a figure reasoning score of 112, a mathematics age of 11.0 years and a vocabulary score of V-.

Although this student has a relatively high reasoning score, her mathematics and vocabulary scores are low.

Her affective profile for biology is poor. There is uncertainty about attending, slight acquiescence and willingness to respond, but no real satisfaction in responding. Valuing is at a very low level. It shows, generally, a taxonomic decline.

One would predict from this profile that student 'A' would not be a good biology student and this is substantiated to a large extent in her end of session T score of 34.

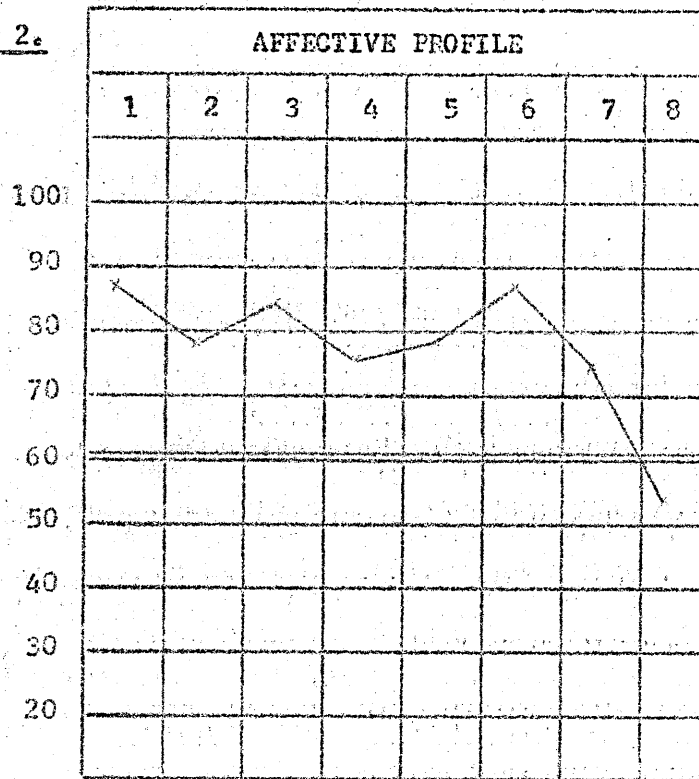
Case Study 2.

Fig.20. Affective Profile of Student 'B'.

Full data sheet is given in Appendix 11.

Student 'B' is a seventeen year old male student on the A-level course taking Botany and Zoology. He has a figure reasoning score of 116, a mathematics age of 12.4 and a vocabulary score of IV. The affective profile is largely in the upper part of the frame as one might expect of an A-level student with a heavy investment in the biological sciences.

Although a taxonomic decline is shown for the category 'Valuing', the scores are high. One might anticipate that the 'Commitment' score (Section 8) would improve during the course.

With a high reasoning score and a very satisfactory affective profile, one could predict that this student would be successful in his biological science studies. The T score of 51 confirms this prediction.

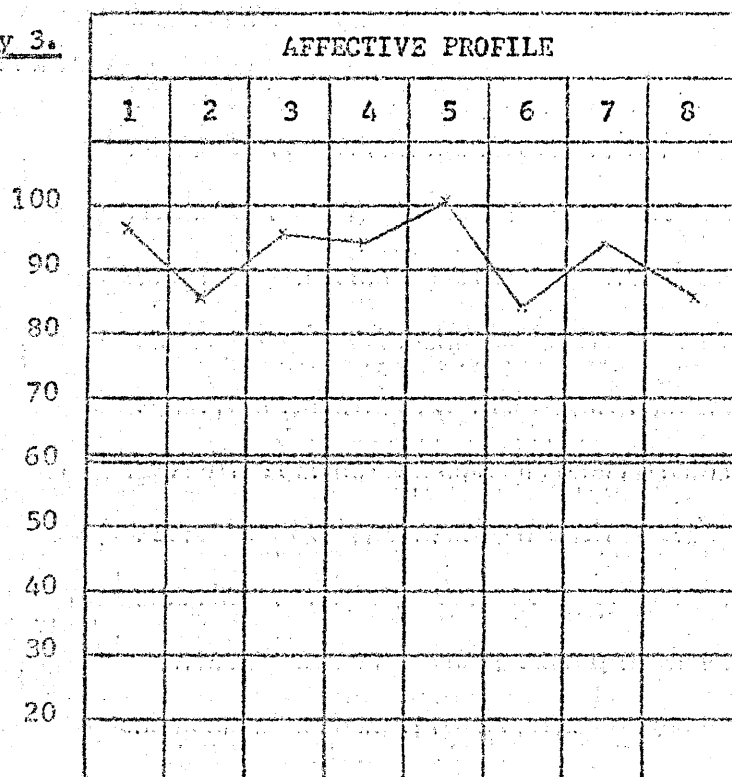
Case Study 3.

Fig. 21. Affective Profile of Student 'C'.

Full data sheet is given in Appendix 12.

Student 'C' is a seventeen year old female student on the A-level course taking Botany and Zoology. Her standardised scores are low for an A-level student, with a figure reasoning score of 105, a mathematics age of 10.4 and a vocabulary score of IV. However, this student has had a longstanding interest in the biological sciences and has a very high level of motivation, which is reflected in the percentage scores of the affective profile.

Despite low standardised scores and with an extremely favourable affective profile, this girl obtained a T score of 67 in the end of session examinations. In this relatively rare instance, the affective profile had proved the more accurate predictor of success.

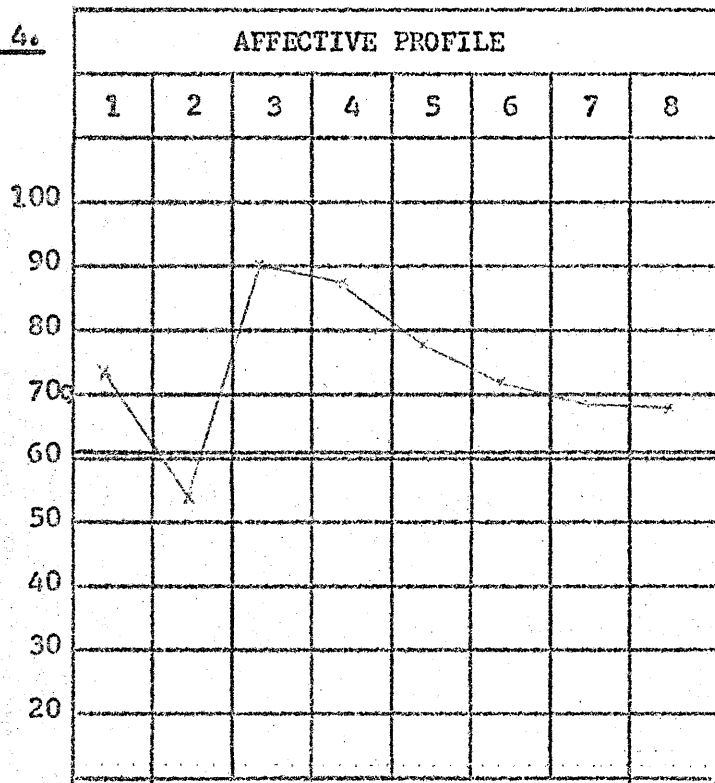
Case Study 4.

Fig.22. Affective Profile of Student 'D'.

Full data sheet given in Appendix 13.

Student 'D' is a sixteen year old male student taking Human Biology as an option at O-level. He has a figure reasoning score of 123, a mathematics age of 13.8 and a vocabulary score of IV.

Although he has relatively low scores for the category 'Attending', the scores for 'Responding' and 'Valuing' show a taxonomic decline. This is a typical profile for an O-level student, with scores that are largely favourable, but which are not generally as high as for A-level students. Student 'D' obtained a T score of 56.2 in the end of session examinations.

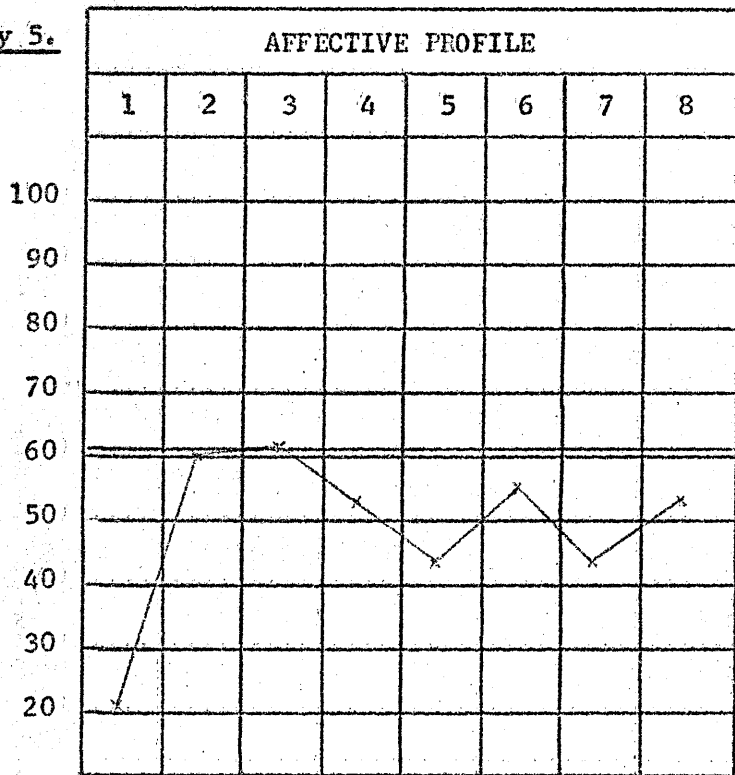
Case Study 5.

Fig.23. Affective Profile of Student 'E'.

Full data sheet given in Appendix 14.

Student 'E' has been selected from the control group of 0-level students not studying a biological science. He is a sixteen year old male student with a figure reasoning score of 116, a mathematics age of 12.6 and a vocabulary score of IV+. His affective profile clearly indicates that he would be unsuitable as a biology student, with all scores lying at or below sixty percent.

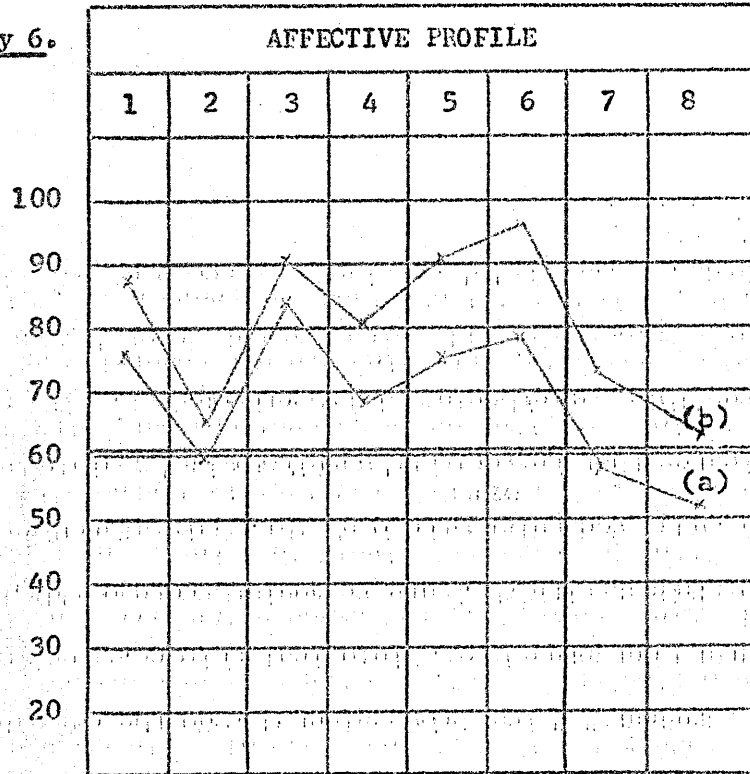
Case Study 6.

Fig.24. Affective Profiles for student 'F' before embarking on a)Science Pre-entry course and one year subsequently on b)A-level course.

Full data sheet given in Appendix 15.

Student 'F' has been selected to exemplify a respondent who took part in the first year of the survey as an O-level (Science Pre-entry course) student and in the second year of the survey as an A-level student. She has a relatively low figure reasoning score of 95, but a vocabulary score of III- and a mathematics age of 14.6 years, which compares well with her chronological age of sixteen years at the time of testing.

It can be seen that the basic shape of the profile remains the same, but that the percentage scores have increased. The student has thus shown a general growth in affective development and in the highest levels of 'Preference for a value' and 'Commitment' has moved from a slightly unfavourable state to a slightly favourable state.

It is typical of students proceeding from O-level to A-level study in biology, that their affective profile remains basically the same shape but that the percentage scores improve.

CHAPTER NINETEEN

ANALYSIS OF SUB-GROUPS

For each of the subdivisions of the affective taxonomy, responses were compared for the various sub-groups that participated in the survey. For each of the sub-groups an average Likert weighting was calculated. Since this was corrected for reversed items the actual figure is referred to as a 'Mean Favourability Weighting'. The maximum mean favourability weighting is 5.00 and can only be achieved if all respondents within a sub-group answer 'Strongly agree' (or 'Strongly disagree' for reversed items) to all items on that particular sub-scale. Exactly the opposite response would yield a mean favourability weighting of 1.00. The mean favourability weightings for a variety of sub-groups is given in Table 2, overleaf.

The most important general point to emerge is that in every subdivision of the taxonomy the total group of O-level students have lower mean favourability weightings than the total group of A-level students, indicating positive affective development in those students who proceed from an O-level study of a biological science to A-level study. The differences in mean favourability weightings are shown in Table 3.¹ This finding accords with general teaching experience that A-level students are easier to teach in the sense that they are, in taxonomic terms, more attentive, responsive and developing value systems in line with those of their biology teachers.

Other important sub-group differences are illuminated by a consideration of the taxonomic subdivisions separately.

¹see page 117.

LEVEL	SUB-GROUP	N	MEAN FAVOURABILITY WEIGHTING							
			1	2	3	4	5	6	7	8
0-level Bi	Bh	59	3.61	2.99	3.82	3.52	3.57	3.79	3.29	3.16
	Bi	32	3.79	3.01	3.85	3.47	3.57	3.70	3.50	3.20
	Bh + Bi	91	3.67	3.00	3.84	3.50	3.57	3.76	3.36	3.17
	Male(Bh + Bi)	44	3.60	2.99	3.70	3.51	3.49	3.66	3.31	3.25
	Female(Bh + Bi)	47	3.73	3.01	3.97	3.49	3.63	3.84	3.41	3.11
	SPN(Bi)	34	3.98	3.30	3.86	3.69	3.87	3.85	3.52	3.33
	Pre-Nurses(Bh)	70	3.75	2.99	3.91	3.63	3.60	3.86	3.26	3.17
	HPN(Bh)	15	3.70	3.03	3.73	3.57	3.57	3.64	3.10	3.04
	Non biologists	26	3.35	2.96	3.91	3.46	3.19	3.55	2.97	2.70
	TOTAL(biologists)	210	3.75	3.05	3.86	3.58	3.63	3.80	3.33	3.19
A-level Year One	Bi	18	3.81	3.52	4.06	3.80	3.88	3.85	3.73	3.45
	Bo + Zo	9	4.04	3.59	4.17	3.85	4.11	4.17	3.95	3.28
	Bi + Bo + Zo	27	3.90	3.54	4.10	3.82	3.96	3.96	3.80	3.39
	Male(Bi + Bo + Zo)	10	3.84	3.66	3.89	3.66	3.82	3.80	4.05	3.40
	Female(Bi + Bo + Zo)	17	3.97	3.46	4.23	3.91	4.04	4.06	3.66	3.39
A-level Year Two	Bi	14	3.93	3.51	4.03	3.99	3.79	4.07	3.86	3.54
	Bo + Zo	9	4.04	3.32	3.87	3.92	4.12	3.96	3.83	3.56
	Bi + Bo + Zo	23	3.97	3.44	3.97	3.96	3.91	4.03	3.85	3.55
	Male(Bi + Bo + Zo)	12	3.89	3.51	3.83	3.75	3.93	3.79	3.88	3.60
	Female(Bi + Bo + Zo)	11	4.07	3.36	4.11	4.17	3.90	4.29	3.82	3.51
	TOTAL(A biologists)	50	3.93	3.49	4.04	3.88	3.94	3.99	3.82	3.46

Key : Bi = biology, Bh = human biology, Bo = botany, Zo = zoology.

Table 2. Mean favourability weightings for sub-groups in the survey.

Subdivision	O-level weighting	A-level weighting	Difference AL-OL weighting
1.2	3.75	3.93	0.18
1.3	3.05	3.49	0.44
2.1	3.86	4.04	0.18
2.2	3.58	3.88	0.30
2.3	3.63	3.94	0.31
3.1	3.80	3.99	0.19
3.2	3.33	3.82	0.49
3.3	3.19	3.46	0.27

Table 3. Differences between AL and OL mean favourability weightings.

1.0 Receiving

1.2 Willingness to Receive

At the O-level stage the most willing students are those in the Science Pre-entry group and this may be related to the vocational significance of the course. The least willing group, as might be predicted, is the non-biology control group although they do show slight favourability.

Biology students score more highly than human biology students, largely because the latter group do not appreciate the significance of general biology topics and take a narrow view of the subject. Such students will often pose questions in class such as "Why do we have to learn about plants?"

At A-level the students taking Botany and Zoology show greater willingness than Biology students, possibly highlighting again the vocational significance of their subject choices.

Female students show greater willingness to be receptive at both O-level and A-level.

1.3 Selected Attention

This is the lowest scoring subdivision of the taxonomy for both O-level and A-level. The O-level groups as a whole show uncertainty, whilst the A-level students are more favourable. All O-level groups have approximately the same weighting except the Science Pre-entry group, which is much higher and perhaps again is related to the stronger vocational significance of the course.

Although there is no difference between male and female scores at O-level, at A-level males have higher scores than females indicating that their activities are more likely to revolve around their biological interests.

Perhaps the generally low scores for this subdivision ought not to cause too much concern, for they indicate that students are not single minded about biology, but have a range of competing interests. At O-level this is educationally very desirable, whilst the higher scores for A-level indicate a refinement of interests.

2.0 Responding

2.1 Acquiescence in Response

This is the highest scoring subdivision for both O-level and A-level, with the non-biology group also obtaining high scores. At both levels females are more acquiescent than males.

In its simplest terms, acquiescence in response means that the student will follow a recommendation or advice merely because it has been given. The high scores of the non-biology group indicate that biologists are no more virtuous in this respect than non-biologists.

2.2 Willing to Respond

In contrast with the previous section, this subdivision involves behavioural activity and the non-biology group return to low scores. The highest scores at O-level are obtained by the Science Pre-entry group with the Pre-nurses close behind, again indicating the importance of vocational relevance, particularly when compared with the biology and human biology students respectively.

Although there is no difference in the scores of males and females at O-level, at A-level the females show greater willingness, with the difference increasing between the first and second years.

2.3 Satisfaction in Response

The greatest satisfaction in response is gained by students for whom a biological science has the greatest vocational significance. At O-level these are the Science Pre-entry and Pre-nursing groups and at A-level the students studying botany and zoology.

At O-level and first year A-level female students obtain more satisfaction in response than male students, but by the second year of the A-level course this difference has disappeared.

3.0 Valuing

3.1 Acceptance of a Value

The highest O-level scores were gained by the Science Pre-entry and Pre-nursing groups and at all levels female students obtained higher scores than male students. The non-biology group obtained the lowest scores as one would expect.

3.2 Preference for a Value

Biology students at O-level score higher than the human biology students and the non-biology group have the lowest scores. The female

sub-groups at O-level have slightly higher scores than the males.

At A-level the botany and zoology students obtain higher scores in the first year, but this difference has disappeared by the second year. It is the male students who have the highest scores, although the difference diminishes from the first year to the second year.

3.3 Commitment

The scores show steady improvement from O-level to the second year A-level group. There is a tendency for males to obtain slightly higher scores than females.

The two recurring features of the analysis of sub-groups are those of :

1. Girls and Biology

It is generally the case that girls obtain higher mean favourability weightings than boys, except in the two highest subdivisions of the taxonomy. This study is therefore in line with most attitude surveys in pointing to differences in the affective development of boys and girls.¹

2. Vocational Significance

The affective development of students who have made some kind of vocational commitment to the biological sciences is generally more advanced than for students following more general courses. Students on vocationally related courses are therefore likely to be 'easier' to teach in the sense that they are more receptive, responsive and have values which parallel those of their teachers.

¹see Chapter 2.

CHAPTER TWENTY

ANALYSIS OF INDIVIDUAL QUESTIONS

For each question in the affective instrument mean favourability weightings were computed for each of the sub-groups in the survey. A sample question analysis sheet is given in Appendix 16.

The questions were analysed in their taxonomic subdivision groupings.

1.2 Willing to Receive

The questions were all phrased in the same style, namely 'I would like to know more about.....', and covered a wide range of biology topics such as development, identification, dissection, evolution, structure, physiology, behaviour, heredity and modern biology. In general the mean favourability weightings were related to the specific interests of the sub-groups. Questions involving some aspect of plant biology tended to draw the lowest weightings from students of human biology who, presumably, saw little relevance in these topics. Vocational relevance was illuminated in questions such as 'I would like to know more about dissecting animals and plants¹', which produced a low favourability weighting for students of human biology on the general O-level course, yet produced a much higher weighting for pre-nursing students taking the same subject. For both O-level and A-level students, this question also indicated that, with the exception of the vocational O-level groups, the males were more interested in dissection than the females. Identification

¹see Appendix 16.

of plants and heredity, on the other hand, were more likely to interest females than males.

1.3 Controlled or Selected Attention

The mean favourability weightings for this section are low, indicating that students have a number of interests which compete with biological interests. The questions were phrased to contrast a biologically relevant activity with a non-relevant activity. Some points are worthy of note. Not, for example, until the second year of A-level study do students prefer reading a Natural History/Biology book to watching television. All groups would prefer to visit a zoo rather than a stately home, but males react more favourably than females and biologists more than human biologists.

When contrasting the reading of a Natural History book with a novel, the choice at O-level is for the novel, whereas at A-level only the males are more favourably disposed towards the Natural History book.

2.1 Acquiescence in Response

This subdivision of the taxonomy produced high mean favourability weightings for all groups. Encouragingly, the two items producing the highest scores were those involved with safety, where acquiescence relates to physical well-being. It is generally true that females are more acquiescent than males.

2.2 Willing to Respond

In contrast to the previous subdivision, this section contains items which indicate that the student is willing to become involved in some relevant biological activity. Again it is generally the case that females obtain higher mean favourability weightings than males.

2.3 Satisfaction in Response

All of the items in this section have been formulated to indicate enjoyment of particular aspects of biology. Practical work is enjoyed by all sub-groups, particularly the Science Pre-entry group at O-level and females obtain higher weightings than males at all stages.

Two items, one on enjoying learning about plants and the other on learning about animals, produce interesting weightings. At O-level students do not enjoy learning about plants, a situation which improves by A-level, particularly for the botany/zoology group. With the animal item, however, high weightings are obtained by O-level groups and even improve by A-level. Such a dichotomy of weightings points to a great need to consider the way in which the plant aspects of biology are presented in schools, for they appear to have a poor image amongst students taking up the subject at college.

3.1 Acceptance of a Value

This subdivision contained a series of mildly controversial statements, which students holding 'biological' values would react favourably towards. At A-level females obtain higher scores than males for most items. A particularly high scoring item relates to safety, where the student 'feels a set of laboratory rules is essential'.

3.2 Preference for a Value

The items in this section gave students the opportunity to indicate that they would like to see a range of biological activities extended. A-level students would, for example, like to own more biology books if they were cheaper, whereas O-level students tended to be more uncertain. All of the sub-groups except the control, despite the fact that they were taking a range of subjects, tended to agree that there 'is something special about biology compared with other subjects'.

3.3 Commitment

The items were devised to give an indication of whether students were becoming committed biologists. With the exception of very low scores in the control group, there were no clear patterns of difference between the various sub-groups.

CHAPTER TWENTY-ONE

MULTIPLE CORRELATION ANALYSIS

For each of the sub-groups within the survey a correlation matrix was prepared with the aid of a computer. The product moment correlation coefficients for eleven variables, affective and cognitive, were computed.

The variables are given in Figure 25.

Code	Variable
1.2	Willing to receive
1.3	Controlled or selected attention
2.1	Acquiescence in response
2.2	Willing to respond
2.3	Satisfaction in response
3.1	Acceptance of a value
3.2	Preference for a value
3.3	Commitment
R	Figure reasoning quotient
V	Mathematics age
S	Sessional examination (Normalised T) score

Fig.25. Variables used in multiple correlation analysis.

Because the sessional examinations were held at the end of the college year the sub-group sizes were often lower than those quoted in previous sections. The principal reasons for this were :

1. Student 'wastage' during the year.

2. Absences from sessional examinations.

The matrices are given in Appendices 17-25.

In general no clear pattern of relationship between affective and cognitive variables emerges from an examination of the correlation matrices, although it is clear that there are important group differences.

The matrices were considered for each sub-group.

O-level Human Biology (Appendix 17)

None of the affective variables can be used to predict sessional examination success for this sub-group, but the figure reasoning quotient provides a small correlation ($r = 0.30$, $p < 0.05$).

O-level Biology (Appendix 18)

Neither affective nor cognitive variables provide significant correlations for this sub-group.

Science Pre-entry (Appendix 19)

Neither affective nor cognitive variables provide significant correlations for this group.

Home Economics Pre-entry (Appendix 20)

Two affective variables provide significant correlation coefficients. They are :

Satisfaction in response $r = 0.63$ $p < 0.05$

Acceptance of a value $r = 0.61$ $p < 0.05$

These give a multiple correlation coefficient of $R_{s.2.3,3.1} = 0.73$, which indicates that fifty-four percent of the variance in sessional examination scores can be explained by a linear combination of 2.3 and 3.1 scores.

The mathematics age also correlates significantly, $r = 0.57$
 $p < 0.05$.

Pre-nursing (Appendix 21)

Two affective and two cognitive variables correlate significantly for this sub-group. The affective variables are :

Acceptance of a value $r = 0.35$ $p < 0.01$

Preference for a value $r = 0.27$ $p < 0.05$

No advantage is gained by computing the multiple correlation coefficient in this case.

The cognitive variables are :

Figure reasoning quotient $r = 0.44$ $p < 0.001$

Mathematics age $r = 0.33$ $p < 0.05$

First year A-level biology (Appendix 22)

Only the 'mathematics age' correlates significantly for this sub-group.

Mathematics age $r = 0.55$ $p < 0.05$

Second year A-level biology (Appendix 23)

Neither affective nor cognitive variables provide significant correlations for this sub-group.

First year A-level botany/zoology (Appendix 24)

Four of the affective variables and none of the cognitive variables correlate with the sessional examination scores. The variables are :

Willing to respond $r = 0.70$ $p < 0.05$

Satisfaction in response $r = 0.65$ $p < 0.05$

Preference for a value $r = 0.70$ $p < 0.05$

Commitment $r = 0.65$ $p < 0.05$

By combining the two highest coefficients a multiple correlation coefficient of $R_{s,2,2,2,2} = 0.73$ is obtained, indicating that fifty-four percent of the variance in sessional examination scores can be explained

by a linear combination of 2.2 and 3.2 scores.

Second year A-level botany/zoology (Appendix 25)

Neither affective nor cognitive variables provide significant correlations for this sub-group.

The two general points which emerge from this analysis are :

1. The standardised cognitive variables do not provide a consistent prediction of sessional examination success when sub-groups are considered separately.
2. The affective variables do not provide a consistent pattern of prediction of sessional examination success, but when they do correlate significantly the correlation coefficients tend to be high. In the case of one group, affective variables provided the only prediction of examination success.

It seems that in Further Education, it is possible to detect a balance between affective and cognitive variables as predictors of examination success. Whether the balance is biased in favour of affective or cognitive variables depends on a number of factors. One of these is the subject the student studies, be it biology, human biology, botany or zoology. Another is the vocational significance of the subject to the student.

The relative importance of cognitive and affective variables in determining the abilities of students in the further education age range was illuminated by Vernon¹ :

"While we have a fairly clear conception of the main factors underlying the abilities of school-children and of unselected adults, the picture among older adolescents and adults of superior ability is much more complex and obscure. A g-factor can still be

¹Vernon, P.E., The Measurement of Abilities, 2nd edn., (London : University of London Press Ltd., 1972), p.146.

extracted from their mental test results, but it seems to play a decreasingly important part in educational or vocational achievement, and interests, work attitudes, and temperament traits become more influential."

CHAPTER TWENTY-TWO

SUMMARY

In this study a taxonomic model of affective development was taken and converted into operational form for the biological sciences. The final instrument was used to measure the affective development of all students studying a biological science in a further education college over a two year period. Analysis of the instrument has provided information in the following areas.

22.1 Affective Profiles

The graphic representation of a set of scores for an individual is used in a number of standardised tests. Examples of profiles for basic skills are given in Thorndike and Hagen¹ and a profile of values is depicted in Anastasi.² The technique is used more in the United States of America than in this country.

It is suggested that an affective profile, graphing the student's score for each subdivision of the taxonomy, can provide a useful representation of the level of affective development in relation to the biological sciences. Read in conjunction with standardised cognitive data, affective profiles can provide a useful prediction of the future success of the student. In comparing the affective profile with standardised cognitive data, three possibilities arise :

¹Thorndike, R.L. and Hagen, E.P., Measurement and Evaluation in Psychology and Education, 3rd edn., (New York : Wiley, 1969), p.235.

²Anastasi, A., Psychological Testing, 3rd edn., (London : Macmillan, 1968), p.489.

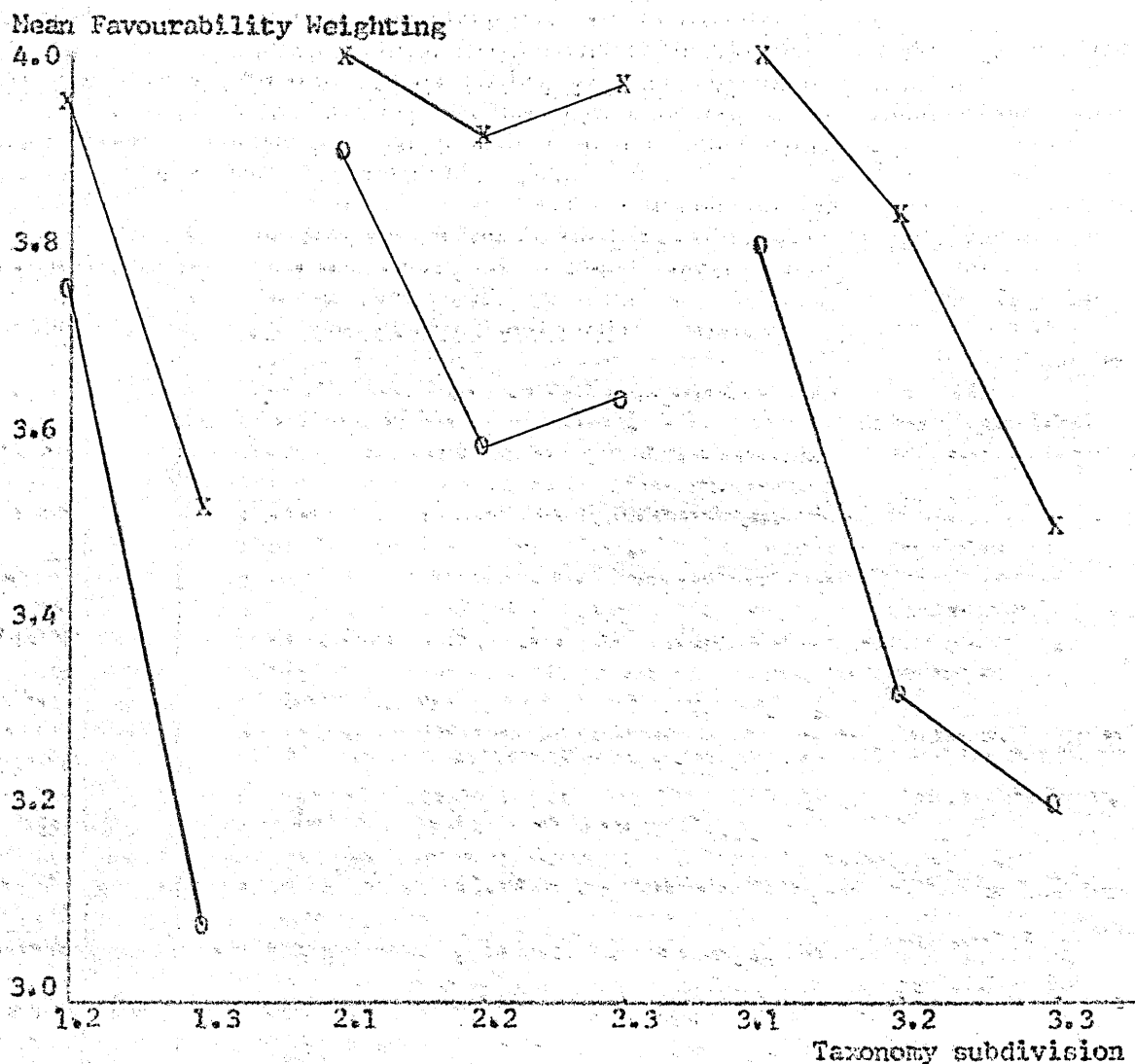
- a. The affective and cognitive scores may show consistency. High scores in both domains would provide grounds for cautious optimism that the student would complete the course successfully. Consistent low scores would indicate that the student would be unlikely to cope with a biological science course successfully.
- b. The affective and cognitive scores may be inconsistent, with low cognitive scores but a high affective profile. Such students are likely to be willing, interested and responsive in class despite an ability handicap. It is quite possible that their high level of affective development may enable them to persist with academic difficulties and to complete the course successfully.
- c. The affective and cognitive scores may be inconsistent, with high cognitive scores but a low affective profile. Such students may have the academic potential to complete the course successfully, but because of low levels of interest, willingness and responsiveness may not achieve this potential. An attempt to discover the motives of students with this type of inconsistency should be made, before admitting to a biological science course.

Low scores on Section Two of the profile, corresponding to the Selected Attention subdivision of the taxonomy, should not necessarily be regarded with concern, for students taking a general education course will normally have a range of competing interests. On other sections of the profile, particularly the early sections, low scores should be taken to indicate retarded affective development, which may require further careful investigation.

22.2 Affective Development

The hierarchical nature of affective development is revealed by plotting graphs of mean favourability weightings against taxonomy subdivisions separately for the O-level and A-level students.

The graphs are given in Figure 26.



Key : X A-level, O O-level.

Figure 26. Graphs of mean favourability weightings against taxonomy subdivision for all A-level and O-level students in the survey.

The graphs yield several pieces of information :

- a. For all subdivisions of the taxonomy, A-level students obtain higher mean favourability weightings than O-level students. This indicates that A-level students do not improve in affective development just at the higher levels but also improve at the lower levels of the taxonomy.

To some extent, this is at odds with the model proposed by Schock³, which shows a decline in the level of affective development as formal education proceeds. The present study shows a clear improvement in affective development as students proceed from O-level to A-level studies in the biological sciences.

- b. For each of the three taxonomy categories measured, the mean favourability weightings show a decline indicating a hierarchical structure. The increase from subdivision 2.2 to 2.3 is small and not significant.
- c. If the low mean favourability weightings on subdivision 1.3 (Selected attention) are disregarded, because interests which compete with biology are not unacceptable on a general education course, then the mean favourability weightings for O- and A-level students do not decline sharply until category 3.0 (Valuing) is reached. This suggests that the overall level of development reached by students is an early stage of valuing. In general terms, the A-level students have reached subdivision 3.2 (Preference for a value), whilst O-level students have reached the lower subdivision 3.1 (Acceptance of a value). Neither group of students have reached the level of commitment, but the A-level students have higher mean favourability weightings on this

³see page 79.

subdivision than the C-level students.

- d. Even the youngest students admitted to a further education college have reached a moderately advanced level of affective development. More information about the hierarchical nature of the lower categories of the taxonomy would be obtained by using the instrument at various stages of secondary education.

22.3 Prediction of Examination Success

Although it is possible, in certain individual cases, to use an affective profile to predict examination success, this study has not identified any consistent pattern of relationship between affective and cognitive variables for groups of students.

Multiple correlation matrices were compiled for each sub-group in the study, giving eight affective and two standardised cognitive variables which might have been used to predict scores in the end of session biology examinations. At O-level, the standardised scores provided significant correlations with the sessional examination marks for the three groups taking human biology, but not for the two groups taking biology. At A-level the only significant correlation was for the first year biology group.

Affective variables correlated with sessional examination marks for the Pre-nursing and Home Economics Pre-entry groups at O-level and for the first year botany/zoology group at A-level. In the latter case, the affective variables gave significant correlations where the standardised cognitive variables did not.

Of the eight instances where affective variables correlated with sessional examination results significantly, three involved variables in the taxonomic category 'Responding' and five in the category 'Valuing'. There were no instances where the category 'Receiving' correlated significantly with sessional examination results. It can therefore be

suggested that the higher the taxonomic category, the more valuable it is in predicting examination success. More work would need to be done, however, to substantiate this suggestion.

22.4 Affective Development and Vocational Grouping

The sub-groups used in the study can be divided into two broad classes. The first would include the O-level biology, O-level human biology and A-level biology groups where students were generally taking a biological science subject as part of a general education course. The second would include the Science Pre-entry, Home Economics Pre-entry and Pre-nursing groups at O-level and the botany/zoology groups at A-level, where students were following science-based courses with a strong vocational influence.

When the mean favourability weightings for the different subdivisions of the taxonomy are examined for each of the sub-groups in the study, it is common to find that the highest weightings are related to the groups for which a biological science has a vocational significance.

It is not difficult to imagine that the affective development of a student in the biological sciences would be improved if the student belonged to a group for whom a biological science had a strong vocational significance. In further education it is an increasing trend for courses to be designed with a vocational component, such as work experience.

22.5 Affective Development and Gender

This study has shown that there are differences in the levels of affective development of male and female students. It is generally found that female students obtain higher mean favourability weightings than male students, except at the two highest subdivisions tested, when the tendency is for males to obtain slightly higher weightings.

This indicates that female students are more receptive and responsive to the biological sciences than male students, although the male students have a slightly greater tendency to show preference for biological values and commitment to the subject. It is as if female students show a higher level of interest in the subject, but are more cautious when developing values related to the biological sciences. Males, on the other hand, display lower levels of interest, but are more ready to adopt the subject's values.

No reasons for this gender difference can be offered from an analysis of the affective instrument. One suspects that the suggestion of Hutchings and Clowsley⁴, discussed in an earlier chapter, that girls are more susceptible to social pressures emphasizing the dichotomy between careers and family life, has a basis in truth.

22.6 Development of the Project

It is felt that the work begun in this project could be usefully developed along the following lines :

- a. The instrument could be used as the basis of a larger survey, using a larger number of establishments and respondents. This would reduce any anomalies due to the use of a single establishment and small groups.
- b. The instrument could be used with secondary school populations to provide greater insight into the earlier stages of affective development. It would be valuable to analyse the responses of different year groups in secondary schools.
- c. Methods might be devised to measure development in the two highest categories of the taxonomy.

⁴see page 9.

d. This work might be used as a foundation for a similar approach to affective development in other subjects. Students entering further education often have poor attitudes towards basic subjects, such as mathematics, and it would be of value to discover whether the taxonomic model of affective development could offer insight into such problems.

BIBLIOGRAPHY

References cited in the text.

- Ahlgren, A. and Walberg, H.J. (1973) 'Changing Attitudes to Science among Adolescents', Nature, 245, 187-190.
- Allen, E.A. (1966) 'A New Look at Adolescents' Attitudes to School', in The Psychology of Adolescence. Nine Lectures. Swansea : Faculty of Education, University College of Swansea.
- Allport, G.W. (1935) 'Attitudes', in A Handbook of Social Psychology, ed. Murchison, C. Worcester, Mass. : Clarke University Press.
- Anastasi, A. (1968) Psychological Testing. 3rd edn. London : Macmillan.
- Angus, L. (1950) 'A Comparative Study of the Methods of Measuring Interest in Science and its Relation to Ability and Achievement', Br.J.Ed.Psy., 20, 63-65.
- Ashton, B.G. and Meredith, H.M. (1969) 'The Attitudes of Sixth Formers', Sch.Sci.Rev., 51, 174, 15-19.
- Assessment of Performance Unit (1977) 'Assessment of Scientific Development', D.E.S. Consultative Paper, October 1977.
- Association for Science Education (1971) Science and General Education, 1971, Hatfield, Herts. : A.S.E.
- Association for Science Education (1971) Science for the Under-Thirteens Hatfield, Herts. : A.S.E.
- Association for Science Education (1979) Alternatives for Science Education. Hatfield, Herts. : A.S.E.
- Beard, R. (1970) Teaching and Learning in Higher Education. Harmondsworth, Middlesex : Penguin.
- Bell, A. (1977) 'A Consideration of Objectives', T.E.S., Nov.28th 1977.
- Bem, D.J. (1967) 'Self-Perception : An Alternative Interpretation of Cognitive Dissonance Phenomena', Psy.Rev., 74, 188-200.
- Bloom, B.S. ed. (1956) Taxonomy of Educational Objectives. Book 1 ; Cognitive Domain. New York : McKay.
- Bloom, B.S., Hastings, J.T. and Madaus, G.F. (1971) Handbook on Formative and Summative Evaluation of Student Learning. New York : McGraw-Hill.

- Box, S. and Ford, J. (1967) 'Commitment to Science : A Solution to Student Marginality?', Sociology, 1, 225-238.
- Bradley, J. and Hutchings, D.W. (1973) 'Concepts of Science and Scientists as Factors Affecting Subject Choice in Secondary Schools', Sch.Sci.Rev., 55, 190, 8-15.
- Broadbent, D.E. (1958) Perception and Communication. Oxford : Pergamon Press.
- Brown, N.M. (1953) 'Some Educational Influences on the Choice of a Science Career by Grammar School Girls', Br.J.Ed.Psy., 23, 188-195.
- Brown, S. (1976) Attitude Goals in Secondary School Science. Stirling : Department of Education, University of Stirling.
- Brown, S. and Davis, T.N. (1973) 'The Development of an "Attitude to Science" Scale for 12-14 Year Olds', Scottish Educ.Stud., 5, 2, 85-94.
- Burroughs, G.E.R. (1975) Design and Analysis in Educational Research. 2nd edn. Birmingham : School of Education, University of Birmingham.
- Butcher, H.J. (1969) 'An Investigation of the "Swing from Science"', Res.in Educ., 1, 38-57.
- Butcher, H.J. (1969) 'The Structure of Abilities, Interests and Personality in 1,000 Scottish School Children', Br.J.Ed.Psy., 39, 2, 154-165.
- Carrick, T. (1978) 'Problems of Assessing Readability of Biology Textbooks for First Examinations', J.Biol.Ed., 12, 2, 113-122.
- Causes of the Swing from Science (1979) review of The Continuing Swing? Pupils' Reluctance to Study Science by Duckworth, D., Education, March 30, 1979, 373.
- Chanan, G. (1976) 'Science or Ideology?', T.E.S., March 5, 1976, 21.
- Charen, G. (1963) 'The Effect of Open-Ended Experiments in Chemistry on the Achievement of Certain Objectives in Science Teaching', J.Res.Sci.Teach., 1, 184-190.
- Charen, G. (1966) 'Laboratory Methods Build Attitudes', Sci.Educ., 50, 1, 54-57.
- Clift, P. and Sexton, B. (1969) '.....And All Things Nice', Educ.Res., 21, 3, 194-199.
- Council for Scientific Policy (1968) Inquiry into the Flow of Candidates in Science and Technology into Higher Education. [Dainton Report]. London : H.M.S.O.
- Defleur, M.L. and Westie, F.R. (1971) 'Attitude as a Scientific Concept' in Attitudes and Behaviour, ed. Thomas, K., Harmondsworth, Middlesex Penguin.

- Department of Education and Science (1977) Curriculum 11-16, Working Papers by H.M. Inspectorate : a Contribution to the Current Debate. London : H.M.S.O.
- Department of Education and Science (1978) 'Assessing the Performance of Pupils', D.E.S. Report on Education, No.93, 1.
- Dinkele, G. (1976) 'The Affective Domain', T.E.S., June 11, 1976, 30.
- Douglas, J.W.B. (1967) The Home and the School. London : Panther Books.
- Duckworth, D. and Entwistle, N.J. (1974) 'The Swing from Science : A Perspective from Hindsight', Educ.Res., 17, 1, 48-53.
- Dunham, J. (1974) 'Attitudes and Motivation' in New Movements in the Study and Teaching of Biology, ed. Selmes, C. London : Pample Smith.
- Entwistle, N.J. (1971) 'Personality and Academic Attainment', Br.J.Ed.Psy. 42, 2, 137-151.
- Evans, K.M. (1965) Attitudes and Interests in Education. London : Routledge and Kegan Paul.
- Festinger, L. (1957) A Theory of Cognitive Dissonance. Stanford : Stanford University Press.
- Foss, D.M. ed. (1966) New Horizons in Psychology 1. Harmondsworth, Middlesex : Penguin.
- Gaetano, M.A.K. (1966) 'A Study to Determine the Distribution of Male and Female Figures in Elementary Science Textbooks', J.Res.Sci.Teach. 4, 178-179.
- Gardner, P.L. (1975) 'Attitude Measurement : A Critique of Some Recent Research', Educ.Res., 17, 2, 101-109.
- Gardner, P.L. (1975) 'Attitudes to Science : A Review', Stud.Sci.Educ., 2, 1-41.
- Gaskell, D.C. (1975) 'The Flow of Chemists', Educ.in Sci., 62, 22-24.
- Hall, W.C. (1969) 'General Science to O-level', Sch.Sci.Rev., 51, 175, 433-437.
- Hallworth, H.J. and Waite, G. (1966) 'A Comparative Study of the Value Judgements of Adolescents', Br.J.Ed. Psy., 36, 202-209.
- Haney, R.E. (1964) 'The Development of Scientific Attitudes', The Science Teacher, Dec.1964, 33-35.
- Harrow, A.J. (1972) A Taxonomy of the Psychomotor Domain. New York : McKay.
- Hornsby-Smith, M.P. (1973) 'Styles of Teaching and their Influence on the Interest of Students in Science', Durham Research Review, 7, 31, 807-815.

- Houghton, E.M. (1972) 'Attitudes to Biology'. Unpublished M.A. Thesis. University of Leeds.
- Hovland, C.I., Janis, I.L. and Kelley, H.H. (1973) 'A Summary of Experimental Studies of Opinion Change', in Attitudes, ed. Warren, N. and Jahoda, M., 2nd edn., Harmondsworth, Middlesex : Penguin.
- Hudson, L (1967) 'The Stereotypical Scientist', Nature, 213, 228-229.
- Hutchings, D. and Clowsley, J. (1970) 'Why do Girls Settle for Less?', Further Education, (Autumn), 6-7.
- Iliffe, A.H. (1968) The Foundation Year in the University of Keele- A Report. Soc.Rev. Monograph 12, Keele University.
- Ingle, R.B. and Shayer, M. (1971) 'Conceptual Demands in Nuffield O-level Chemistry', Educ.in Chem., 8, 5, 182-183.
- Johnson, R.K. (1979) 'Readability', Sch.Sci.Rev., 60, 212, 562-568.
- Katz, D. (1960) 'The Functional Approach to the Study of Attitudes', Pub.Opin.Quart., 24, 163-204.
- Kelly, A. (1975) 'Why do Girls Study Biology?', Sch.Sci.Rev., 56, 196, 628-632.
- Kelly, G.A. (1955) The Psychology of Personal Constructs. New York : Norton.
- Kelly, P.J. (1961) 'An Investigation of the Factors which Influence Grammar School Pupils to Prefer Scientific Subjects', Br.J.Ed.Psy., 31, 43-44.
- Kelly, P.J. (1971) 'Curriculum Development and Curriculum Mechanism', Unpublished Ph.D. Thesis, Chelsea College.
- Khan, S.B. and Weiss, J. (1973) 'The Teaching of Affective Responses', in Second Handbook of Research on Teaching, ed. Travers, R.M.W. Chicago : American Educational Research Association.
- Klopfer, L.E. (1971) 'Evaluation and Learning in Science' in Handbook of Formative and Summative Evaluation of Student Learning, ed. Bloom, B.S. Hastings, J.T. and Madaus, G.F. New York : McGraw-Hill.
- Krathwohl, D.R., Bloom, B.S. and Masia, B.B. (1964) Taxonomy of Educational Objectives. Book 2 : Affective Domain. New York : McKay.
- Laughton, W.H. and Wilkinson, W.J. (1968) 'Pupils' Attitudes to Science Teaching', Educ.in Sci., Feb.1968, 31-33.
- Laughton, W.H. and Wilkinson, W.J. (1970) 'The Science Opinion Poll', Educ.in Sci., Apr.1970, 25-27.
- Lewy, A. (1968) 'The Empirical Validity of Major Properties of a Taxonomy of Affective Educational Objectives', J.Exp.Educ., 36, 3, 70-77.

- Mace, C.A. (1968) The Psychology of Study. Harmondsworth, Middlesex : Penguin
- Mager, R.F. (1968) Developing Attitude to Learning. Belmont, California : Fearon.
- Marjoram, T. (1977) 'Patience Rewarded', T.E.S., October 14, 1977, 2.
- Mathews, J.C. (1973) 'The Assessment of Attitudes' in Techniques and Problems of Assessment, ed. Mackintosh, H.G. London : Arnold.
- McGuire, W.J. (1969) 'Innate and Physiological Aspects of Attitudes' in Attitudes, ed. Warren, N. and Jahoda, M., 2nd edn. Harmondsworth, Middlesex : Penguin, 1973.
- Mead, M. and Metraux, R. (1957) 'The Image of the Scientist among High-School Students', Science, 126, 384-390.
- Metfessel, N.S., Michael, W.B. and Kirsner, D.A. (1969) 'Instrumentation of Bloom's and Krathwohl's Taxonomies for the Writing of Educational Objectives', Psychology in the Schools, 6, 3, 227-231.
- Meyer, G.R. and Penfold, D.M.E. (1961) 'Factors Associated with Interest in Science', Br.J.Ed.Psy., 31, 1, 33-37.
- Moray, N. (1969) Attention. Selective Processes in Vision and Hearing. London : Hutchinson.
- Newall, A.B. (1969) 'The Views of Science Teachers', Sch.Sci.Rev., 51, 174, 20-22.
- Newcomb, T.M., Turner, R.H. and Converse, P.E. (1966) Social Psychology. London : Routledge and Kegan Paul.
- Newton, D.P. (1975) 'Attitudes to Science', Sch.Sci.Rev., 57, 199, 368-371.
- Nuffield Foundation (1966) Nuffield Biology Teachers' Guide 1, Introducing Living Things. Harmondsworth, Middlesex : Penguin.
- Nuffield Foundation (1970) Nuffield Advanced Science, Teachers' Guide to the Study Guide : Evidence and Deduction in Biological Science. Harmondsworth, Middlesex : Penguin.
- Okunrotifa, P.O. (1975) 'Attitudes of Nigerian Secondary School Children to Programmed Instruction in Geography', Educ.Res., 17, 2, 110-114.
- Oppenheim, A.N. (1966) Questionnaire Design and Attitude Measurement. London : Heinemann.
- Ormerod, M.B. (1971) 'The "Social Implications Factor" in Attitudes to Science', Br.J.Ed. Psy., 41, 3, 335-338.
- Ormerod, M.B. and Duckworth, D. (1975) Pupils' Attitudes to Science : A Review of Research, Slough : N.F.E.R.
- Osgood, C.E., Suci, G.J. and Tannenbaum, P.H. The Measurement of Meaning. Urbana, Ill : University of Illinois Press, 1957.

- Pell, A.W. (1977) 'Subject Swings at A-level : Attitudes to Physics', Sch.Sci.Rev., 58, 205, 763-770.
- Plewes, J.A. (1975) 'An Attempt to Evaluate Attitudes and Interest Towards the End of a Modern Introductory Course in a British Forces School in Germany', Sch.Sci.Rev., 56, 197, 796-800.
- Reich, B. and Adcock, C. (1976) Values, Attitudes and Behaviour Change. Essential Psychology Series, ed. Herriot, P. London : Methuen.
- Rosenberg, M.J. (1956) 'Cognitive Structure and Attitudinal Affect', J.Ab.Soc.Psy., 53, 367-372.
- Rowntree, D. (1977) Assessing Students. How Shall We Know Them? London : Harper and Row.
- Rubin, L. ed. (1973) Facts and Feelings in the Classroom. London : Ward Lock.
- Schock, N.H. (1973) 'An Analysis of the Relationship which Exists Between Cognitive and Affective Educational Objectives', J.Res.Sci.Teach., 10, 4, 299-315.
- Schools Council Bulletin No.3. (1970) Changes in School Science Teaching. Evans/Methuen Education.
- Schools Council (1977) Schools Council 18+ Research Programme : Studies Based on the N and F Proposals : Report of the Science Steering Group to the Joint Examinations Sub-Committee of the Schools Council. Schools Council, April 1977.
- Scottish Education Department, Consultative Committee on the Curriculum (1969) Curriculum Paper 7 : Science for General Education. Edinburgh : H.M.S.O.
- Selmes, C. (1969) 'The Attitudes of 12/13-year-old Pupils', Sch.Sci.Rev., 51, 174, 7-14.
- Selmes, C. (1971) 'Attitudes Towards Science. The Design, Construction, Validation and Use of an Attitude Scale'. Unpublished Ph.D Thesis, University of Bath.
- Selmes, C. ed. (1974) New Movements in the Study and Teaching of Biology London : Temple Smith.
- Shayer, M. (1970) 'How to Assess Science Courses', Educ.in Chem., 7, 5, 182-186.
- Shayer, M. (1972) 'Conceptual Demands in Nuffield O-level Physics Course', Sch.Sci.Rev., 186, 54, 26-34.
- Shayer, M. (1974) 'Conceptual Demands in Nuffield O-level Biology Course', Sch.Sci.Rev., 195, 56, 381-388.
- Slee, F.W. (1968) 'The Feminine Image Factor in Girls' Attitudes to School Subjects', Br.J.Ed.Psy., 38, 212-214.

- Stanley, J.C. and Hopkins, K.D. (1972) Educational and Psychological Measurement and Evaluation. New Jersey : Prentice-Hall.
- Stones, E. and Anderson, D. (1972) Educational Objectives and the Teaching of Educational Psychology. London : Methuen.
- Summer, R. and Warburton, F.W. (1972) Achievement in Secondary School : Attitudes, Personality and School Success. Slough : N.F.E.R.
- Thistlethwaite, F. (1950) 'Attitude and Structure as Factors in the Distortion of Reasoning', J.Ab.Soc.Psy., 45, 442-458.
- Thorndike, R.L. and Hagen, E.P. (1969) Measurement and Evaluation in Psychology and Education. 3rd edn. New York : Wiley.
- Travers, R.M.W. ed. (1973) Second Handbook of Research on Teaching. Chicago : American Educational Research Association.
- Treisman, A. (1966) 'Human Attention' in New Horizons in Psychology 1. ed. Foss, B.M. Harmondsworth, Middlesex : Penguin.
- Triandis, H.C. (1971) Attitude and Attitude Change. New York : Wiley.
- University of London (1979) General Certificate in Education Examination : Regulations and Syllabuses : June 1981 and January 1982. London : University of London.
- Vernon, P.E. (1956) The Measurement of Abilities. 2nd edn. London : University of London Press.
- Warren, N. and Jahoda, M. (1973) Attitudes. 2nd edn. Harmondsworth, Middlesex : Penguin.
- Wright, D.S. (1962) 'A Comparative Study of the Adolescent's Concepts of his Parents and Teachers', Educ.Rev., 14, 226-232.
- Wynn, D.C. and Bledsoe, J.C. (1967) 'Factors Relating to Gain and Loss of Scientific Interest During High School', Sci.Educ., 51, 67-73.
- Zinberg, D. (1971) 'The Widening Gap : Attitudes of First Year Students and Staff Towards Chemistry, Science Careers and Commitment', Sci.Stud., 1, 287-313.

References not cited in the text

- Burstall, C. (1978) 'The Matthew Effect in the Classroom', Educ.Res., 21, 1, 19-25.
- Carlson, E. (1956) 'Attitude Change through Modification of Attitude Structure', J.Ab.Soc.Psy., 52, 256-261.
- Child, D. (1973) Psychology and the Teacher. London : Holt, Rinehart and Winston.
- Cornelius, M.L. and Cockburn, D. (1978) 'Influences on Pupil Performance', Educ.Res., 21, 1, 48-53.

- Cronbach, L. (1970) Essentials of Psychological Testing. 3rd edn. New York : Harper and Row.
- De Cecco, J.P. and Crawford, W.R. (1974) The Psychology of Learning and Instruction. 2nd edn. New Jersey : Prentice-Hall.
- Dowdswell, W.H. (1979) 'Biology and the New Sixth Form', Biologist, 26, 2, 89-90.
- Eggleston, J.F. and Kerr, J.F. (1969) Studies in Assessment. London : The English Universities Press.
- Entwistle, N.J. and Nisbet, J.D. (1972) Educational Research in Action. London : University of London Press.
- Evans, P. (1975) Motivation. London : Methuen.
- Evans, J.D. and Baker, D. (1977) 'How Secondary Pupils See the Sciences', Sch.Sci.Rev., 58, 205, 771-780.
- Fielker, D. (1978) 'The Psychologies of not Learning Mathematics', T.E.S. July 7, 1978, 23.
- Gagne, R.M. (1970) The Conditions of Learning. 2nd edn. London : Holt, Rinehart and Winston.
- Gardner, P.L. (1974) 'Deterioration in High School Students' Attitudes to Physics', Nature, 250, 465-466.
- Holt, J. (1964) How Children Fail. Harmondsworth, Middlesex : Penguin.
- Holt, J. (1967) How Children Learn. Harmondsworth, Middlesex : Penguin.
- Hudson, B. ed. (1973) Assessment Techniques. London : Methuen.
- Kempa, R.F. and Dube, G.E. (1974) 'Science Interest and Attitude Traits in Students Subsequent to the Study of Chemistry at the Ordinary Level of the General Certificate of Education', J.Res.Sci.Teach., 11, 4, 361-370.
- Laycock, S.R. and Munro, B.C. (1972) Educational Psychology. London : Pitman Education Library.
- Lovell, K. (1972) The Growth of Basic Mathematical and Scientific Concepts in Children. 5th edn. London : University of London Press.
- Ley, P. (1972) Quantitative Aspects of Psychological Assessment. London : Gerald Duckworth and Co.
- McKellar, P. (1968) Experience and Behaviour. Harmondsworth, Middlesex : Penguin.
- Mager, R.F. and Beach, K.M. (1977) Developing Vocational Instruction. Belmont, California : Fearon.

- Mallinson, G.G. (1977) A Summary of Research in Science Education-1975 (Supplement to Science Education). New York : Wiley.
- Open University (1973) Educational Studies : A Third Level Course. E341 Methods of Educational Enquiry. Bletchley, Bucks. : Open University Press.
- Ormell, C.P. (1974) 'Bloom's Taxonomy and the Objectives of Education', Educ.Res., 17, 1, 3-18.
- Ormerod, M.B. (1973) 'Social and Subject Factors in Attitudes to Science' Sch.Sci.Rev., 54, 189, 645-660.
- Schwirian, P.M. (1968) 'On Measuring Attitudes Towards Science', Sci.Educ., 52, 2, 172-179.
- Shouksmith, G. (1970) Intelligence, Creativity and Cognitive Style. London : Batsford.
- Summer, R. (1974) Looking at School Achievement. Windsor, Berks. : N.F.E.R.
- Swain, J.R.L. (1975) 'Teacher and Pupil Attitudes to Nuffield Physical Science Course', Sch.Sci.Rev., 57, 199, 357-362.
- Tamir, P. (1978) 'Inquiry and Curiosity in Biology', J.Biol.Ed., 12, 3, 215-223.
- Thomas, K. (1971) Attitudes and Behaviour. Selected Readings. Harmondsworth, Middlesex : Penguin.
- Thyne, J.M. (1966) The Psychology of Learning and Techniques of Teaching. 2nd edn. London : University of London Press.
- Vernon, M.D. (1962) The Psychology of Perception. Harmondsworth, Middlesex : Penguin.
- Whitfield, R.C. (1979) 'Educational Research and Science Teaching', Sch.Sci.Rev., 60, 212, 411-430.
- Wood, R. (1977) 'Cable's Comparison Factor : Is This Where Girls' Troubles Start?', Mathematics in School, 6, 4, 18-21.

APPENDIX 1

Pilot Affective Instrument : Sub-scales

1.2 Willing to Receive

1. I would like to learn more about how animals develop.
2. I would like to learn more about how to identify plants.
3. I would like to learn more about dissecting animals and plants.
4. I would like to learn more about evolution.
5. I would like to learn more about the origin of life.
6. I would like to learn more about the structure of animals and plants.
7. I would like to learn more about how plants and animals function.

1.3 Controlled or Selected Attention

8. I would rather watch T.V. than read a biology book.
9. I would rather go out in the evenings than stay in and do homework.
10. I would rather relax at weekends than do college-related work.
11. I would rather follow a sport at weekends than do college work.
12. I would rather rest in the summer vacation than do college work.
13. I would rather do a biology project in the summer vacation than rest or do other work.
14. If there was a Natural History programme on one T.V. channel and a pop programme on the other, I would really prefer to watch the pop programme.
15. I would rather do homework than go out with friends.

2.1 Acquiescence in Response

16. It is important to comply with laboratory rules when doing practical work.

17. If a lecturer asked me to wear a laboratory coat for practical work, I would do so.
18. It is important to follow a lecturer's advice about studying a particular topic.
19. It is important to hand in homework by the deadline set by the lecturer.
20. If a lecturer suggested I did some extra work on a topic, I would do so.
21. If a lecturer recommended a T.V. programme, I would try to see it.

2.2 Willing to Respond

22. My mind sometimes wanders off the subject during biology lessons.
23. I like to leave my homework to the last minute.
24. I always try to get top marks for my work.
25. When given a difficult problem, I like to try to find the answer.
26. I usually work hard for examinations.
27. I dislike being given tests on my classwork.
28. I work hard most of the time.
29. I always try hard to get my homework right.
30. I think that three hour practical lessons in biology are too long.
31. If a biology society was set up at college, I would like to become a member.
32. I would like to do some project work in biology.

2.3 Satisfaction in Response

33. I enjoy most biology lessons.
34. I enjoy doing practical work in biology.
35. I enjoy learning about plants and animals.
36. I enjoy reading books on biology.
37. I enjoy learning about living things.

38. I enjoy watching Natural History programmes on T.V.
39. I enjoy talking about biological problems with people.

3.0 Valuing

40. The study of biology is unrelated to everyday life.
41. Science gives little scope for self-expression.
42. A student who studies biology has less scope for developing personal ideas and opinions than a student who studies history.
43. Biology shows that man is no different to any other animal.
44. A biology teacher is not really a biologist, but a person who shows what biologists do.
45. Studying biology can help one to understand people better.
46. Students who study sciences are less interesting than students who study the arts.

Career Attitudes

47. There are good career prospects in biology.
48. On the whole, biologists who work in industry do dull, routine work.
49. It is very difficult to get a job in biology.
50. Only people with very high qualifications get jobs in biology.

APPENDIX 2

Pilot Affective Instrument : Final Form

[A] and [D] indicate whether maximum weighting is given to an agreement or disagreement response, respectively.

1. I always try hard to get my homework right. [A]
2. If there was a Natural History programme on one T.V. channel and a pop programme on the other, I would really prefer to watch the pop programme. [D]
3. I would like to do some project work in biology. [A]
4. I enjoy learning about living things. [A]
5. It is important to comply with laboratory rules when doing practical work. [A]
6. I like to leave my homework to the last minute. [D]
7. I would like to learn more about the structure of animals and plants. [A]
8. I would like to learn about how to identify plants. [A]
9. I would rather go out in the evenings than stay in and do homework. [D]
10. I dislike being given tests on my classwork. [D]
11. I work hard most of the time. [A]
12. Biology shows that man is no different to any other animal. [A]
13. I would rather rest in the summer vacation than do college work. [D]
14. My mind sometimes wanders off the subject during biology lessons.
[D]
15. I enjoy most biology lessons. [A]

16. I enjoy talking about biology problems with people. [A]
17. The study of biology is unrelated to everyday life. [D]
18. Studying biology can help one to understand people better. [A]
19. Students who study the sciences are less interesting than students who study the arts. [D]
20. A biology teacher is not really a biologist, but a person who shows what biologists do. [D]
21. I enjoy watching Natural History programmes on T.V. [A]
22. I would rather do homework than go out with friends. [A]
23. I usually work hard for exams. [A]
24. If a biology society was set up at college, I would like to become a member. [A]
25. I enjoy learning about plants and animals. [A]
26. On the whole, biologists employed in industry do dull, routine work. [D]
27. I would rather follow a sport at weekends than do college work. [D]
28. It is important to hand in homework by the deadline set by the lecturer. [A]
29. I would like to learn more about the origin of life. [A]
30. If a lecturer suggested I did some extra work on a topic, I would do it. [A]
31. I enjoy doing practical work in biology. [A]
32. If a lecturer asked me to wear a laboratory coat for practical work, I would do so. [A]
33. I would like to learn more about evolution. [A]
34. A student who studies biology has less scope for developing personal ideas and opinions than a student who studies history. [D]
35. I would like to learn more about how animals develop. [A]
36. I would rather watch T.V. than read a biology book. [D]

37. Only people with very high qualifications get jobs in biology. [D]
38. It is important to follow a lecturer's advice about studying a particular topic. [A]
39. I would like to learn more about dissecting animals and plants. [A]
40. Science gives little scope for self expression. [D]
41. I would like to learn more about how plants and animals function. [A]
42. When given a difficult problem I like to try and find the answer. [A]
43. I enjoy reading books on biology. [A]
44. I would rather do a biology project in the summer vacation than rest or do other work. [A]
45. I think that three hour practical lessons in biology are too long. [D]
46. It is very difficult to get a job in biology. [D]
47. There are good career prospects in biology. [A]
48. I always try to get top marks for my work. [A]
49. I would rather relax at weekends than do college work. [D]
50. If a lecturer recommended a T.V. programme, I would try to watch it. [A]

APPENDIX 3

Pilot Affective Instrument : Score Sheet

NAME
DATE
AFFECTIVE INSTRUMENT

-
- | | | |
|---------------|---------------|---------------|
| 1. A B C D E | 18. A B C D E | 35. A B C D E |
| 2. A B C D E | 19. A B C D E | 36. A B C D E |
| 3. A B C D E | 20. A B C D E | 37. A B C D E |
| 4. A B C D E | 21. A B C D E | 38. A B C D E |
| 5. A B C D E | 22. A B C D E | 39. A B C D E |
| 6. A B C D E | 23. A B C D E | 40. A B C D E |
| 7. A B C D E | 24. A B C D E | 41. A B C D E |
| 8. A B C D E | 25. A B C D E | 42. A B C D E |
| 9. A B C D E | 26. A B C D E | 43. A B C D E |
| 10. A B C D E | 27. A B C D E | 44. A B C D E |
| 11. A B C D E | 28. A B C D E | 45. A B C D E |
| 12. A B C D E | 29. A B C D E | 46. A B C D E |
| 13. A B C D E | 30. A B C D E | 47. A B C D E |
| 14. A B C D E | 31. A B C D E | 48. A B C D E |
| 15. A B C D E | 32. A B C D E | 49. A B C D E |
| 16. A B C D E | 33. A B C D E | 50. A B C D E |
| 17. A B C D E | 34. A B C D E | |
-

How to score your answers

A- strongly agree, B- agree, C- uncertain, D- disagree, E- strongly disagree

APPENDIX 4

Indices of Favourability for Pilot Items

1.2 Willing to Receive

<u>Item No.</u>	<u>First Year Index(%)</u>	<u>Second Year Index(%)</u>
7	77	88
8	81	77
29	86	88
33	79	90
35	80	87
39	79	86
41	80	84

Product moment correlation coefficient $r = -0.07$ (N.S.)

1.3 Controlled or Selected Attention

<u>Item No.</u>	<u>First Year Index(%)</u>	<u>Second Year Index(%)</u>
2	57	71
9	44	51
13	44	59
22	41	51
27	57	70
36	59	66
44	49	58
49	47	51

Product moment correlation coefficient $r = 0.89$ ($p < 0.01$)

2.1 Acquiescence in Response

<u>Item No.</u>	<u>First Year Index(%)</u>	<u>Second Year Index(%)</u>
5	96	92
28	87	86
30	77	79
32	91	91
38	86	79
50	83	87

Product moment correlation coefficient $r = 0.79$ ($p < 0.05$)

2.2 Willing to Respond

<u>Item No.</u>	<u>First Year Score(%)</u>	<u>Second Year Score(%)</u>
1	84	81
3	61	71
6	84	73
10	66	77
11	77	66
14	51	58
23	83	76
24	63	69
42	80	86
45	73	71
48	79	77

Product moment correlation coefficient $r = 0.68$ ($p < 0.05$)

2.3 Satisfaction in Response

<u>Item No.</u>	<u>First Year Index(%)</u>	<u>Second Year Index(%)</u>
4	91	93
15	84	86
16	61	81
21	77	82
25	84	88
31	79	80
43	67	79

Product moment correlation coefficient $r = 0.99$ ($p < 0.001$)

3.0 Valuing

<u>Item No.</u>	<u>First Year Index(%)</u>	<u>Second Year Index(%)</u>
17	86	96
18	60	67
19	77	83
20	69	74
34	90	89
40	80	80

Product moment correlation coefficient $r = 0.92$ ($p < 0.01$)

Career Attitudes

<u>Item No.</u>	<u>First Year Index(%)</u>	<u>Second Year Index(%)</u>
26	64	69
37	57	76
46	60	61
47	73	76

Product moment correlation coefficient $r = 0.33$ (N.S.)

APPENDIX 5

Affective II Instrument : Sub-scales

[A] and [D] indicate whether maximum weighting is to be given to an agreement or disagreement response, respectively.

1.2 Willing to Receive

1. I would like to know more about how animals develop. [A]
2. I would like to know more about how to identify plants. [A]
3. I would like to know more about dissecting animals and plants. [A]
4. I would like to know more about how animals and plants have evolved. [A]
5. I would like to know more about how life began. [A]
6. I would like to know more about the structure of animals and plants. [A]
7. I would like to know more about how animals and plants function. [A]
8. I would like to know more about animal behaviour. [A]
9. I would like to know more about how characteristics are inherited. [A]
10. I would like to know more about recent advances in biology. [A]

1.3 Controlled or Selected Attention

1. I would rather watch T.V. than read a book on Natural History/Biology. [D]
2. Given a choice between visiting a stately home and a zoo, I would rather visit the zoo. [A]

3. If I had to go to a 90 minute illustrated talk on 'Local Wildlife', my mind would wander very easily. [D]
4. I would rather read one of the following types of book than one on Natural History :
 - A. A novel. [D]
 - B. A crime story. [D]
 - C. A book on sport. [D]
5. I would rather watch a Natural History television programme than :
 - A. A programme on current affairs. [A]
 - B. A programme on pop music. [A]
 - C. A comedy programme. [A]
 - D. A television play. [A]

2.1 Acquiescence in Response

1. It is important to follow a lecturer's advice about studying a particular topic. [A]
2. It is not very important to hand in homework by the deadline set by the lecturer. [D]
3. If a lecturer suggested I did some extra work on a topic, I would do it. [A]
4. If a lecturer recommended a T.V. programme, I would try to see it. [A]
5. If a lecturer recommended that I join an extra tutorial class, I would probably not turn up. [D]
6. I would probably not consult a library book recommended by a lecturer. [D]
7. When doing practical work it is important to follow laboratory rules. [A]
8. I would not always follow a lecturer's advice. [D]
9. If a lecturer asked me to do some extra work in the lunch hour, I

would prefer not to do it. [D]

10. If a lecturer asked me to wear protective clothing, I would do so.

[A]

2.2 Willing to Respond

1. I like to leave my homework to the last minute. [D]

2. I always try to get top marks for my work. [A]

3. When given a difficult problem, I like to try to find the answer. [A]

4. I do not usually work hard for exams. [D]

5. I dislike being given tests on my classwork. [D]

6. I work hard most of the time. [A]

7. I do not always try to get my homework right. [D]

8. If a biology society was set up at college, I would not want to join. [D]

9. I would like to do some project work in biology. [A]

10. If a weekend field course was run in biology, I would like to go on it. [A]

2.3 Satisfaction in Response

1. I enjoy most biology lessons. [A]

2. I do not enjoy doing practical work in biology. [D]

3. I enjoy learning about plants. [A]

4. I enjoy learning about animals. [A]

5. I do not enjoy reading books on biology/Natural History. [D]

6. I do not enjoy doing biology homework. [D]

7. I do not enjoy watching Natural History programmes on T.V. [D]

8. I enjoy talking about biological problems with people. [A]

9. I do not enjoy learning about living things. [D]

10. I enjoy working in a biology laboratory. [A]

3.1 Acceptance of a Value

1. The study of biology is unrelated to everyday life. [D]
2. Studying biology can help one to understand people better. [A]
3. A biologist has less scope for developing personal ideas than a historian. [D]
4. Biology students are less interesting than students studying modern languages. [D]
5. All school pupils should have to follow a basic biology course. [A]
6. I feel that a set of rules for working in the laboratory is not essential. [D]
7. The study of biology makes an important contribution to a person's overall education. [A]
8. By studying biology people develop a better understanding of themselves. [A]
9. Studying biology can give people a better understanding of the world around them. [A]
10. For most people a biology course is of little value. [D]

3.2 Preference for a value

1. I would like to see more Natural History films produced for T.V. [A]
2. I am glad we don't have to do a field course in biology. [D]
3. There is not enough time on the timetable for a thorough study of biology. [A]
4. If biology books were cheaper, I would like to own more. [A]
5. There is nothing special about biology compared with other subjects. [D]

3.3 Commitment

1. If biology was removed from the 'O' and 'A' level options, I would make an appointment with the course director to register my

protest. [A]

2. If a biology society was set up in the college, I would try to seek election to the committee. [A]
3. If a local newspaper printed an article, which I knew misrepresented some aspect of biology, then I would write a letter to the editor.
[A]
4. If a fellow student disagreed with my views on a particular topic (eg. conservation), I would try to convert him/her to my way of thinking. [A]
5. Nothing will make me change my mind about wanting to study biology.

[A]

STUDENT ATTITUDES IN BIOLOGY *No 2*

G.I. BENTLEY

THE OPEN UNIVERSITY

Introduction to the Project

The questions in this booklet are part of a project, under the direction of the Open University, to discover how the attitudes of biology students are related to their future success.

Most of the students asked to participate will be studying a biological subject. Some students, however, are being asked to participate because they are not biology students. We would like the non-biology students to answer the questions as best they can, since their answers will be particularly valuable for comparison with those of biology students.

The booklet contains a series of questions. We would like you to answer them with complete honesty, bearing in mind that since they ask, on the whole, for your opinions, there are no 'right' or 'wrong' answers. It is most important that you choose the answer that most accurately reflects your own opinion, rather than an answer that appears to make you more virtuous than you really are!

For our part, we guarantee that the information you give will only be used for this project and will not be made available to your teachers. Thankyou for helping with the project.

The Open University

How to fill in the Answer Sheet

For each of the questions there are five possible answers :

- a - Strongly agree
- b - Agree
- c - Uncertain
- d - Disagree
- e - Strongly disagree

Please put a ring around the answer you think is most appropriate. If you were, for example, uncertain about your answer to a question you would put a ring around the letter 'c'. Thus your answer would be a b c d e.

If you put a ring through a letter and then change your mind, please cross out the letter and put a ring around your new answer. If, for example, you ringed the letter 'd' and then changed your mind to the letter 'e', your answer would look like this a b c ~~d~~ e.

Please answer all of the questions and remember that your answers will only be of use if they are absolutely honest !

Thankyou.

Please answer these questions on the Answer Sheet provided.

Section One

1. I would like to know more about how animals develop.
2. I would like to know more about how to identify plants.
3. I would like to know more about dissecting animals and plants.
4. I would like to know more about how plants and animals have evolved.
5. I would like to know more about how life began.
6. I would like to know more about the structure of animals and plants.
7. I would like to know more about how animals and plants function.
8. I would like to know more about animal behaviour.
9. I would like to know more about how characteristics are inherited.
10. I would like to know more about recent advances in biology.

Section Two

1. I would rather watch T.V. than read a book on Natural History/Biology.
2. Given a choice between visiting a stately home and a zoo, I would prefer to visit the zoo.
3. If I had to go to a 90 minute illustrated talk on 'Local Wildlife', my mind would wander very easily.
4. I would rather read one of the following types of book than one on Natural History :
 - A. A novel.
 - B. A crime story.
 - C. A book on sport.
5. I would rather watch a Natural History television programme than :
 - A. A programme on current affairs.
 - B. A programme on pop music.
 - C. A comedy programme.
 - D. A television play.

Section Three

1. It is important to follow a lecturer's advice about studying a particular topic.
2. It is not very important to hand in work by the deadline set by the lecturer.
3. If a lecturer suggested I did some extra work on a topic, I would do it.
4. If a lecturer recommended a T.V. programme, I would try to see it.
5. If a lecturer recommended that I join an extra tutorial class, I would probably not turn up.
6. I would probably not consult a library book recommended by a lecturer.
7. When doing practical work it is important to follow laboratory rules.
8. I would not always follow a lecturer's advice.
9. If a lecturer asked me to do some extra work in the lunch hour, I would prefer not to do it.
10. If a lecturer asked me to wear protective clothing, I would do so.

Section Four

1. I like to leave my homework to the last minute.
2. I always try to get top marks for my work.
3. When given a difficult problem, I like to try to find the answer.
4. I do not usually work hard for exams.
5. I dislike being given tests on my classwork.
6. I work hard most of the time.
7. I do not always try to get my homework right.
8. If a biology society was set up at the college, I would not want to join.
9. I would like to do some project work in biology.
10. If a weekend field course was run in biology, I would like to go on it.

Section Five

1. I enjoy most lessons.
2. I do not enjoy doing practical work in biology.
3. I enjoy learning about plants.
4. I enjoy learning about animals.
5. I do not enjoy reading books on Natural History/Biology.
6. I do not enjoy doing biology homework.
7. I do not enjoy watching Natural History programmes on T.V.
8. I enjoy talking about biological problems with people.
9. I do not enjoy learning about living things.
10. I enjoy working in a biology laboratory.

Section Six

1. The study of biology is unrelated to everyday life.
2. Studying biology helps one to understand people better.
3. A biologist has less scope for developing personal ideas than a historian.
4. Biology students are less interesting than students studying modern languages.
5. All school pupils should have to follow a basic biology course.
6. I feel that a set of rules for working in the laboratory is not essential.
7. The study of biology makes an important contribution to a person's overall education.
8. By studying biology people develop a better understanding of themselves.
9. Studying biology can give people a greater interest in the world around them.
10. For most people a biology course is of little value.

Section Seven

1. I would like to see more Natural History films produced for T.V.
2. I am glad we do not have to do a field course in biology.
3. There is not enough time on the timetable for a thorough study of biology.
4. If biology books were cheaper, I would like to own more.
5. There is nothing special about biology compared with other subjects.

Section Eight.

1. If biology was removed from the 'O' and 'A' level options, I would make an appointment with the course director to register my protest.
2. If a biology society was set up at the college, I would try to seek election to the committee.
3. If a local newspaper printed an article, which I knew misrepresented some aspect of biology, then I would write a letter to the editor.
4. If a fellow student disagreed with my views on a particular topic (eg. conservation), I would try to convert him/her to my way of thinking.
5. Nothing will make me change my mind about wanting to study biology.

APPENDIX 7

NAME
DATE

a- Strongly agree b- Agree c- Uncertain d- Disagree e- Strongly disagree

<u>Section One</u>	<u>Section Three</u>	<u>Section Five</u>	<u>Section Seven</u>
1 a b c d e	1 a b c d e	1 a b c d e	1 a b c d e
2 a b c d e	2 a b c d e	2 a b c d e	2 a b c d e
3 a b c d e	3 a b c d e	3 a b c d e	3 a b c d e
4 a b c d e	4 a b c d e	4 a b c d e	4 a b c d e
5 a b c d e	5 a b c d e	5 a b c d e	5 a b c d e
6 a b c d e	6 a b c d e	6 a b c d e	
7 a b c d e	7 a b c d e	7 a b c d e	
8 a b c d e	8 a b c d e	8 a b c d e	
9 a b c d e	9 a b c d e	9 a b c d e	
10 a b c d e	10 a b c d e	10 a b c d e	
<u>Section Two</u>	<u>Section Four</u>	<u>Section Six</u>	<u>Section Eight</u>
1 a b c d e	1 a b c d e	1 a b c d e	1 a b c d e
2 a b c d e	2 a b c d e	2 a b c d e	2 a b c d e
3 a b c d e	3 a b c d e	3 a b c d e	3 a b c d e
4A a b c d e	4 a b c d e	4 a b c d e	4 a b c d e
4B a b c d e	5 a b c d e	5 a b c d e	5 a b c d e
4C a b c d e	6 a b c d e	6 a b c d e	
5A a b c d e	7 a b c d e	7 a b c d e	
5B a b c d e	8 a b c d e	8 a b c d e	
5C a b c d e	9 a b c d e	9 a b c d e	
5D a b c d e	10 a b c d e	10 a b c d e	

STUDENT ATTITUDES IN BIOLOGYNOTES FOR THE SUPERVISOR

YOU HAVE BEEN PROVIDED WITH

	QUESTIONNAIRE BOOKLETS	GROUP
	ANSWER SHEETS	

1. Please distribute questionnaires and answer sheets at the rate of one per student.
2. Please explain to students that they are being asked to help with an Open University project on attitudes of biology students. Some students will not be studying biology at the college- they will be used as a control group and should answer questions as best they can.
3. Please reassure the students that the information they provide is completely confidential and will not be available to staff at the college.

PROCEDURE

1. Please ask students to turn to the 'Introduction to the Project' in the booklet and give them time to read it.
2. Turn over the page and read 'How to fill in the Answer Sheet'. Ask if everyone is happy about what is involved - and deal with any queries.
3. Turn over and begin the questions. Ask students to mark the answer sheet and not to mark the question booklet in any way.

There is no time limit, but students ought to be able to finish in about 30 minutes.

Please return booklets and answer sheets to me in Room 506.

Thankyou for your help.

Ian Bentley

APPENDIX 9. SPECIMEN DATA SHEET

NAME	
------	--

SEX	
-----	--

Gp	
----	--

REASONING	
MATHS	
VERBAL	

CSE BIOL.	
GCE BIOL.	
CSE SCI.	
GCE SCI.	

MOCK PAV	
NORMALISED T	

	AFFECTIVE II
1	
2	
3	
4	
5	
6	
7	
8	

AFFECTIVE PROFILE								
	1	2	3	4	5	6	7	8
100								
90								
80								
70								
60								
50								
40								
30								
20								

APPENDIX 10. DATA SHEET FOR STUDENT 'A'.

NAME	Student 'A'
------	-------------

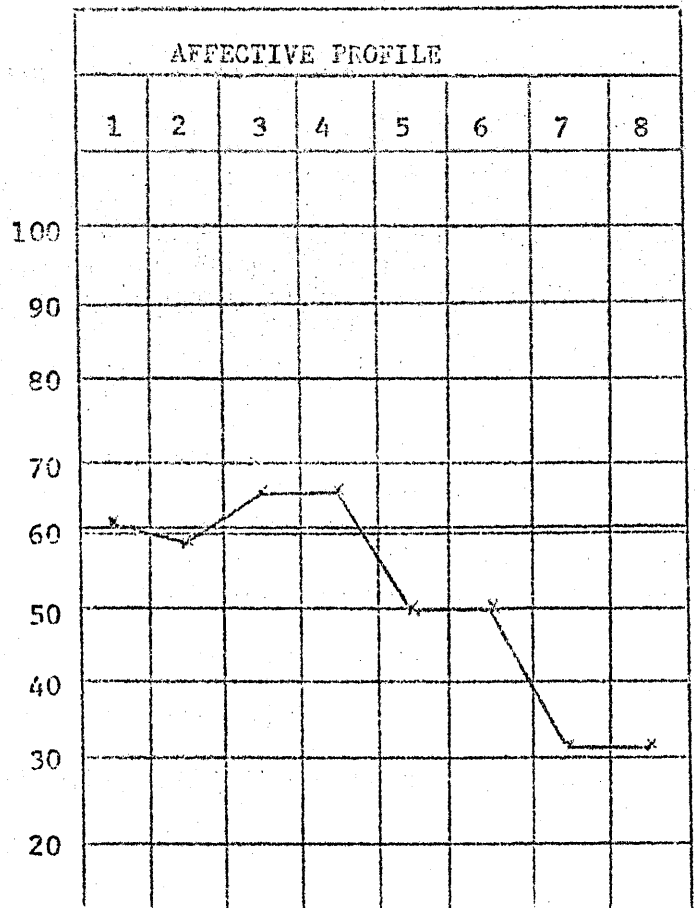
SEX	F
-----	---

Gp	HEPE
----	------

REASONING	112
MATHS	11.0
VERBAL	V-
CSE BIOL	-
GCE BIOL	-
CSE SCI	-
GCE SCI	-

	AFFECTIVE II
1	62
2	58
3	66
4	66
5	50
6	50
7	32
8	32

MOCK RAW	17
NORMALISED T	34



APPENDIX 11. DATA SHEET FOR STUDENT 'B'.

NAME	Student 'B'
------	-------------

SEX	M
-----	---

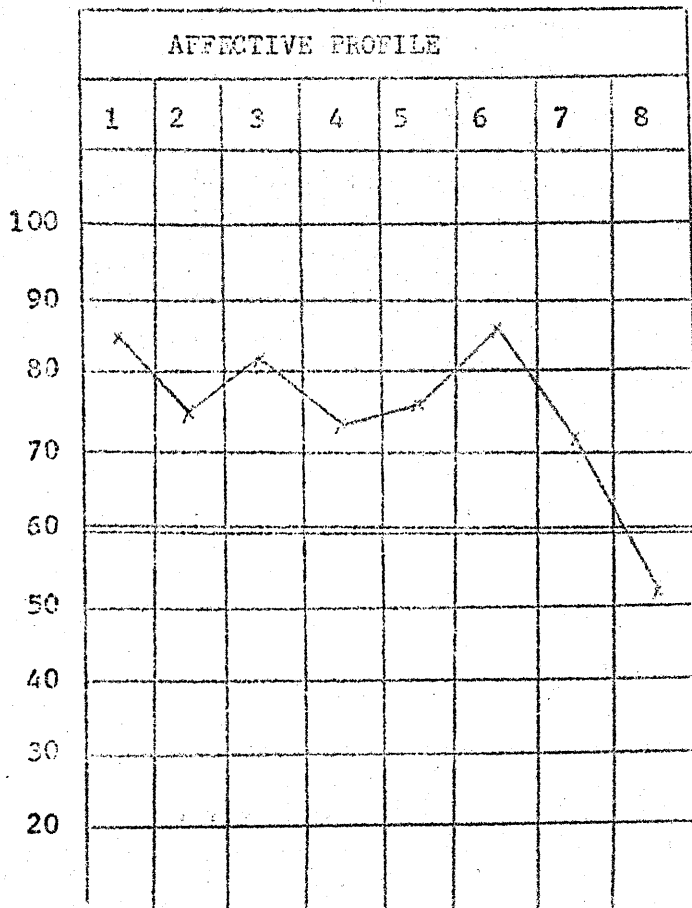
Gp	AL1 Bo/Zo
----	-----------

REASONING	116
MATHS	12.4
VERBAL	IV

	AFFECTIVE II
1	86
2	76
3	82
4	74
5	76
6	86
7	72
8	52

CSE BIOL	-
GCE BIOL	A
CSE SCI	-
GCE SCI	-

MOCK RAW	66
NORMALISED T	51



APPENDIX 12. DATA SHEET FOR STUDENT 'C'.

NAME	Student 'C'
------	-------------

SEX	F
-----	---

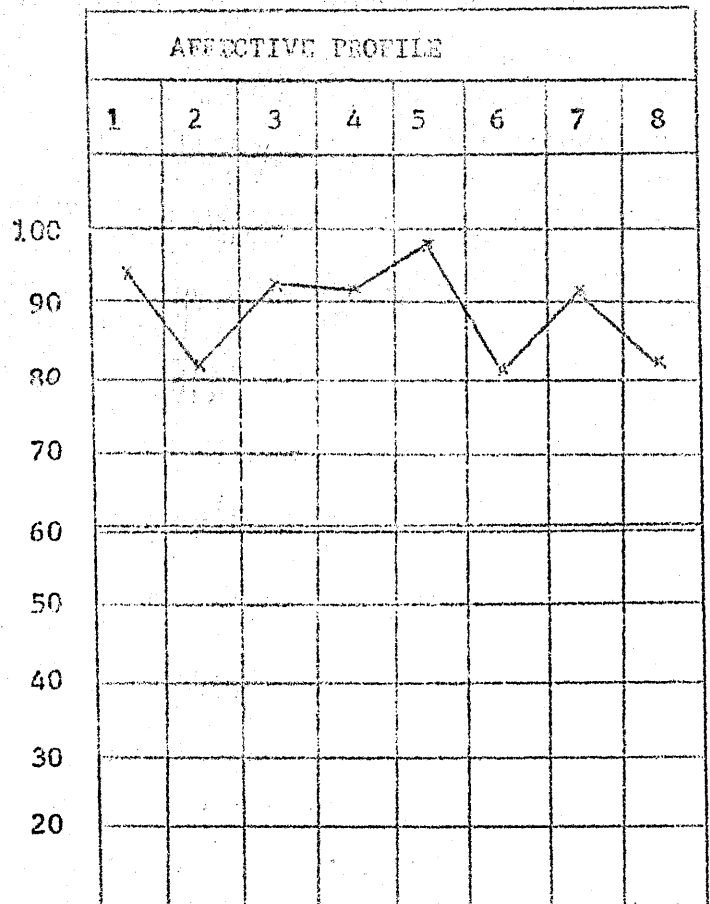
Gp	AL1 Bo/ZO
----	-----------

REASONING	105
MATHS	10.4
VERBAL	IV

	AFFECTIVE II
1	94
2	82
3	94
4	92
5	98
6	82
7	92
8	84

CSE BIOL	-
GCE BIOL	-
CSE SCI	-
GCE SCI	-

MOCK RAW	90
NORMALISED T	67



APPENDIX 13. DATA SHEET FOR STUDENT 'D'.

NAME	Student 'D'
------	-------------

SEX	M
-----	---

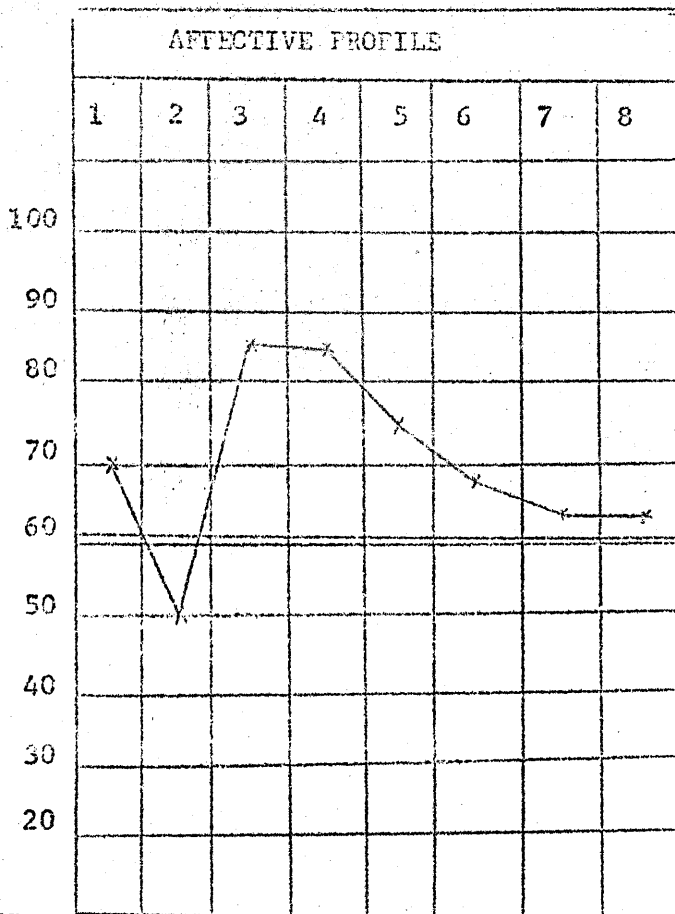
GP	O Bh
----	------

REASONING	123
MATHS	13.8
VERBAL	IV

	AFFECTIVE II
1	70
2	50
3	86
4	84
5	74
6	68
7	64
8	64

CSE BIOL	Bh 3
GCE BIOL	-
CSE SCI	-
GCE SCI	-

MOCK RAW	44
NORMALISED T	56



APPENDIX 14. DATA SHEET FOR STUDENT 'E'.

NAME	Student 'E'
------	-------------

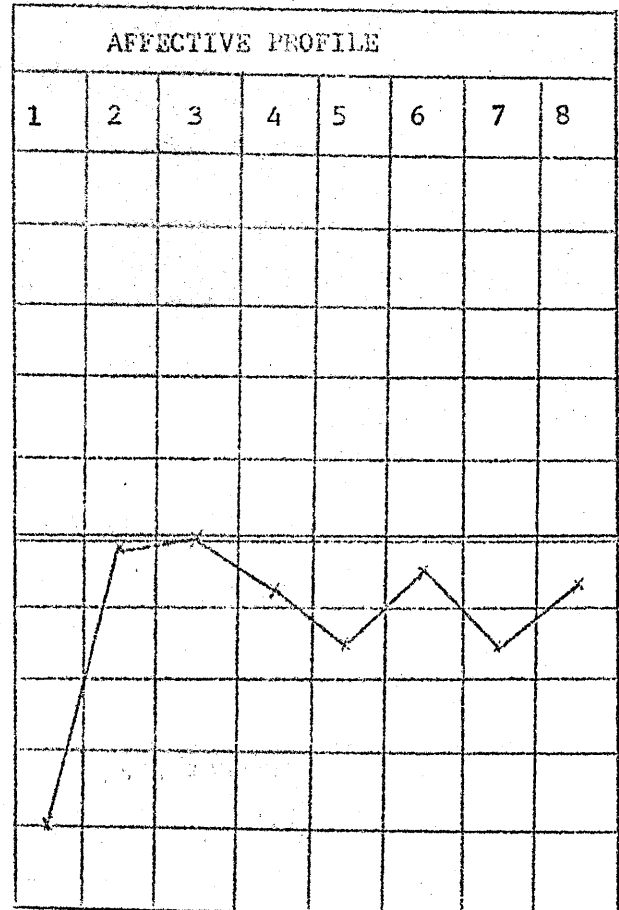
SEX	M
-----	---

Gp	0
----	---

REASONING	116
MATHS	12.6
VERBAL	IV+

	AFFECTIVE II
1	20
2	58
3	60
4	52
5	44
6	56
7	44
8	52

CSE BIOL	-
GCE BIOL	-
CSE SCI	-
GCE SCI	-



APPENDIX 15. AFFECTIVE PROFILES OF STUDENT 'F'.

NAME	Student 'F'
------	-------------

SEX	F
-----	---

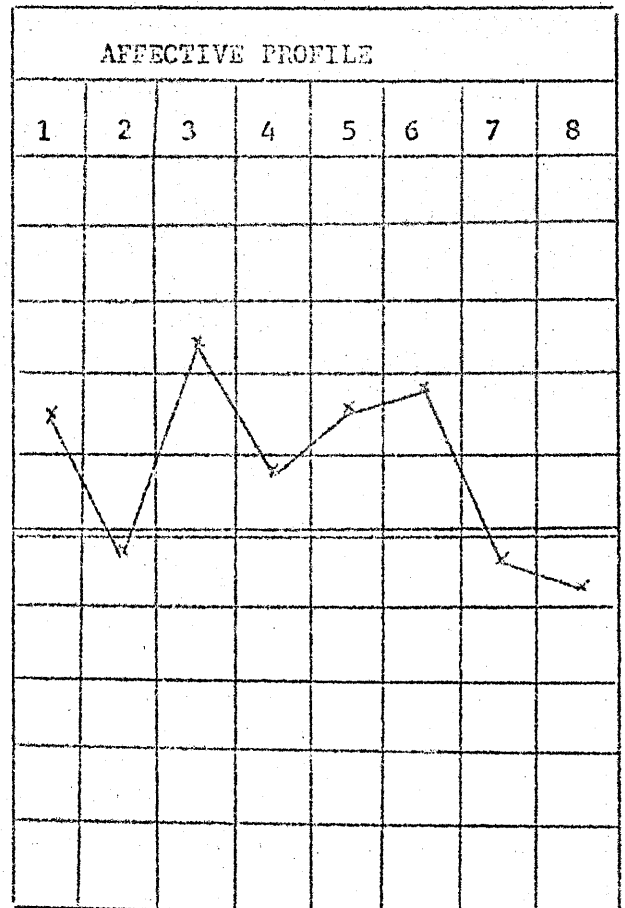
Gp	SPE
----	-----

REASONING	95
MATHS	14.6
VERBAL	III-

	AFFECTIVE II
1	76
2	58
3	84
4	68
5	76
6	78
7	56
8	52

CSE BIOL	1
GCE BIOL	-
CSE SCI	2
GCE SCI	-

MOCK PAW	65
NORMALISED T	63



APPENDIX 15. cont.

NAME	Student 'E'
------	-------------

SEX	F
-----	---

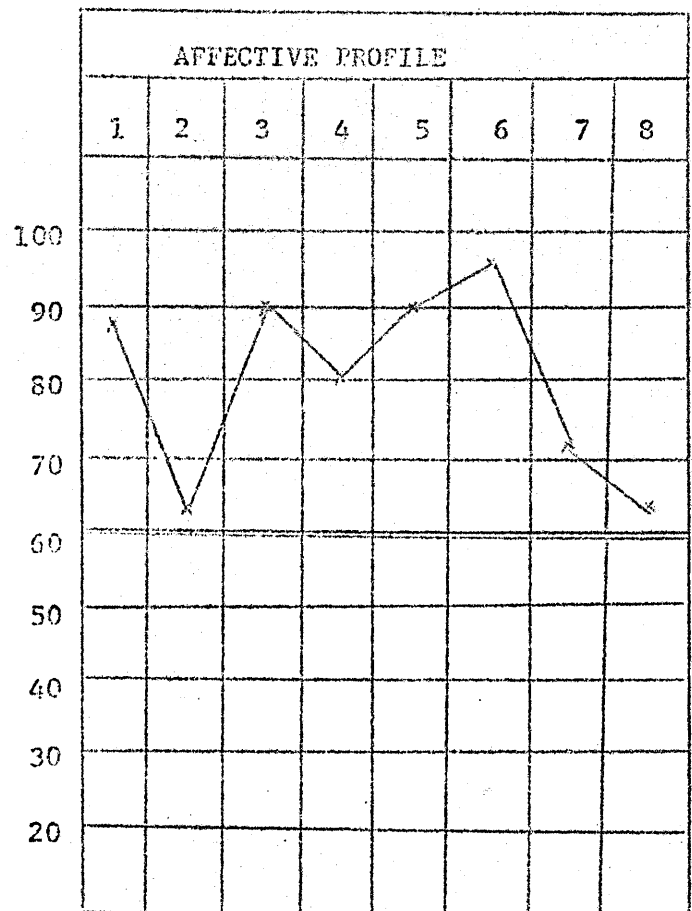
Gp	ALL Bo/Zo
----	-----------

REASONING	95
MATHS	14.6
VERBAL	III-

	AFFECTIVE II
1	88
2	64
3	90
4	80
5	90
6	96
7	72
8	64

CSE BIOL	1
GCE BIOL	B
CSE SCI	2
GCE SCI	-

MOCK RAW	51
NORMALISED T	41



APPENDIX 16. SAMPLE QUESTION ANALYSIS SHEET FOR 1977-1978 GROUP

AFFECTIVE II ANALYSIS OF THE INSTRUMENT

1977-1978 GROUP

Sec	Qu	I would like to know more about dissecting animals and plants.
1	3	

GROUP	SPECIFICATION	MEAN	N
O.L.	All biological Sc	3.44	52
	Bh only	2.88	34
	Bi only	4.00	18
	Male Bh + Bi	3.80	20
	Female Bh + Bi	3.08	32
	SPE	3.87	15
	FNA	3.83	18
	HEPE	3.73	15
TOTAL	O	3.62	100
AL1	Bi	3.39	18
	Bo/Zo	4.22	9
	Bi/Bo/Zo	3.81	27
	Male Bi/Bo/Zo	4.50	10
	Female Bi/Bo/Zo	3.12	17
AL2	Bi	3.14	14
	Bo/Zo	4.11	9
	Bi/Bo/Zo	3.63	23
	Male Bi/Bo/Zo	4.17	12
	Female Bi/Bo/Zo	3.09	11
TOTAL	A	3.72	50

APPENDIX 17

Correlation Matrix for 0-level Human Biology

	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	R	V	S
1.2	1.00	0.14	0.00	0.31*	0.57***	0.28*	0.39**	0.43**	0.12	0.12	0.05
1.3		1.00	0.14	0.03	0.15	0.11	0.55***	0.14	0.27*	0.06	0.02
2.1			1.00	0.51***	0.34**	0.24	0.05	0.33*	0.07	0.17	0.19
2.2				1.00	0.55***	0.28	0.38**	0.37**	0.03	0.08	0.06
2.3					1.00	0.20	0.50***	0.38**	0.15	0.28*	0.02
3.1						1.00	0.13	0.32*	0.05	0.22	0.06
3.2							1.00	0.36**	0.04	0.14	0.12
3.3								1.00	0.17	0.12	0.16
R									1.00	0.14	0.30*
V										1.00	0.06
S											1.00

N = 49

SIGNIFICANCE	
P < 0.001	***
P < 0.01	**
P < 0.05	*

APPENDIX 18

Correlation Matrix for 0-level Biology

	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	R	V	S
1.2	1.00	0.02	0.34	0.25	0.53 ^{***}	0.01	0.50 ^{***}	0.52 ^{***}	0.04	0.22	0.05
1.3		1.00	0.00	0.27	0.45 ^{**}	0.19	0.31	0.28	0.31	0.20	0.10
2.1			1.00	0.51 ^{***}	0.44 [*]	0.18	0.05	0.18	0.14	0.17	0.04
2.2				1.00	0.48 [*]	0.20	0.08	0.21	0.22	0.34	0.00
2.3					1.00	0.45 [*]	0.61 ^{**}	0.65 ^{***}	0.05	0.33	0.08
3.1						1.00	0.04	0.39	0.03	0.16	0.00
3.2							1.00	0.74 ^{***}	0.12	0.20	0.24
3.3								1.00	0.17	0.29	0.36
R									1.00	0.46 [*]	0.14
V										1.00	0.31
S											1.00

N = 23

SIGNIFICANCE
p < 0.001 ***
p < 0.01 **
p < 0.05 *

APPENDIX 19

Correlation Matrix for Science Pre-entry Group

	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	R	V	S
1.2	1.00	0.10	0.11	0.25	0.38*	0.21	0.36	0.43**	0.01	0.10	0.24
1.3		1.00	0.10	0.15	0.50**	0.07	0.31	0.06	0.03	0.25	0.17
2.1			1.00	0.24	0.39*	0.23	0.14	0.10	0.12	0.21	0.08
2.2				1.00	0.53***	0.38*	0.41*	0.12	0.07	0.08	0.24
2.3					1.00	0.54***	0.60***	0.26	0.06	0.32*	0.14
3.1						1.00	0.35*	0.18	0.16	0.12	0.30
3.2							1.00	0.35*	0.23	0.20	0.19
3.3								1.00	0.21	0.05	0.29
R									1.00	0.13	0.12
V										1.00	0.08
S											1.00

N = 32

SIGNIFICANCE	
p < 0.001	***
p < 0.01	**
p < 0.05	*

APPENDIX 20

Correlation Matrix for Home Economics Pre-entry Group

	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	R	V	S
1.2	1.00	$\bar{0}.10$	0.23	0.20	0.32	0.50	0.65*	0.29	$\bar{0}.14$	0.13	0.47
1.3		1.00	0.26	0.42	0.68**	$\bar{0}.13$	$\bar{0}.08$	0.48	0.00	0.38	0.22
2.1			1.00	$\bar{0}.11$	0.26	0.29	0.03	0.34	$\bar{0}.56^*$	$\bar{0}.16$	$\bar{0}.03$
2.2				1.00	0.75**	0.34	0.50	0.64*	$\bar{0}.16$	0.10	0.39
2.3					1.00	0.43	0.52	0.85***	$\bar{0}.06$	0.35	0.63*
3.1						1.00	0.61*	0.33	$\bar{0}.39$	$\bar{0}.20$	0.61*
3.2							1.00	0.47	$\bar{0}.16$	0.12	0.54
3.3								1.00	$\bar{0}.33$	0.09	0.26
R									1.00	0.63*	0.30
V										1.00	0.57*
S											1.00

N = 11

SIGNIFICANCE	
P < 0.001	***
P < 0.01	**
P < 0.05	*

APPENDIX 21

Correlation Matrix for Pre-nursing Group

	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	R	V	S
1.2	1.00	0.02	0.12	0.33	0.47*	0.31	0.41*	0.36*	0.03	0.12	0.11
1.3		1.00	0.00	0.01	0.29*	0.06	0.36*	0.05	0.10	0.13	0.06
2.1			1.00	0.54***	0.36*	0.34*	0.13	0.37*	0.10	0.12	0.05
2.2				1.00	0.45***	0.30*	0.26*	0.44***	0.08	0.27*	0.15
2.3					1.00	0.41*	0.59***	0.55***	0.12	0.05	0.15
3.1						1.00	0.48***	0.33*	0.11	0.08	0.35**
3.2							1.00	0.34*	0.11	0.07	0.27*
3.3								1.00	0.08	0.07	0.07
R									1.00	0.58***	0.44***
V										1.00	0.33*
S											1.00

N = 56

SIGNIFICANCE	
p < 0.001	***
p < 0.01	**
p < 0.05	*

APPENDIX 22

Correlation Matrix for First Year A-level Biology Group

	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	R	V	S
1.2	1.00	0.65*	0.72**	0.55*	0.63*	0.70**	0.62*	0.46	$\bar{0}.54$	0.21	0.21
1.3		1.00	0.60*	0.61*	0.72**	0.59*	0.67*	0.77**	$\bar{0}.38$	$\bar{0}.04$	0.45
2.1			1.00	0.70**	0.76**	0.73**	0.68*	0.39	$\bar{0}.69$ **	$\bar{0}.42$	$\bar{0}.23$
2.2				1.00	0.90***	0.72**	0.51	0.43	$\bar{0}.48$	$\bar{0}.25$	$\bar{0}.07$
2.3					1.00	0.71**	0.76**	0.56*	$\bar{0}.50$	$\bar{0}.12$	0.04
3.1						1.00	0.56*	0.33	$\bar{0}.34$	$\bar{0}.01$	$\bar{0}.21$
3.2							1.00	0.71**	$\bar{0}.43$	$\bar{0}.07$	0.07
3.3								1.00	$\bar{0}.20$	0.03	0.49
R									1.00	0.38	$\bar{0}.03$
V										1.00	0.55*
S											1.00

N = 13

SIGNIFICANCE	
p < 0.001	***
p < 0.01	**
p < 0.05	*

APPENDIX 23

Correlation Matrix for Second Year A-level Biology Group

	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	R	V	S
1.2	1.00	0.01	0.43	0.58*	0.53	0.27	0.56	0.38	0.32	0.70*	0.40
1.3		1.00	0.37	0.28	0.30	0.30	0.05	0.13	0.01	0.18	0.03
2.1			1.00	0.64*	0.72**	0.52	0.33	0.57	0.20	0.22	0.23
2.2				1.00	0.84**	0.79**	0.73**	0.52	0.41	0.50	0.09
2.3					1.00	0.58*	0.55	0.39	0.23	0.28	0.21
3.1						1.00	0.50	0.39	0.07	0.14	0.27
3.2							1.00	0.38	0.47	0.61*	0.05
3.3								1.00	0.26	0.48	0.46
R									1.00	0.53	0.08
V										1.00	0.21
S											1.00

N = 11

SIGNIFICANCE	
p < 0.001	***
p < 0.01	**
p < 0.05	*

APPENDIX 24

Correlation Matrix for First Year A-level Botany/Zoology Group

	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	R	V	S
1.2	1.00	0.61*	0.54	0.81**	0.72*	0.56	0.59	0.72*	0.29	0.07	0.58
1.3		1.00	0.04	0.32	0.30	0.07	0.56	0.44	0.17	0.50	0.56
2.1			1.00	0.74**	0.74**	0.50	0.15	0.47	0.48	0.19	0.45
2.2				1.00	0.90**	0.58	0.71*	0.87**	0.59	0.04	0.70*
2.3					1.00	0.68*	0.69*	0.82**	0.43	0.12	0.65*
3.1						1.00	0.23	0.37	0.37	0.32	0.06
3.2							1.00	0.85**	0.32	0.13	0.70*
3.3								1.00	0.34	0.13	0.65*
R									1.00	0.36	0.31
V										1.00	0.21
S											1.00

N = 9

SIGNIFICANCE	
p < 0.001	***
p < 0.01	**
p < 0.05	*

APPENDIX 25

Correlation Matrix for Second Year A-level Botany/Zoology Group

	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	R..	V	S
1.2	1.00	$\bar{0}.02$	$\bar{0}.14$	$\bar{0}.13$	0.43	0.33	0.24	$\bar{0}.31$	0.53	0.08	0.13
1.3		1.00	0.31	0.65*	0.76**	0.62*	0.77**	0.55	$\bar{0}.38$	$\bar{0}.78$ **	$\bar{0}.05$
2.1			1.00	0.65*	0.39	$\bar{0}.01$	0.23	0.17	0.21	$\bar{0}.55$	0.54
2.2				1.00	0.66*	0.01	0.46	0.65*	0.15	$\bar{0}.50$	0.22
2.3					1.00	0.39	0.82**	0.26	0.09	$\bar{0}.69$	0.43
3.1						1.00	0.35	0.23	$\bar{0}.20$	$\bar{0}.36$	$\bar{0}.28$
3.2							1.00	0.17	$\bar{0}.19$	$\bar{0}.82$ **	0.18
3.3								1.00	0.00	$\bar{0}.06$	$\bar{0}.39$
R									1.00	0.38	0.21
V										1.00	$\bar{0}.36$
S											1.00

N = 9

SIGNIFICANCE	
p < 0.001	***
p < 0.01	**
p < 0.05	*