"THE MEASUREMENT OF AFFECTIVE BEHAVIOUR IN

C.S.E. MATHEMATICS"

A thesis submitted for the degree of Doctor of Philosophy

by M. Preston.

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INTRODUCTION

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The terms 'curriculum development' and 'curriculum change' reflect one of the major trends in education in the 1960's. From a wide variety of sources[1] came recognition of the need to re-examine the content of the curriculum and, if this were found wanting, to provide research facilities to design, test and implement new material.

The majority of these researches appreciated the prime necessity of stating the educational objectives within the specific content areas before proceeding further. As these investigations progressed it became clear that many were developing along a similar theoretical structure. The opportunity for establishing modern curriculum theory was evident to many. The importance to education of the link between theory and practice cannot be overstressed. The application of curriculum theory can be made to all sections of the educational structure. Among the many models of curriculum theory[2] one of the clearest and most adaptable to British education is that developed by Kerr in "The Problem of Curriculum Reform"[3]. This well known model directs attention to four major areas in curriculum development: the recognition and definition of objectives; the related content (knowledge) and its structure; the relevant school learning experiences; and finally the evaluation of both pupil and curriculum.

It is worthwhile to study briefly these four areas in relation to recently completed or current projects. The Schools Council, initially in

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1. Hoyle, E. "How does the curriculum change?", Journal of Curriculum Studies, Vol 1. No. 2., 1969, p. 137, lists these sources as: The Schools Council, Private Foundations, Commercial agencies, Research agencies, Teacher-training institutions, Professional organisations, Her Majesty's Inspectorate, L.E.A. Inspectors and Advisors, Examining Bodies, Teacher's Unions.

2. Johnson, M. "Definitions and Models in Curriculum Theory", Educational Theory 17, April 1967, pp. 127 - 140.

3. Kerr, J.F. "The Problem of Curriculum Reform", Leicester University Press, 1967.

conjunction with the Nuffield Foundation, is the main contributor to current curriculum change[4]. That the Schools Council consciously accepted the need to state objectives in behavioural terms is clear from Banks' report on developments between 1963 and 1968.

> "At the end of the feasibility study one would expect to have not just a statement of educational objectives pertinent to the area of the curriculum under study . . . but rather an attempt to state specific objectives in view in terms which ultimately will be amenable to validation by research in some form."[5]

It is evident from the report that the ensuing stages in Schools Council developments follow very closely the second and third stages of Kerr's model. Banks recognises the importance of the fourth stage - evaluation - but has to report that:

> "inevitably the Schools Council, only four years old, has not much to contribute here yet. The <u>only</u> major thrust in final evaluation so far is the large-scale attempt to assess the effects of introducing French into the Primary school curriculum, undertaken by the National Foundation for Educational Research."[6]

Recently Caston has confirmed the evaluative role for the Council and agreed that it still is far from adequate. He writes:

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4. Schools Council Working Papers, Examination Bulletins, Curriculum Bulletins, have all contributed to curriculum change and hence educational change. Nuffield Foundation - Working guides and similar publications.

5. Banks, L.J. (Curriculum Developments Officer, Schools Council, 1964 - 1968). "Journal of Curriculum Studies", Vol. 1. No. 2., Nov. 1969 p. 249.

6. ibid., p. 258.

"Thirdly I hope the Council to be the front runner in research and development work in new techniques of assessment . . . .. A little is being done already. Much more is needed and it is probably in this respect that the Council has so far disappointed its founders, its members and its staff."[7]

This would seem to suggest two factors in curriculum development. Firstly that no development is complete until some form of evaluation is achieved. This would, in the main, answer many of the criticisms raised in the first Black Paper[8]. Secondly that curriculum change is a long-term development. This is well demonstrated by the changes in primary school mathematics over the last decade; a satisfactory evaluation of the 'discovery' method has still not been made.

It is against this background, and with the realisation of the necessity to provide evaluation, that this work attempts to develop and answer some of the problems raised in an earlier research[9]. The aim of this previous work was to reassess the evaluation procedures at present being employed in the light of a thorough scrutiny of the vital basic issues underlying the development of the C.S.E. mathematics course. The assessment of the evaluative techniques was achieved by detailing the objectives of mathematics teaching at this level; by considering the content of the curriculum; by considering the variety of teaching situations employed; and finally forming the relation-

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7. Caston, G. "Journal of Curriculum Studies", Vol. 3. No. 1., May 1971, p. 62.

8. Cox, C.B. and Dyson, A.E. (eds). "Fight for Education", The Critical Quarterly Society, 1968. 'it is our belief that disastrous mistakes are being made in modern education, and an urgent reappraisal is required of the assumptions on which progressive ideas are based' p. 6.

9. Preston, M. "A study of evaluative techniques in C.S.E. mathematics", unpublished M.Ed. thesis, Leicester University, 1968.

ship between the assessment currently being made and its success in relating to curriculum objectives.

A decisive outcome of this previous work was the evolvement of a three-dimensional model capable of demonstrating the strongest bonds between specific objectives, content and learning situations. Having established the optimum triad for each objective, a hypothesis was formulated that the mode of evaluation most apt to the circumstance could be selected. This supposition held for those objectives identified to be within the cognitive domain. Those within the affective domain:- inventiveness - interest - commitment - were identified within the three-dimensional structure but the fourth dimension of evaluation remained unsatisfied.

The objectives of C.S.E. mathematics were found to lie within seven major areas[10], three of these within the affective domain. Hence a large area of desired behaviour remains unmeasured. Further evidence of this need can be found from a wide variety of sources, showing, in fact, that the problem is not purely restricted to mathematics. In developing the components of scientific ability Fox found that:

> "Creativity, comprehension and literacy appears always to be important. From amongst the other nine clusters different ones stand out as especially significant in particular situations; these are open-mindedness, deduction and inference, knowledge and dexterity, persistence."[11]

A number of these components are ascribed to the affective domain. After considering evaluation processes Fox concludes that objectives within this domain

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10. ibid., p. 46.

11. Eggleston, J.F. and Kerr, J.F. "Studies in Assessment", English University Press, 1969,
Fox, D.H. Study Number Four "Assessing Scientific Ability through Special Studies, p. 162

can only be assessed effectively by the teacher. The subjective nature of an assessment in an area of such complexity must preclude any reliability being placed on the outcome.

Eggleston and Lobel[12] reporting on Study Number Two list one of the objectives of History as - interest, enthusiasm and persistence. Further discussion follows on the importance of attaining these objectives; stress being placed upon the motivational aspect underlying this behaviour. Nevertheless this experimental group failed to grasp the evaluative problem - mainly on account of time - and concluded their discussion on this specific objective by stating:

> "Unless and until we can arrive at acceptable definitions of these behaviours which can provide concrete and reliable evidence of the state of a pupil's motivation, it seems best to reserve this area for those occasions when a description of the pupil is needed to supplement a quantitative assessment of his attainment."[13]

As this particular study was orientated to assessment at C.S.E. level this conclusion must be considered critically. A teacher's assessment of a candidate must inevitably include, knowingly or unwittingly, some appreciation of the development within the affective domain of behaviour. As some examining boards will allow up to 50 per cent of the total assessment for course work, then it can be argued that within this percentage 12½ per cent may well represent the teacher's opinion of the candidate's affective behaviour[14]. Eggleston and Lobel are right to draw attention to the need for this assessment to be reliable but fail to recognise that currently one eighth of the total

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12. ibid., p. 79.

13. ibid., p. 80.

14. op. cit., p. 83. (Preston, M.)

assessment could be attributed to this area of behaviour. This argues that the group should have continued to pay attention to this area of evaluation.

With the rapid development of the curriculum within the sciences over the last decade, the realisation of the need to integrate affective objectives into the pupil's sphere of behaviour has constantly been recognised. Its evaluation has just as regularly been considered to be impracticable and hence shelved. Romberg and Kilpatrick[15] working on a "Study of Evaluation in Mathematics Education" report:

> "The first restriction the group made was to limit its investigation to cognitive behaviour. This does not detract from the importance of affective or psychomotor behaviour. We felt, however, that cognitive behaviour has been described and investigated in enough detail that its components could be discussed. To some extent this is not yet true with other domains of behaviour."

An inquiry into "Practical Work in School Science"[16] identified and emphasised the affective objectives in experimental work, for example:

> "The physicists wanted an examination to test initiative"[17]

The inquiry team went on to suggest possible types of problem that could involve some measure of affective behaviour. However they left the problem at this stage and the type of experimental work suggested may well include some evaluation of affective attainment but this particular aspect cannot be differen-

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15. Romberg, T. and Kilpatrick, J. "Preliminary Study on Evaluation in Mathematics Education". Unpublished material, University of Wisconsin, 1966.

16. Kerr, J.F. et al., "Practical Work in School Science", Leicester University Press, 1964.

17. ibid., p. 61.

tiated from the conglomerate whole.

There should be a sense of urgency to provide a scheme which can help teachers to quantify affective behaviour. The development of a viable system of evaluation of behaviour within this affective framework in mathematics is the objective of this research.

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C H A P T E R I I

THE AFFECTIVE DOMAIN OF BEHAVIOUR

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A convenient starting point for a study of affective behaviour is the taxonomic categorisation of educational objectives produced by Krathwohl (et al[1]) in 1964. This classification of elements of affective behaviour sets out to structure them in an hierarchical order of complexity. Within the limits imposed by the abstract nature of the components the taxonomy succeeds[2] in identifying and ordering the objectives in a logical progression. The five categories represent different positions on a continuum. The continuum, or growth of complexity, is defined as a process of 'internalisation' or -

> "a process through which there is first an incomplete and tentative adoption of only overt manifestations of the desired behaviour and later a more complete adoption."[3]

The evolution of such behaviour is constantly recognised and looked for by teachers in all learning situations. Preston[4] identified a significant degree of agreement that 'commitment' and 'interest' formed basic mathematical objectives and it was clear that teachers felt that these aspects of affective behaviour should be present in all content situations. Lewis[5], reviewing the objectives of science teaching, notes that

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1. Krathwohl, D.R. (et al) "Taxonomy of Educational Objectives - Handbook 2 - The Affective Domain", McKay, New York, 1964.

2. Lewy, A. "The Empirical Validity of major properties of a taxonomy of Affective Educational Objectives", The Journal of Experimental Education, Vol. 36. No. 3., Spring 1968. '- From analyses of the data, we conclude that the constructs of the model have empirical referents among affective educational objectives, and that the hierarchical structure of these referents corresponds to that claimed by the model'.

3. see footnote 1. p. 29.

4. Preston, M. op. cit. pp. 54 - 55.

5. Lewis, D.G. "Objectives in the teaching of science", Educational Research 7:3, 1965, p. 186.

> "all would agree that the stimulation and maintenance of interest is a prerequisite of enlightened teaching."

The affective continuum is shown to advantage in Table 2.1; in addition this table reflects the similarity and extensive overlap of the categories. The equivalence of the terms, particularly within the mid-point range of the continuum, demonstrates the semantic difficulties faced by researchers using the taxonomic model. The linguistic problem encountered must be solved by careful and concise definitions of the terms involved. When discussing this problem Baggaley[6] writes

> "Unfortunately behavioural science has inherited from the common parlance many terms with rather vague meanings, for example, habit, instinct, purpose, role, status. This has meant that in many cases a particular researcher has had to specify rather precisely in which sense he is using a particular term in his investigation. Sometimes new words were coined so as to avoid the excess literary connotation adhering to existing terms."

The affective objectives developed from teachers' completed questionnaires by Preston[7] reflected this problem and, when these objectives were relayed back to other teachers, they had to be translated into concise terms so that the practising teacher, who may not necessarily be a mathematician, can comprehend and relate the objectives to specific learning situations. The pruning of these affective statements inevitably limited and generalised the shades of meaning that the taxonomy had produced in their construction.

The consequence of this semantic difficulty, together with an appreciation

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6. Baggaley, A.R. "Intermediate Correlational Methods". Wiley, New York, 1964 pp. 92 - 93.

7. Preston, M., op. cit., pp. 41 - 42.

The range of meaning typical of commonly used affective terms measured against the Taxonomy continuum

1.1 Awareness

1.2 Willingness to receive

1.3 Controlled or selected attention

2.1 Acquiescence in responding

2.2 Willingness to respond

2.3 Satisfaction in response

3.1 Acceptance of a value

3.2 Preference for a value

3.3 Commitment

4.1 Conceptualisation of a value

4.2 Organisation of a value system

5.1 Generalised set - revalidation of views

5.2 Characterisation of a philosophy - development

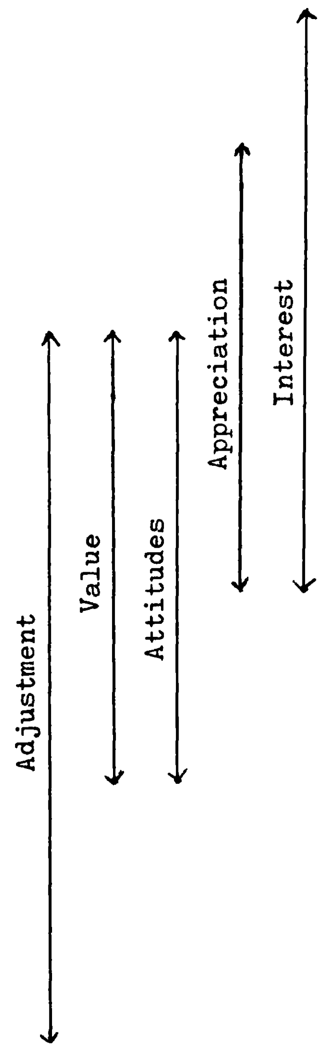

Table 2.1

(Taken from Krathwohl, D.R., et al., op. cit. p. 36) of the objective of this research - the formulation of an evaluative procedure to measure differences in affective attainment - directs attention to the need for a multi-facet instrument where each facet is free from ambiguity but can be identified as relating to a specific area of the affective continuum. The hypothesis at this stage is that an item can be written that is clear in meaning and diagnostic of a specific strength of identifiable behaviour.

The significance that a particular work conveys must vary from person to person, this variation being considerable in the understanding, interpretations and depth of meaning of affective terminology. The uncertainty of affective meanings is a sizeable problem to be faced by the researcher wishing to develop test items within this field. The word 'meaning' itself indicates a certain individuality of thought but nevertheless the successful measurement of meaning in this complex field of behaviour is basic to the success of the research. Osgood[8] has made a particular study of the measurement of meaning. His work has resulted in a method often referred to as 'The Semantic Differential'. This approach, using advanced statistical techniques, isolates three major areas of meaning - evaluative, strength and activity - the evaluation dimension being the most dominant. The semantic differential requires the subject to discriminate on a bi-polar adjectival scale how he rates a particular concept. Osgood[9] states that

> "the semantic differential is proposed as an index of certain aspects of meaning, particularly connotative aspects."

Therefore the semantic differential is basically recording a combination of the participant's associations with the concept involved, together with a scaling procedure which attempts to record the strength of these associations.

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8. Osgood, C.E., Suci, J.G., and Tannenbaum, P.H. "The measurement of Meaning", University of Illinois Press, 1967.

9. ibid., p. 273.

If the instrument is effective and the results easily produced then it might well be possible to use a form of the semantic differential to test the attainment of affective objectives in mathematics. Problems immediately present themselves. The evaluation of a semantic differential procedure is a highly complex undertaking well beyond the scope of the C.S.E. examiner. Secondly, the manner of formation of the pupil's associations with a particular concept must be identified before an effective evaluation instrument can be assembled. The complexity of the semantic differential would appear to prohibit its use unless a simple method for the evaluation of results can be formulated. Its importance in delineating the shades of meaning between two persons cannot be gainsaid and this is one of the prime objectives of this research. Therefore a closer investigation of the possibilities of using the semantic differential in a practical situation will be undertaken.

A further problem that must be confronted is the manner in which the student builds up the associations relevant to the affective domain. A study of the curriculum development process would suggest that the contributing factors are

(1) the associated body of cognitive content;

(2) the learning situation;

(3) society and its immediate culture pattern.

The first factor can be substantiated from a number of sources, to quote a recent research:

> "The frequency of occurrence of statements which implied a keen awareness by teachers of the affective changes which learning brings about, that is changes related to interests, appreciations and attitudes, clearly indicates the hazards of working exclusively in the cognitive domain . . . What we do say is that very often improved affective

behaviour raises the level of cognitive performance and so any assessment of cognitive attainment may be taking account of affective outcomes."[10]

The second factor - the learning situation - provides a considerable source of evidence relating to the formation of attitudes, interests and values. The major components of the learning situation are

(a) the pupil;

(b) the teacher;

(c) the classroom.

A great deal is known about the pupil. Evidence of child development, readiness for learning, cognitive growth etc. is readily available. There is an increasing amount of information at hand in relation to the growth of the pupil's attitudes, beliefs and values. Krathwohl[11] reports that undoubtedly almost every teacher is on the alert for evidence of desirable interests, attitudes and character development. This evidence, however, tends to be that which is almost forced on the teacher's attention and therefore tends to represent abnormal rather than normal behaviour. It is evident that what is missing is a systematic and standardised method of recording behavioural change in this domain. Thus the team developing the taxonomy investigated the growth and formation of the significant aspects of affective development.

The classification of affective objectives ranging from 'low-level' to 'high-level' categories is analogous to the cognitive taxonomy and suggests that the same conclusions can be drawn. That is, that the 'low-level' objectives can be easily and quickly achieved whilst the higher level objectives,

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10. Eggleston, J.F. and Kerr, J.F. op. cit., p. 20

11. Krathwohl, D.R., Bloom, J.S. and Masia, B.B. op. cit., pp. 15 - 86.

particularly in the affective domain, will take considerably longer to achieve. With the Certificate of Secondary Education coming towards the end of the secondary stage of education, it can be reasonably expected that the pupil should reach an affective attainment represented by categories in the mid-point of the classification.

The continuum reflects the growth of interests, appreciations, attitudes, beliefs and values, from the early stage of the student being aware that a particular phenonmenon exists, thus showing a minimal interest, to the stage where the response is voluntary and enthusiastic. Similar scales can be identified for the growth of attitudes, beliefs and values. The similarity to the cognitive growth pattern is very marked and it may well be that the individual facets of behaviour are so inextricably woven as to defy clear definition or measurement. The evidence at the present time, on the relationship between the two domains, is rather perplexing. On the one hand, Eggleston and Kerr produce strong practical evidence from teachers resulting in the following statement:

> "The weft and warp of cognitive and affective behaviours are so intimately interwoven in the fabric of the total effect of our teaching that it is difficult to identify and isolate them."[12]

On the other hand, Aiken and Dreger (1961), Brown and Holtzmann (1955) and Shultz and Green (1955) all report small positive correlations between scores on the attainment of goals in the respective domains, thus establishing the feasibility of making separate measures. Current opinion would see the problem as more complex than is shown by the attempts to measure the direct relationship.

The second facet of the learning situation - the teacher - has attracted

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12. Eggleston, J.F. and Kerr, J.F. op. cit., pp. 12 - 13.

considerable attention recently. An awareness of the potency of the teacher in relation to the pupil's attainment of affective objectives has been demonstrated by the Teaching Research Unit at Birmingham University.[13] Factor analysis of biographical, personality, motivation and attitude variables suggests that science teachers can be categorised into eight personality types. The research team further report that the analysis suggests that each of these 'personality types' may affect the pupil's attitudes in significantly different ways. This would suggest that the attainment of affective objectives within a class is limited by the confines of the teacher's attitudes and beliefs. The Birmingham research is, therefore, extremely relevant to this work, for, at first sight, this would seem to invalidate teachers' assessments of pupils' attainments in the affective domain as they would be reflective of their own attitudes, beliefs and values. Furthermore, any evaluation instrument that is constructed must seek to deduce the true conceptual associations of the pupil and not those imposed by the teacher within the environmental situation of the classroom. If similar results were found in relation to mathematics teachers, and the ethos of science and mathematics being so akin this seems likely, then further study must be undertaken in this aspect of affective evaluation.

The third facet of the learning situation - the classroom - is the environment in which the teacher and pupil find themselves. The actual conditions of the classroom may affect the attainment of affective objectives. However the change in terms of behaviour brought about purely by the surroundings must be very limited and, although this aspect will be borne in mind when developing the evaluation instrument, the hypothesis put forward is that the contribution of this facet is minimal.

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13. Taylor, P.H., Christie, T., Platts, C.V. "Studies in the Structure of Science Teaching", unpublished material, University of Birmingham School of Education, 1970.

The third contributing factor to affective attainment - society and its immediate culture pattern - has a complex composition. Its effect on general affective development is considerable and is not the concern of this research. The extent to which society influences the affective attainment related to individual disciplines is problematical and more likely to be evident at sixth form and university level. An already complex and involved measurement has to be made of relatively short-term behavioural change in the affective domain. It is arguable whether society, within this term of reference, has any identifiable contribution to make over the range of the Certificate of Secondary Education.

The Birmingham research[14] poses considerable problems for the researcher attempting to measure the attainment of affective objectives if the suggested mode of evaluation seeks to involve the teacher. Further evidence of the extent and manner of the teacher's influence on the affective development of children must be examined if a successful and objective measurement is to be made. Amidon and Flanders express in very clear terms the width of the teacher's influence and at the same time show the complexity of the interaction:

> "In the process of this interaction he (the teacher) influences the children, sometimes intentionally with planned behaviour, sometimes consciously without planning but often without awareness of his behaviour and the effect of this behaviour on the learning process."[15]

Following this thesis, the authors justify the need for the teacher to form

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14. ibid.

15. Amidon, E.J., Flanders, N.A. "The role of the teacher in the classroom", Assoc. for Productive Teaching Inc. Minneapolis, 1967. p. 1.

appreciations of his behaviour and, if and where necessary, to alter one or more aspects of his modus operandi. The formation and hardening of attitudes constitute a critical dimension in a child's development. The Birmingham research demonstrates the importance and responsibility of the teacher in this field. If some form of measurement is to be undertaken at the conclusion of a course, then this may well focus the attention of the teacher on the importance of the student's affective development as well as his cognitive attainment.

It has already been suggested that affective behaviour and cognitive growth are inextricably woven. Mussen[16] furthers this view in drawing the conclusion that the components of attitudes are cognitive, affective and connative. Lewis[17] writes of values as influencing and guiding behaviour, and Williams defines a value as

> "any aspect of a situation, event or object that is invested with a preferential interest as being 'good', 'bad', 'desirable' and the like. Values are not concrete goals of action but rather the criteria by which goals are chosen."[18]

The basic elements of attitudes and values are, then, an involvement in, say, mathematics, a consistency in feeling toward mathematics and a potential direction of behaviour relating to mathematics. Teachers have identified these elements in the terms 'commitment' and 'interest'.

The acceptance that the teacher is effecting behavioural change in his

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16. Mussen, P.H. et al. "Handbook of Research Methods in Child Development", J. Wiley & Sons, 1964. p. 646.

17. Lewis, K. et al. "Constructs in psychology and psychological ecology", University of Iowa. Child Welfare 1944. (20) p. 308

18. Williams, R. "Value orientations in American Society" in "Social perspectives in Behaviour". Glencoe Free Press 1958. p. 288

pupil through his own behaviour, knowingly or unknowingly, is recognised by Morrison and McIntyre, who can be said to corroborate the findings of the Birmingham research, that

> "Although scholastic assessment is a dominating concern, teachers spend a far greater proportion of their time observing, evaluating and acting upon indications of ongoing social behaviour and upon forming impressions of the more or less persisting personal traits of pupils. Virtually all of this is done informally and so taken for granted there is little conscious awareness of doing so."[19]

The point must be taken further and the question posed as to how the particular personality and characteristics of the individual teacher influence the achievement of affective behaviour in his pupils. The teacher has personal needs and goals which must influence his choice of objectives for his pupils. His background is composed of standards and values derived from his own experience. But these, together with his future aspirations, may well direct, in some large measure, the selection of objectives, content and learning experiences chosen for his pupils. Seen in this light it is not surprising that the Birmingham research team arrived at their conclusion.

The techniques of attitude measurement are complex and the wider reference of affective measurement even more so. If separate components of affective behaviour can be measured then it may well be possible to combine the elemental scores using the methodology of Osgood's semantic space. Both attitudes and values involve the idea of a continuum, from, for example, good to bad or positive commitment to rejection. Therefore measurement in terms of a qualit-

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19. Morrison, A. and McIntyre, D., "Teachers and Teaching", Penguin Books Ltd., 1969, p. 169.

ative scale is possible. Osgood uses such a technique in his semantic differential. The aim to provide an effective measurement of these growth points at the level of the Certificate of Secondary Education rules out all verbal and interview techniques on account of size of sample, validity and reliability difficulties. The evaluation instrument must be based on the written response of the student. Possibly an attitude inventory is needed, which will seek to include the components of affective behaviour.

Before such an inventory can be constructed discussion must take place on a point raised earlier in the chapter. The equivalence of terms, particularly within the restrictive framework of mathematical attitudes, values and beliefs, demonstrates the semantic difficulties facing the test constructor.

Whilst undertaking an analysis of affective terminology, it must be appreciated that any analytical division of the pupil's behaviour into the three domains, as outlined by Bloom, is a matter of convenience for research. Much of the evidence already reviewed reflects the complexity and total involvement of the domains into the pupil's overall attainment. This concept of integrated growth in attainment is implicit in many teacher's assessments. Changes in cognitive behaviour will automatically bring about the allied changes in affective and psychomotor behaviour. The recognition of this process does not prevent the reverse action taking place; that is, that changes in affective behaviour will bring about the allied changes in cognitive and psychomotor behaviour.

Researches[20] on the relationship between interest and cognitive attainment (aptitude) have shown small but positive correlations. The evidence is certainly not strong enough to support the supposition that all affective objectives will be realised through cognitive processes. The need to enumerate

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20. Brown and Heltzmann, 1955; Aiken and Dreger, 1961; Neidt and Hedlund, 1967.

the beliefs, attitudes and values that our pupils must acquire becomes obvious. From this stems the requirement that the terminology used in the formulation of affective objectives should be precise and exactly valued.

The inter-relationship between the many facets of the child's development and its affective attainment have been considered. In any move to classify vocabulary it is necessary to widen the scope of a specific value to take in peripheral and overlapping areas. To initiate the identification of possible regions, it is necessary to establish the mathematical objectives developed by teachers[21].

"1 (a) To acquire an understanding of the fundamental relationships in numeracy.

(b) To develop a working knowledge of the laws of operational procedures.

(c) To acquire the basic facts that form the framework on which mathematics is built.

2 (a) To develop an understanding of method and logical progression in the solution of mathematical problems.

(b) To recognise identities and properties of specific mathematical areas.

3 (a) To acquire the full use of mathematics as a means of communication.

(b) To interpret and draw conclusions from mathematical symbolism, represented in many varying forms.

4 To develop the ability to apply mathematical principles to new situations.

5 To acquire skill in analysing and ordering a problem.

6, 7, 8 To develop the ability to process 'new' data and evaluate and hypothesise on the results.

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21. Preston, M., op. cit., pp. 42 - 43.

9 To develop interest in mathematics.

10 To acquire appreciation and satisfaction from mathematical operations.

11 To form an appetite for and a healthy attitude to mathematics."

Considering these objectives, together with the criteria relating to affective attainment developed in this chapter, the general regions may be mapped into the following ten groups. These may be linked in pairs to provide a series of bi-polar scales.

1 Heuristic values.

2 Algorithmic values.

3 Cognitive realisation.

4 Affective belief.

5 Logical attitude.

6 A methodological attitude.

7 Commitment.

8 Uninterestedness.

9 Positive evaluation.

10 Rejection.

The definition and interpretation of these groups will be derived by considering the qualities that mathematics teachers expect to be contained in each specific region. The initial mapping of boundaries to provide some definition of the limits of each region can be detailed in the following terms. The qualities are not listed in any structural order.

1 Heuristic values:

Intuitive, instinctive, insightful, impulsive, impressionistic.

2 Algorithmic values:

Mechanical, pedantic, exacting, precise, inflexible.

3 Cognitive realisation:

Progressive, enterprising, incisive, forward-looking, assured.

4 Affective belief:

Content, satisfied, secure, voracious, aspiring.

5 Logical attitude:

Logical, conformable, conventional, orthodox, consistent.

6 A methodological attitude:

Practical, formal, individualistic, gregarious, adaptable.

7 Commitment:

Enthusiastic, zealous, willing, active, cooperative.

8 Uninterestedness:

Indifferent, unwilling, impassive, inactive, lax.

9 Positive evaluation:

Acquiescent, approving, positive, assertive, insistent.

10 Rejection:

Rejecting, uncompliant, resistant, begrudging, negative.

Berelson and Steiner[22] claim that the precepts of opinion, attitude and belief defy precise definition of meaning. By listing the qualities being ascribed to each affective region it is hoped that the difficulties enumerated by Berelson and Steiner will be lessened. If each region, and this will be tested later, relates to some definable aspect of affective behaviour, then the semantics of the situation will not concern the practising teacher. There is little to be gained in identifying each aspect as an attitude, belief or value. Indeed Berelson and Steiner subscribe to this view, that

> "there are no hard and fast boundaries for the terms so that one man's opinion may be another man's attitude and still another

22. Berelson and Steiner, 1964, p. 557.

man's belief."[23]

However it is likely that a mathematics teacher applying the generalised affective objective - "To encourage a heuristic attitude" - would differ considerably from a colleague both in connotative meaning and in interpretation of the characteristics of the desired behaviour. It is just such a problem that was raised earlier in the chapter when an outline of Osgood's Semantic Differential was considered. It is relevant to review these semantic difficulties in the light of the ten affective qualities developed.

McMahon writes

"A variation in connotative meaning must be taken into account when one assesses the efficiency of an attempted communication of course objectives between various people involved in curriculum innovation."[24]

If a particular objective is accompanied by five defining qualities, themselves consistent with the general affective connotative meaning, then, in terms of broadly based behaviour, it will be expected that mathematics teachers over the limiting range of the Certificate of Secondary Education or 'O' level course would attempt to achieve very similar affective behaviour in their pupils. The defining qualities will need to be tested for both acceptance in terms of being expressive of the particular behaviour, and of providing a framework for the formulation of a clearly expressed affective objective. Thus the defining qualities are an attempt to achieve a satisfactory communicability of both connotative meaning and of referential meaning.

Osgood[25] frequently attempts to draw the distinction between 'meaning' which is denotative, designative or referential in character and 'meaning'

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23. ibid., p. 558.

24. McMahon, H. Unpublished M.Ed. thesis, University of Leicester, 1969.

25. op. cit., pp. 2., 79., 290.

which is connotative or emotive in character. However these attempts do not lead to definitions and there would appear to be no clear division between the two fields of meaning. Any attempt to communicate affective objectives must satisfy the inevitably composite nature of its meaning by being clear and unambiguous. Furthermore its extent and scope must be defined to the same degree by a group of mathematics teachers.

As Osgood is unable to draw clear distinctions between the two types of meanings, it is acceptable to infer that the semantic differential is a composite measure of both groups. However, much of his work[26] indicates that the semantic differential is essentially a measure of connotative meaning. This would seem to provide an effective instrument for the measurement of affective mathematical attainment. The major part of this attainment is in the connotative aspects of the attitudes, beliefs and values of the pupil, but at the same time the referential aspect to mathematics and its applied situations can be included.

The semantic differential requires the subject to differentiate his understanding of an item or concept on a set of semantic scales, thus combining the subject's comprehension of a particular concept with a weighting or scaling procedure. In terms of affective behaviour an example could be illustrated thus - Paired affective values: Heuristic <u>vis-à-vis</u> Algorithmic values.

A								B
Intuitive	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Mechanical
Impulsive	___	___	___	___	___	___	___	Pedantic
Instinctive	___	___	___	___	___	___	___	Exacting
Impressionistic	___	___	___	___	___	___	___	Precise
Insightful	___	___	___	___	___	___	___	Inflexible

26. op. cit., pp. 77., 166., 273.,

The scale definitions being:

(1) and (7) .. .. extremely A or B

(2) and (6) .. .. quite A or B

(3) and (5) .. .. slightly A or B

(4) .. .. neither A nor B, or equally A and B.

The process of evaluation is complex and is judged to be too difficult for a C.S.E. pupil to identify his particular affective standing. However the instrument would appear to be a useful one in collating teacher's assessments of the affective attainment of their pupils. Furthermore an analysis of the teachers' responses with both a teacher-attitude instrument and a pupil-attitude instrument could well validate the identification of individual affective characteristics and, at the same time, reflect the conclusions reached by the Birmingham research.

Osgood sees each scale as representative of a straight-line function which passes through the origin of semantic space. A group of scales reflect, for example, the extent of comprehension or strength of attitude that a particular subject holds, and therefore this score can be represented by the coordinates of the particular dimension. As each group of scales represents differing dimensions it can be seen that the semantic differential is a multi-dimensional instrument. However, to define each group with maximum efficiency, it is necessary to identify the minimum number of orthogonal dimensions or axes which exhaust the semantic space. This creates the formation of component scores which are reflective of the scales heavily loaded on the major values. Osgood states that

> "the connotative meaning of the concept is defined operationally by the set of component scores which specifies its position in multi-

dimensional semantic space."[27]

By comparing the differing positions of concepts in semantic space, conclusions on the subject's affective attainment can be drawn. Further conclusions can be deduced by comparing a particular group's affective behaviour with other groups and on the group position in relation to the teacher's position. This review of the Semantic Differential suggests that it should prove to be an extremely valuable instrument for comparison purposes but is too sophisticated for use as a primary measuring technique.

If areas of affective behaviour can be identified then there is little doubt that the appropriate objectives can be formulated and the curriculum process implemented. Taba writes:

> "Teaching for values and feelings has often been regarded as beyond the powers of the school . . . because the idea still prevails that values and feelings somehow belong to the innate aspects of personality that are impervious to change by educational methods."[28]

It is against this background that this research will try to identify each step in the realisation and evaluation of affective attainment. The review developed in this chapter provides three major areas for investigation, namely

(i) the establishment of recognisable affective behaviour traits;

(ii) the identification of affective attainment in C.S.E. pupils;

(iii) the role and effect of the teacher on affective behaviour.

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27. loc. cit.

28. Taba, H. "Curriculum Development - Theory and Practice", Harcourt Brace, New York, 1962, p. 68.

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C H A P T E R I I I

THE RECOGNITION OF AFFECTIVE BEHAVIOUR

- -oOo- -

The hypothesis developed in the previous chapter states that affective behavioural change should be able to be identified in ten areas:

(i) (ii) Heuristic and Algorithmic values;

(iii) (iv) Cognitive and Affective realisation;

(v) (vi) Logical and methodological attitudes;

(vii)(viii) Commitment and disinterestedness;

(ix) (x) Positive evaluation and rejection.

The testing of an hypothesis requires a series of intermediate steps to be taken before an acceptable instrument can be presented.

The primary task is to identify each category as a realistic value of the affective domain; demonstrable in its own right and not as an element of a compound behaviour. Furthermore the identification of these values must be at the operative level of the C.S.E. pupil. The instrument should be based on a simple response mechanism to easily understood items. A review of established attitude scaling procedures would suggest that the Likert[1] method is probably the most adaptable to the needs of this particular research.

To create the initial scale each area of affective behaviour will have ten statements ascribed to it. These statements will vary from slightly expressive to strongly expressive of the particular value; numerically this will be expressed by weightings of 1, 2 and 3. The bi-polar nature of some of the categories causes some difficulty. Straightforward positive scoring for all items would strengthen the criticism made of the Likert scales, in that identical scores can be obtained by two respondents and yet the meaning and composition of the scores can be very different. The introduction of negative scoring produces some initial problems but does provide greater discrimination. The summation of scores being negative can be avoided by adding a constant (+50).

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1. Likert, R. "A technique for the Measurement of Attitudes", Archives of Psychology, No. 140. 1932.

The attitude continuum requires the respondent to place himself, in response to a statement, in one of five categories:

Strongly agree : Agree : Not sure : Disagree : Strongly disagree

Numerically the continuum will be scored +2 ; +1 ; 0 ; -1 ; -2.

Table 1.

Examples of Affective Scales

	SA	A	NS	D	SD
(i) Mathematics is purely mechanical.				✓	
(ii) I get a good deal of pleasure from maths.	✓				

Table 1 shows an example response to two particular statements. Item (i) is reflective of an algorithmic attitude and weighted at (-3); the respondent disagreed (-1) with the statement and thus scored (-3)(-1) = +3. Item (ii) is reflective of commitment to mathematics and is weighted at (+2); the respondent strongly agreed (+2) with the statement and thus scored (+2)(+2) = +4.

The ten statements on each of the ten categories together with their weightings are show in Table A (p.70) of the appendix. The random placings of the statements and the order of the categories are shown in Table B (p.75) of the appendix. Some personal details of each respondent were required in the introductory part of the attitude questionnaire. This fulfilled two purposes, it provided the student with an opportunity to settle down and respond to material to which answers were known, and secondly it provided some background knowledge of some of the possible areas of variance in the development of affective behaviour. A copy of the complete questionnaire can be found on p.76 of the appendix.

Three comprehensive schools took part in the pilot trial and Table 2 summarises the basic sample.

Table 2.

Composition of Pilot Trial

School	Boys	Girls	Total
A. Kennet School, Thatcham	33	17	50
B. Riversmead School, Cheshunt	18	14	32
C. Lakes School, Windermere	16	18	34
	67	49	116

Bearing in mind the Birmingham research and the work of Morrison and McIntyre, which was considered in the previous chapter, teachers were asked to complete a pupil rating sheet based on the ten affective categories.

Table 3.

Pupil rating sheet

	Strongly	Fairly	Average	Fairly	Strongly	
Intuitive	_	_	_	_	_	Mechanical
Uninterested	_	_	_	_	_	Enthusiastic
Irrational	_	_	_	_	_	Logical
Practical	_	_	_	_	_	Theoretical
Good mathematician	_	_	_	_	_	Poor mathematician

The scoring of the teacher's assessment followed the same weightings as the attitude scale completed by their pupils. The value attributed to each position can be seen in Table C (p.83) in the Appendix.

When analysing the rating sheets it became immediately apparent that the scores obtained did not discriminate as finely as the attitude inventory. In an attempt to produce a greater degree of accuracy, teachers were asked to complete a second rating sheet. This instrument involved the defining qualities of the categories which were detailed in the previous chapter. The scoring followed the same weightings as developed in the attitude scale, and a constant (100) added to avoid negative scoring and bring parity with the teacher's first assessment. The exact composition of this second rating sheet can be seen in Table D (p.84) of the appendix.

An analysis of the pilot sample gives scores on each of the ten affective categories, a total score, two teacher assessments of affective behaviour, together with details of sex, type of course, number of teachers in the past two years. The summary of these results can be seen in Table E (p.85) of the appendix. The evaluation of Table E to identify individual affective categories required a varimax orthogonal factor analysis. As a computer was used this analysis was supported by a promax oblique analysis.

The correlation matrix in Table F (p.91) of the appendix shows the relationship of the ten variables with each other (columns 1 - 10), with the total score (column 11), and with the teachers' two assessments (columns 12 and 13). The matrix demonstrates the high correlations ($0.52 < r < 0.77$) of eight of the ten variables with the total score. This is suggestive of a large general factor being present in these categories.

The correlations of all variables with the teachers' two assessments are remarkably low.

Table 4.

Correlation matrix - Variables/Teacher assessment

Variable	Assessment 1	Assessment 2
1	0.1423	0.1663
2	0.1489	-0.0077
3	0.2372	0.1628
4	0.2245	0.0820
5	0.2175	0.0339
6	0.0206	0.1228
7	0.2682	0.1868
8	0.1529	-0.0165
9	0.2099	0.1269
10	0.2758	0.1984

Summary: $-0.1 < r_{v/ta} < 0.28$

This would suggest that the affective categories measured by the questionnaire differ considerably from the qualities that are represented by the teachers' assessments. This may be seen as supporting the Birmingham research, indicating that the teacher is valuing the attitudes reflected by his own values. On the other hand it may be that there is a resistance by teachers to accept affective evaluation and that their assessments are being coloured by cognitive performance. Within such a complex field a number of reasons could be given for these low correlations. However the overriding factor is that the test is measuring a different quality to that indicated by the teachers' assessments.

The factor analysis, Table G (p.92) of the appendix shows three principal components. As Table 5 below demonstrates the first factor takes out over 50 per cent of the variance and strongly suggests that the tests are all measuring a very similar quality. However the variables 1 and 6 do not load highly on this factor. Test 1 contributes strongly to component II and test 6 very considerably to component III.

Table 5.

Component variance

Component	Root	Variance
1.	5.3136	53.1364
2.	1.2278	12.2778
3.	0.9339	9.3393
		74.7535

The Varimax orthogonal loadings, Table 6, demonstrate the contribution of the tests to each of the three components.

Table 6.

Varimax loadings

Component	I	II	III
Variable 1	0.0460	0.8249	0.0380
2	0.7405	-0.1236	0.0738
3	0.7346	0.4981	-0.0564
4	0.8438	0.2890	0.0417
5	0.8344	-0.1696	0.0855
6	0.1167	0.0563	0.9687
7	0.7951	0.2589	0.2122
8	0.6852	-0.2684	0.3599
9	0.8296	0.2750	0.0430
10	0.7857	0.3494	0.1624
Variance I	49.1906		
II	13.9597		
III	11.6032		

Component I embodies the general factor of affective evaluation as measured by all tests with the exception of tests 1 and 6. Component II consists of a large contribution from test 1 with an element of test 3. Finally component III is represented almost completely by test 6. The variance factors in Table 6 confirm that 75 per cent of the variance is represented by these three components.

These results are supported by the promax oblique rotation of the components. The evidence of this analysis is shown in Table 7.

Table 7.

Promax loadings

Component	I	II	III
Variable 1	-0.0952	0.8575	0.1051
2	0.7996	-0.2490	-0.0495
3	0.7084	0.3887	-0.1287
4	0.8453	0.1611	-0.0625
5	0.9056	-0.3119	-0.0560
6	-0.0312	0.1338	0.9921
7	0.7726	0.1548	0.1194
8	0.7218	-0.3626	0.2431
9	0.8323	0.1491	-0.0601
10	0.7550	0.2460	0.0772

The fact that tests 1 and 6 have negative values in the first component and appear strongly in the second and third components respectively supports the evidence already presented in the Varimax loadings.

The correlation matrix for the Promax factors in Table 8 substantiates the interpretation that has been increasingly evident as the evaluation of the results has proceeded.

Table 8.

Correlations between Promax factors

	I	II	III
1.	1.0000	0.2819	0.2482
2.	0.2819	1.0000	-0.1134
3.	0.2482	-0.1134	1.0000

There is now substantial evidence to conclude that the best items of eight tests (2, 3, 4, 5, 7, 8, 9, 10) could be brought together to form a general affective measurement. The inventory would also include items from tests 1 and 6. Test 1 representing a measure of affective behaviour toward the rather traditional algorithmic mathematical experience. This is supported by a contribution from Test 3. Test 6, on the other hand, is assessing the attitudes or values held in respect of mathematical experience and environment. Overall, the factor analysis indicates the need to restructure the inventory into items measuring three components, namely:

Factor A: Tending to see mathematics as an algorithmic, mechanical and somewhat stereotyped subject;

Factor B: Tending to see mathematics in an open-ended, intuitive and heuristic setting;

Factor C Representing commitment, interest and application to mathematics.

The distribution of items within the new inventory must recognise the loadings within the varimax and promax analyses.

Item Analysis and revalidation

To assist in developing a reliable and valid inventory an item analysis and revalidation exercise was carried out on the results of the pilot questionnaire. The first exercise followed a standard analytical pattern developed by Nuttall and Skurnik[2]. Tables 9 and 10 show the data generated by this analysis.

Table 9.

Inventory mean:	57.60
Standard Deviation:	15.58
Reliability:	0.93
Standard error of measurement:	4.19

Number of inventories included in analysis: 50

Table 10.

Unsatisfactory Items

(Inc. those to be used with caution)

1.	Algorithmic values.	11, 70, 72, 76.
2.	Heuristic values.	3, 61, 93.
3.	Disinterestedness.	7, 10.
4.	Commitment.	-
5.	Logical attitude.	1.
6.	Methodological attitude.	25, 45, 47, 48.
7.	Affective realisation.	68.
8.	Cognitive realisation.	12, 13.
9.	Positive evaluation.	14, 49.
10.	Rejection.	22, 58.

Total number of items unsatisfactory: 21.

The revalidation of items was achieved by asking a group of mathemat-

2. Nuttall, D.L. and Skurnik, L.S., "Examination and Item Analysis Manual", NFER, 1969.

icians to familiarise themselves with the ten categories presented in the inventory and then to allocate each item to a specific category. This exercise was not particularly successful as a number of the respondents found difficulty in identifying the boundaries between similar attributes. The varimax and promax analyses with the loading on general interest and commitment confirmed this opinion. Table 11 records those items where there was an overall majority of agreed responses.

Table 11.

Items gaining majority of agreed responses

4, 8, 10, 13, 15, 16, 17, 22, 23, 24, 25, 26, 30,
32, 34, 35, 36, 39, 41, 42, 46, 47, 49, 54, 55, 57,
58, 59, 60, 61, 64, 65, 66, 68, 69, 71, 72, 73, 74,
78, 79, 81, 83, 84, 85, 87, 89, 91, 92, 94, 99, 100

Total number of items gaining overall majority:- 52

The stated hypothesis at the beginning of the chapter proposed to measure affective behaviour within ten identifiable factors. The pilot trial with its revalidation and analysis has reduced the factors to three and indicated those items which can be used in further developments. The work of the next section is to develop and test a restructured inventory.

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C H A P T E R   I V

THE MEASUREMENT OF AFFECTIVE BEHAVIOUR

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The reconstruction of the inventory based on the need for items which refer only to three factors and also on the information provided by the item analysis indicated a more succinct form of questionnaire. The balance of items in the new instrument should reflect the loadings produced in the factor analysis.

Consideration of these points led to a forty item inventory (appendix p.94 Table H), the allocation of items within this structure being:

Factor A	10 items;
Factor B	10 items;
Factor C	20 items.

The weightings of items within the original inventory had caused a number of difficulties in scoring and the revalidation exercise showed it to be unreliable. The reconstructed inventory retained it's character of offering a choice of five responses but each item carried equal weight. This immediately benefitted the scoring procedure, as a straighforward positive scale of 1 to 5 was now able to be used. The direction of the scale ranged from Strongly Disagree - 1 to Strongly Agree - 5, the mid-point of the continuum - Not Sure - scoring 3. To achieve a distribution of responses over all the five options some items selected from the original inventory were those written with the opposite value in mind.

Before embarking on a full field sample of the inventory a further pilot trial was felt to be necessary, as the changes involved in the reconstruction of the test instrument had been considerable. This second sample involved four schools in Carlisle and produced a total of 358 completed questionnaires and teacher assessment forms. The following tables and comments summarise the results of this survey. The index figures note the 1 per cent and 5 per cent level of significant differences from the mean.

Table 1.

Mean scores for each factor and teacher assessments.

	A	B	C	TA
School 1.	32.0	31.1	60.9[5]	12.6[1]
School 2.	31.0	30.7	66.9	13.6
School 3.	31.4	28.8[5]	65.9	16.0
School 4.	30.6	30.7	67.7	15.2
All schools (n = 358)	31.0	30.4	66.6	14.8

The teachers' assessments in School 1 are markedly lower than those in the other three schools. However this may well appear justified as the pupils would appear to be significantly less committed and interested than those in other schools.

Table 2.

Mean scores Female/Male

	A	B	C	TA
Female	31.9[1]	29.4[1]	63.1[1]	14.0[1]
Male	30.4	31.0	69.0	15.4
All schools (n = 358)	31.0	30.4	66.6	14.8

The table shows the extremely interesting fact that all the girls' differences from the mean scores are at the 1 per cent level. From the initial evidence the statement could be made that:

> "Girls see mathematics as a mechanical and stereotyped subject, set in a rather restricted and predictable environment. They are less committed and interested in mathematics than boys and lack the foresight to apply the subject."

This hypothesis must be examined in the larger field sample.

Table 3.

Mean scores by examinations

	A	B	C	TA
'O' level	29.1[1]	31.9[1]	70.0[1]	16.3[1]
'O' and C.S.E.	29.8	31.2	66.4	14.7
C.S.E.	31.8	29.7	65.5	14.3
Internal or no exams.	34.2[1]	28.8	59.3[1]	11.7[1]
Sample mean	31.0	30.4	66.6	14.8

The consistent rank order of the columns of scores in this table confirms the interrelationship of affective behaviour with cognitive skill. The reverse order of Factor A set against B and C tends to confirm the factor analysis. Furthermore many teachers would agree that the less able tend to become more mechanical in their approach to mathematics. The 1 per cent level of significance for all the 'O' level scores points to a general level of higher expectation, motivation and possibly better facilities. This view is supported by the three scores at the 1 per cent level for the non examination pupils.

Table 4.

Mean scores by number of teachers

	A	B	C	TA
1 teacher	30.6	31.0	67.4	15.2
2 teachers	31.0	29.6	65.5	14.3
3+ teachers	32.9[5/1]	30.1	65.8	14.7
Sample mean	31.0	30.4	66.6	14.8

The fact that the less able candidate tended to have more teachers produces the predictable significant difference, approaching the 1 per cent level, in the table. Otherwise there appears to be little advantage or disadvantage in having a number of teachers over the two year period under investigation.

Table 5.

Correlation matrix for the three factors A, B and C

	A	B	C
A	-	-0.37	-0.47
B	-0.37	-	0.41
C	-0.47	0.41	-

Table 6a.

Correlations of the three factors with the Teachers' Assessments

	A	B	C
Teachers' Assmnts.	0.22	0.17	0.39

The relatively low correlations of each factor with the teacher's assessment would indicate that each is measuring something significantly specific whereas the teacher's assessment is a compound measure. This view is supported by statistical theory, Guilford[1] writes;

> "The value of having zero intercorrelation among tests in a battery is obvious. If one tries to achieve zero intercorrelations among tests when each test is measuring a unique factor, however he will often find that each test tends to correlate low with the criterion (in this case the teacher's assessment) . . .. Where there has to be a choice it seems wisest to give less attention to the first principle (maximising

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1. Guilford, J.P. "Fundamental statistics in psychology and education", McGraw Hill, New York, fourth ed. 1965.

correlations of each test with the criterion)
and greater attention to the second (minimising intercorrelations)."

It is proposed to leave the teachers' assessment procedure as it stands. The intercorrelations being low but nevertheless indicative, would seem to point to a satisfactory instrument. Table 6b shows the multiple correlation coefficients (R) of the three factors with the teachers' assessments.

Table 6b.

	AB	AC	BC
Teachers' assessments	0.12	0.36	0.41

The introduction of the general factor C improves the level of R in each case whereas the combination of the factor A with factor B lowers the intercorrelation. This is predictable and adds confirmation to the results of the factor analysis.

Item analysis and revalidation (Table H, appendix p.98)

Table H in the appendix shows the item analysis for each of the forty items in terms of facility, discrimination and item variance. The items are grouped within their factor classification. The four items that are indicated 'to be used with caution' will be retained as they are all in the upper limits of the border zone. The only unsatisfactory item, number 6, will be rewritten before presentation in the final form of the inventory.

A similar revalidation exercise to that utilised in the first trial was administered with a markedly improved result. Twenty of the items were unanimously identified in their category, fifteen items achieved a 75 per cent majority whilst the remaining five items gained an overall majority in their identification.

Before proceeding to a final draft of the inventory, a check on the balance of responses over the continuum (Strongly agree ⟶ Strongly disagree) was carried out. Table 7 shows the distribution of responses of a random sample of 100 inventories taken from the Carlisle pilot trial.

Table 7.

Distribution of responses

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
Raw scores	301	1449	883	1073	294
Mean response per inventory	3.01	14.49	8.83	10.73	2.94
Percentage dist. corrected to 0.5%	7.5%	36%	22%	27%	7.5%

(Sample = 100)

The distribution appears to be evenly balanced and, taken in conjunction with the item analysis tests, indicates a satisfactory response pattern.

As a result of these various test construction techniques, the final form of the inventory could now be prepared. The printed instrument in its final form follows.

WHAT DO YOU REALLY THINK ABOUT MATHS?

These questions are attempting to find out the answer to this question.

All you have to do is place a tick in one of the columns; for example in answer to the item "Mathematics is purely Mechanical" you have to answer in one of the columns which are headed:-

Strongly agree	agree	not sure	disagree	strongly disagree

If you agree with the statement, a tick would be placed thus:-

Strongly agree	agree	not sure	disagree	strongly disagree
	√			

if, on the other hand you strongly disagree the tick would be placed thus:-

Strongly agree	agree	not sure	disagree	strongly disagree
				√

Please work quickly and put your first reaction down as the answer.

Some of the statements are very similar, so please do **NOT** look back or change any answer.

If you understand these instructions please turn over and complete the details on the next page.

If you do not understand please ask the member of staff any question you wish

Name .... Candidate's No. [ ] School Reg. No. [ ]

Age:- .... years .... months

Please **underline** correct answer

1. Male/Female

2. Boys/Girls/Mixed school

3. Secondary modern, Grammar, Comprehensive, Bilateral, Other

4. Number of teachers who have taught you maths in the last 2 years.

   1, 2, 3, 4, 5, more than 5.

5. I am taking:

   C.S.E. G.C.E. 'O' level Internal Leaving Certificate no exams

Please turn over and work through remaining pages

	Strongly agree	agree	not sure	disagree	strongly disagree
1 Maths demand rigid thinking along set lines					
2 Maths was an essential part of my primary school but not my secondary school					
3 Group project work in maths is good fun and successful in teaching me mathematics					
4 Time passes quickly in maths					
5 Maths is such an important subject that I really work hard					
6 Maths like science should be learnt in a practical manner					
7 Doing maths gives me satisfaction					
8 I find working in a small group helps my progress in maths					
9 Mathematics is an exploring science					
10 Individual project work is a good way to learn maths					
11 My maths course has prepared me for life out of school					
12 Maths is logical and purposeful					
13 Mathematics is like a machine it demands an inflexible method					
14 Mathematics helps you direct your thinking					
15 I have an appetite for maths					
16 Monotony and mathematics go hand in hand					
17 I felt my maths course to be worthless					
18 Maths follows a pattern of set directions and laws					
19 Maths is fascinating					
20 I can't really get on with maths					

Please turn over

	Strongly agree	agree	not sure	disagree	strongly disagree
21 Mathematics demands a set sequence in solving problems					
22 The course in mathematics was valuable					
23 There is something attractive about mathematics					
24 Maths does not allow any individuality					
25 The best way to teach maths is for the teacher to work examples and for me to practice					
26 I think mathematics is as dry as dust					
27 There is a fixed routine in mathematics					
28 Maths is so different from other subjects that it should be taught entirely on its own					
29 Applying the rules of maths provides the answers					
30 Only those that can do maths should study it					
31 Mathematics is purely mechanical					
32 Maths is a useful subject as it helps in life outside school					
33 I find the best way to learn maths is using it in other subjects					
34 I don't really understand or care for mathematics					
35 I prefer class teaching and working from a textbook					
36 Learning maths by finding out for yourself is an interesting task					
37 Maths commands my attention					
38 I enjoy doing practical maths — experiments and investigations, it is a good way of learning maths					
39 I think maths helps you to organise all sorts of problems					
40 Finding out by yourself is the best way of learning mathematics					

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C H A P T E R V

THE RESULTS OF AN INQUIRY INTO AFFECTIVE BEHAVIOUR IN MATHEMATICS

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With the cooperation of the South Western Examinations Board it was found possible to hold an extensive field trial which resulted in 2690 inventories and their corresponding teacher-assessment sheets being completed. The Secretary to the Examinations Board circulated information about the project to all schools within the catchment area. The result of this circular led to 278 schools seeking further information on the project and the work involved. After consultation with members of staff, 135 schools offered to take part involving a possible sample of over 7500. This was considered too large a number to handle and therefore a selection procedure based on a number of criteria was undertaken. The factors considered were:

(i) type of school;

(ii) type of environment;

(iii) mode of C.S.E.;

(iv) type of course structure;

(v) other examinations.

A synopsis of the final sample is shown in Table 1. The full details can be found in the Appendix, Table I.* After all the printed material was sent out, one school had to withdraw because the Head of the Mathematics department had to undergo serious hospital treatment.

*(Appendix p.100a)

Table 1.

Analysis of Field Sample

Type of School:-	Comprehensive	Grammar	Secondary Modern	Bilateral
	14	6	13	1
	Independent			Total:-
	1			35
Type of environment:-	City	Urban	Semi-urban/ rural	Rural
	6	4	19	6
Type of examination:-	Mode 1 only	Mode 3 only	Modes 1 and 3	Mode 1 and 'O' level
	11	3	3	3
	Mode 3 and 'O' level		Modes 1 and 3 and 'O' level	
	3		4	
Nature of school:-	Coeducational		Boys	Girls
	24		6	5

Nature of courses:-	Traditional	SMP	MME	Scottish	Westminster
	23	8	1	2	1

The questionnaires and teacher-assessment sheets were marked and the scores card punched. The following tables show the results of the field sample. The definitions of the three factors are restated below.

Factor A: tending to see mathematics as an algorithmic, mechanical and somewhat stereotyped subject;

Factor B; tending to see mathematics in an open-ended, intuitive and heuristic setting;

Factor C: representing commitment, interest and application to mathematics.

The teacher-assessment (TA) score is obtained from the individual pupil profile sheets completed by the teacher. It represents a compound score of the affective behaviour of the pupil

Table 2.

Mean scores: Male/Female

	n	Factor A	Factor B	Factor C	Teacher-assessment TA
Female	1240	30.6298	29.9726[1]	64.9048[1]	14.8000
Male	1450	30.5028	30.7303[1]	71.0628[1]	15.3483
Full sample	2690	30.5613	30.3810	68.2242	15.0956

The statement made as a result of the pilot trial that -

> 'Girls see mathematics as a mechanical and sterotyped subject, set in a rather restricted and predictable environment. They are less committed and interested in mathematics than boys and lack the foresight to apply the subject'

- must be amended. The significant difference in factor A has disappeared but is retained at the 1 per cent level in both factors B and C. The latter part of the statement relating to environment and commitment can now be advanced firmly and is backed by the experimental data.

Table 3 consists of the mean scores of candidates grouped by type of examination. For example the pupils within the 'O level and C.S.E. group' have been entered for both examinations within the same year.

Table 3.

Mean scores: Categorised by Examination entry

	n	A	B	C	TA
'O' level	691	29.1852[1]	29.9493[2]	71.4009[1]	17.8061[1]
'O' level and C.S.E.	281	29.9644[5]	30.6050	69.6406[5]	15.6050
C.S.E.	1606	31.1426[1]	30.5533	67.2671[1]	14.0455[1]
No exams.	104	32.7115[1]	29.7788	56.9904[1]	11.4712[1]
Full sample	2682	30.5613	30.381	68.2242	15.0956

The consistent rank order of the columns of mean scores for factors A, C and Teacher-Assessment confirm the initial finding of the pilot trial and demonstrate the inter-relationship of affective behaviour with cognitive skill.

The significant differences in Factor A, together with the growth pattern of the means, establishes the hypothesis that increasing cognitive skill brings about a greater flexibility of approach and of attitude toward content. On the other hand, Factor B shows the 'O' level candidate to have a significantly lower mean score. The 'O' level pupil appears to have a narrow appreciation of the variety of learning situations to be found in mathematics. The extended depth of an 'O' level syllabus together with the requirement for a higher level of cognitive functioning may prevent the opportunity of exploring the mathematical environment in the way that is often open to the C.S.E. candidate. The philosophy and general approach to C.S.E. and 'O' level would bear out this result.

Factor C corroborates the initial finding that -

'the cognitive skill of a student is indirectly related to his score on the algorithmic scale and directly related to his interest and commitment'

- and clearly underlines the higher level of expectation and motivation evident in 'O' level candidates. The saddening feature of this table is the level of commitment and interest of candidates not taking an examination in mathematics. The mean difference is greater than one standard deviation.

The numerical order of the Teacher-Assessments in relation to examination category, and therefore corresponding to the cognitive skills exhibited by their pupils, reflects the inevitable composite nature of cognitive and affective behaviour. The differences are probably enlarged by the difficulty that the teachers have in divorcing recognition of cognitive skill from affective attainment. The point will be discussed more fully when considering the correlations between the factors and the teacher assessments.

Table 4.

Mean scores by Number of mathematics teachers experienced by the pupil within the last two years

No. of teachers	n	A	B	C	TA
1 teacher	1270	30.2000[1]	30.3945	68.4606	15.5748[1]
2 teachers	944	30.3771	30.1430	68.4841	15.0169
3 teachers	364	31.6786[1]	30.8242	66.1484[1]	13.8681[1]
4+ teachers	111	31.9550[1]	30.5225	68.1351	14.2252[5]
Full sample	2689	30.5613	30.381	68.2242	15.0956

The mean score of Factor A increased with the number of teachers pupils had experienced indicating that the pupil taught by a greater number of teachers becomes more mechanical and stereotyped in his approach to content. The reason for this pattern may well be due to the teacher feeling the need to consolidate work before developing new content. Therefore the candidate is likely to repeat the basic structure of the content rather than obtain a wider view of the subject.

An unusual feature in Table 4 is the differences, at the 1 per cent level, shown in three factors by the candidate being taught by three teachers over the two-year period. The explanation is difficult. Factor A does not appear to need any further comment as it falls within the pattern already discussed. The explanation of the low level of interest and commitment may be that candidates feel a third change of teacher affects their chances in public examinations, with a consequent decrease in enthusiasm and application. The low mean score in Factor C appears to be born out by the corresponding low mean score on the teacher-assessments. It might be expected that pupils having four or more teachers within the two-year period is within a planned teaching structure, each teacher dealing with specific areas of content. This explanation is necessarily tentative and hypothetical.

Table 5.

Mean scores: Environmental situation

Type of environment	n	A	B	C	TA
City and Urban	770	31.0831[1]	30.3286	67.0779	14.3468[1]
Semi-urban semi-rural	1430	30.1431[1]	30.2853	69.7657[1]	15.3762[5]
Rural	490	30.9612	30.7429	65.5265[1]	15.4531
Full sample	2690	30.5613	30.3810	68.2242	15.0956

Table 5 shows that city and urban children see mathematics in a more mechanical and stereotyped way, and are less committed to and interested in mathematics, a view confirmed by the teacher-assessments. All the differences are significant at the 1 per cent level. Correspondingly, students in the semi-urban/semi-rural setting appear to see the subject in a less rigorous way and display greater enthusiasm and commitment than the overall sample. The responses from the totally rural setting reflect a significant drop in Factor C, but remain within the normal band on other scores.

The pattern emerging in Table 6 corresponds to the results obtained in Table 2 (Mean score by examination), particularly in Factor A and the Teacher-Assessments.

Table 6.

Mean scores: School examination mode.

Forms of exam. offered by school	n	n_1	A	B	C	TA
Mode 1	603	(11)	30.5688	30.3367	69.2189[5]	14.1967[1]
Mode 3	131	(3)	31.0000	30.2061	67.8168	14.4656
Mode 1 and 3	276	(4)	31.4094[1]	30.2681	67.8696	14.1775[1]
Mode 3 and O	364	(3)	30.7198	30.2527	67.0082[5]	15.3269
Mode 1 and O	863	(10)	30.3384	30.0104[2]	68.1101	15.8216[1]
Mode 1, 3 and O	453	(4)	30.2053	31.3686[1]	68.4283	15.0353
Full sample	2690	(35)	30.5613	30.3810	68.2242	15.0956

(n_1 gives the number of schools involved in this mode within the sample)

The high level of Factor C for those candidates in a school taking Mode 1 only, reflects a similar affective behaviour pattern to that of 'O' level candidates. The same pressures would seem to be applied. This comment receives further justification in the significant difference in Factor B for those candidates in schools taking 'O' level and Mode 1. As with 'O' level the depressed mean score would seem to indicate a rather closed and directed learning situation.

The candidates within the schools offering modes 1, 3, and 'O' level produced an increased mean score for Factor B at a 1 per cent level of significance. The variety of syllabuses available and their differing philosophies would appear to enable the students to see mathematics in an open-ended and heuristic way. An example of this type of situation can be found in school 35. The mathematics department here offer a SMP 'O' level syllabus, a mode 1 examination and a mode 3 in modern mathematics.

Table 7.

Mean scores: Type of course

Type of course	n	n_1	A	B	C	TA
SMP	699	(8)	30.4890	31.0072[1]	67.0286[1]	15.4650[5]
MME	83	(1)	31.5783	31.0723	67.7590	13.2289
Scottish	116	(2)	30.9310	30.4051	68.0431	14.1638[5]
Westminster	73	(1)	29.5479	29.5068	67.1233	16.7397[1]
Full sample	2690	(35)	30.5613	30.3810	68.2242	15.0956

It would appear that the SMP mathematics syllabus is the only widespread national course widely used in the geographical area of the South Western Examinations Board. The results of pupils taking this course do seem to be significantly different from the norm. The level of the Factor B mean score indicates that these pupils see mathematics in a wider context of application, that they have a more strongly developed sense of intuition and that their approach to problems allows for greater flexibility. The disappointing value emerging from Table 7 is the level of commitment and interest for the SMP pupil. The lower mean score is significant at the 1 per cent level. This trend would appear to be unrecognised by the teacher assessments which are above the norm. However it must be remembered that whereas A, B and C are measuring specific qualities the teacher assessment is a compound score.

The size of the other samples and number of schools involved is too small to warrant drawing positive conclusions. There are no significant differences occurring within the measures of affective attainment. No comment can be made, at present, but this does not invalidate the possibility of evidence from a larger sample.

Table 8.

Mean scores: Types of school

Type of School	n	n_1	A	B	C	TA
Comprehensive	1472	(14)	30.8933[1]	30.5075	67.4477[1]	14.6087[1]
Grammar and Selective Sec.	420	(6)	29.6214[1]	29.6190[1]	68.7333	16.5095[1]
Secondary Modern	613	(13)	30.5106	30.6868	69.7227[1]	15.2969
Bilateral	127	(1)	29.4724[2]	29.9213	66.8661	16.3465[1]
Independent	41	(1)	29.7561	31.1463	64.2683[5]	13.7805
Full sample	2690	(35)	30.5613	30.3810	68.2242	15.0956

The three significant differences for the comprehensive school group show the students to be rather algorithmic and stereotyped in their approach. Furthermore the level of interest and commitment is lower than the norm. Both these facts appear to be recognised and supported by the teacher assessments.

The bilateral and selective schools appear to follow a common pattern. The level of Factor A is significantly lower than the norm and in the case of the grammar school group this is also true of the B Factor mean. Assuming that these schools have a high percentage of 'O' level candidates the figures for these two factors bear close resemblance to the 'O' level group. The pattern of a less rigid approach to content within a structured learning situation is again present, and supported by the teacher assessments.

One of the most satisfying mean scores in this table is the level of Factor C for the secondary modern school. There is here an attempt to relate mathematics to the pupil's needs and interests which would appear to be successful. The last grouping of results is shown in Table 9.

Table 9.

Mean scores: Single sex schools

Type of school	n	n_1	A	B	C	TA
Girls schools	324	(5)	30.1049	29.3549^{2}	66.8920^{1}	16.2774^{1}
Boys schools	413	(6)	29.9636^{5}	30.1889^{2}	70.9782	15.8329^{5}
Full sample						
Girls	1240		30.6298	29.9726	64.9048	14.8000
Boys	1450		30.5028	30.7303	71.0628	15.3483

Pupils in girls schools would appear to see mathematics in a rather closed and restricted situation. There is, however, a significant increase in interest and commitment compared with girls in a coeducational school. The pattern in the boys' schools shows a significant lowering of the mean score in both Factors A and B. The pupils are therefore less mechanical and directed in their approach to the content of mathematics. Nevertheless, they are also less able to perceive the open-ended approach and realise that mathematics can be seen in a variety of situations.

It is interesting to note that teachers in single sex schools rate their pupils significantly higher on this particular assessment.

The correlation matrix for the three factors A, B and C together with the Teacher-Assessment, estimated grade and actual grade for the C.S.E. group is given in Table 10. It was necessary to restrict the group as the actual grade results were not available for the 'O' level candidates. The correlation matrix for the full sample is shown in the Appendix (Table J).(p.101).

Table 10.

Correlation matrix: C.S.E. group

	A	B	C	TA	Estimated grade	Actual grade
A		-0.1716	-0.3512	-0.1916	0.1556	0.1468
B			0.2948	0.0859	0.0301	0.0041
C				0.3418	-0.3254	-0.3085
TA					-0.6616	-0.4773
Estimated grade						0.7008

(Sample n = 1606)

The inter-correlations between the three factors and the teacher assessments are low and confirm the finding of the pilot trial that the factors are measuring individual behaviours which do not relate strongly to each other.

$r_{A/TA} = -0.1916$; $r_{B/TA} = 0.0859$; $r_{C/TA} = 0.3418$

The argument is substantiated by the low correlations of A, B and C with the actual grade gained in the examination.

$r_{A/Actual} = -0.1916$; $r_{B/Actual} = 0.0859$; $r_{C/Actual} = 0.3418$

Two values of real significance stand out in the correlation matrix. The first is the $r_{TA/Estimated\ grade} = -0.6616$ and correspondingly $r_{TA/Actual\ grade} = -0.4773$.[1] The comment made in the report of the pilot trial that the teacher assessment was a compound measure can still apply. To this point must now be added the fact that the assessment involves a measurement of cognitive skill. With this form of assessment it would appear that teachers are unable to divorce affective behaviour from cognitive skills and abilities.

1. The negative signs are explained by high order TA values relating to numerically low order C.S.E. grades (Grade 1 candidate would have high TA).

The second value of significance is the correlation between estimated grade and actual grade: $r_{estimated/actual} = 0.7008$. The level of this correlation indicates the skill with which teachers can estimate cognitive performance in an examination. Recognition of this fact should enable examination authorities to be able to rely on the teacher assessment when they have need of it.[2]

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2. The information is incorporated into moderation procedures by the South-Western Examinations Board.

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C H A P T E R V I

AFFECTIVE BEHAVIOUR PROFILES

- -oOo- -

In addition to the group results obtained in the previous chapter, the inventory was originally intended to identify a pupil's affective behaviour. The pattern of results, so far, justifies the instrument as being useful in the discrimination and identification of three definable areas of affective behaviour.

A profile can be drawn which represents the position of an individual in relation to the norms established within the group results. Table 1 shows the profile form designed to represent the pupil's scores in linear form.

Table 1.

Blank Profile Form

NAME:-

NUMBER:-

SCHOOL:-

Standard Deviation	Factor A	Factor B	Factor C	Teacher Assessment	Estimated grade	Actual grade	Number of Teachers
+3	45.30	43.74	102.40	28.86			
+2	40.39	39.29	91.01	24.27	1	1	1
							Mean
+1	35.49	34.83	79.61	19.68	2	2	2
					Mean		
Mean 0	30.56	30.38	68.22	15.10	3	3	3
						Mean	
-1	25.65	25.93	56.83	10.51	4	4	4
-2	20.73	21.47	45.44	5.92	5	5	5
-3	15.82	17.02	34.05	1.33	6(U)	6(U)	5+

The picture of affective behaviour is recorded by the first five columns. Column 1 defines the scale of standard deviation and columns 2 to 5 represents the respondents score on the three factors A, B and C and the teacher-assessment score. The remaining three columns contain relevant factual data; namely Estimated Grade, Actual Grade, and the number of teachers experienced in the last two years. In all cases the score is represented as a line drawn from the mean.

To demonstrate the value of the profile, three pairs of candidates have been taken as examples. Table 2 and Table 3 show the profiles of 04195 and 07143 respectively.

Table 2.

Affective behaviour profile of candidate 04195

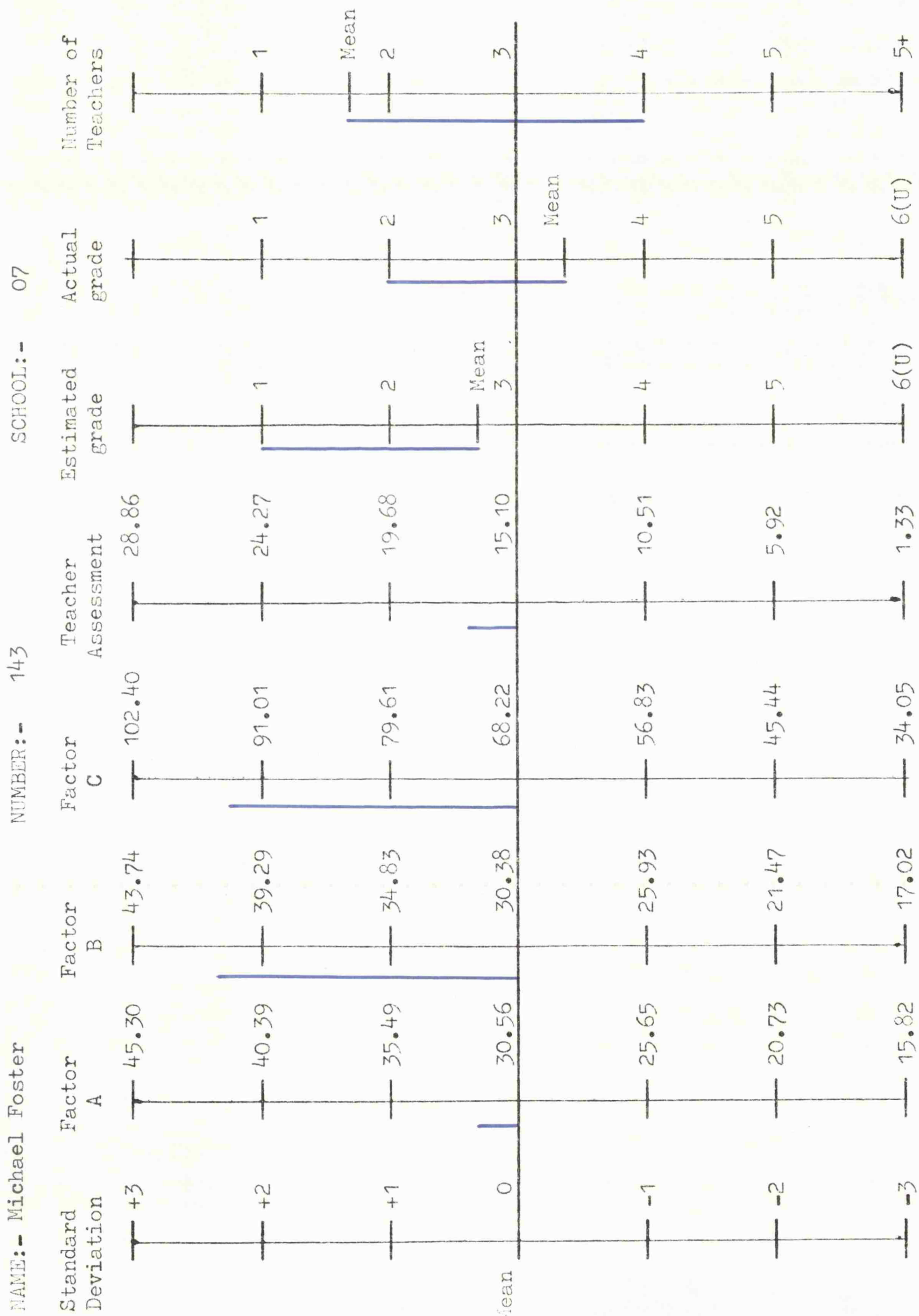
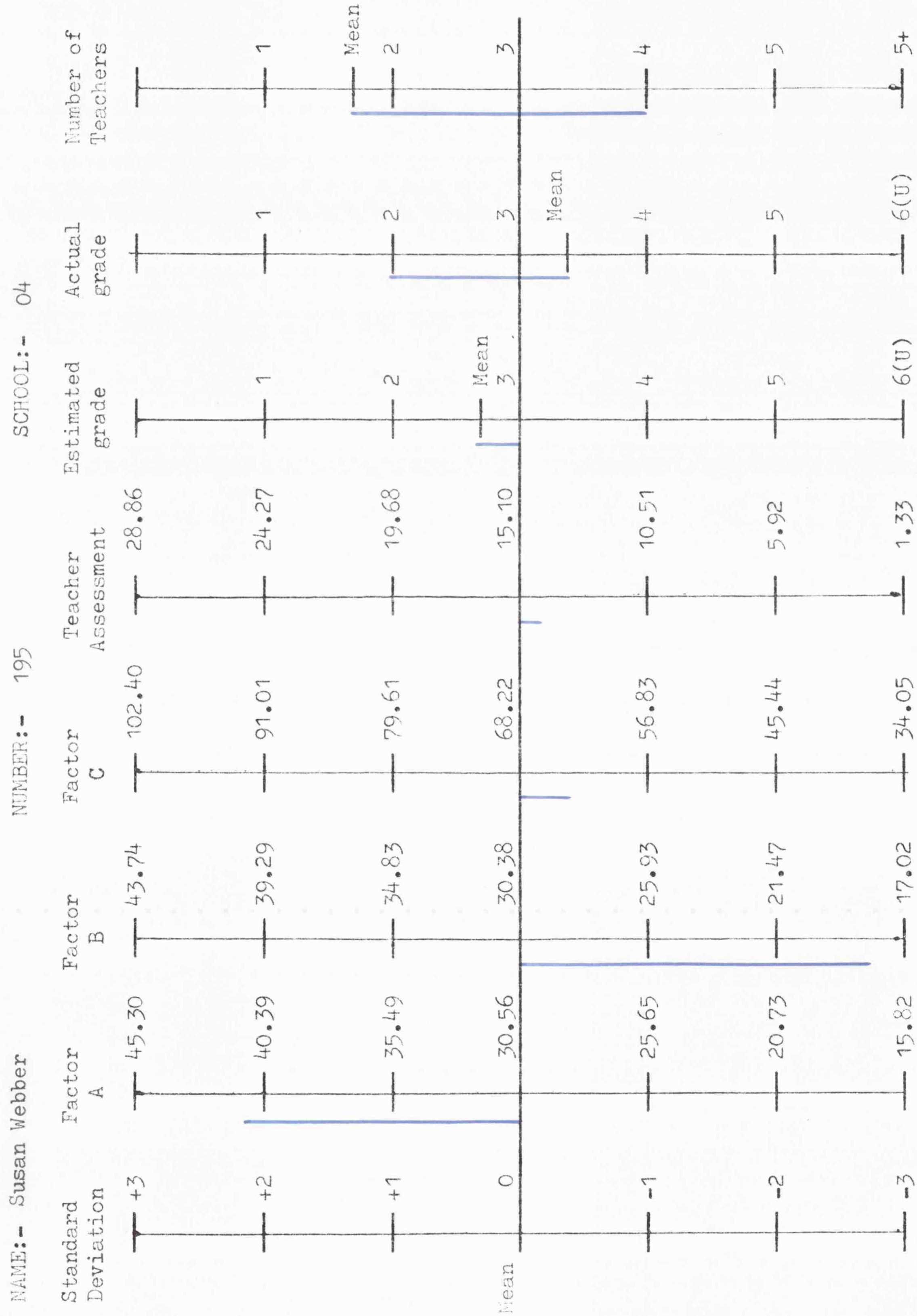


Table 3.

Affective behaviour profile of candidate 07143



Each of these candidates received the same actual grade in the examination; had four teachers during the past two years and scored 15 and 16 respectively on the teacher-assessment. In many cases, the information given here would be the only data available to the teacher or prospective employer. The profiles show marked differences in all three factors. A report on the affective behaviour of 04195 would make the following points:

> 'This student is strongly mechanical and stereotyped in her approach. She sees mathematics in a very restricted setting but displays average interest and commitment to the subject.'

The report on 07143 could read:

> 'This student has a flair for seeing mathematics in a variety of applications and situations. His level of interest and commitment is extremely high.'

The distinction revealed between these two candidates by the inventory would seem to be useful information for both teacher and employer.

The second pair of profiles shown in Table 4 and Table 5 demonstrate the effect of two widely differing candidates. 25119 gained a grade 1 with one teacher over the two-year period. The teacher-assessment was high. 25146 gained an ungraded result with a low teacher-assessment and four teachers over the two-year period. In this case the profiles bear out the cognitive assessment of the candidates and also the teacher's views of their abilities.

Within Factor A the difference ranges from +3 S.D. to -3 S.D. The differential in Factor B is from -2 S.D. to +2 S.D. and for Factor C the margin is -3 S.D. to +2SD. These results speak for themselves and need no further comment.

Table 4.

Affective behaviour profile of candidate 25119

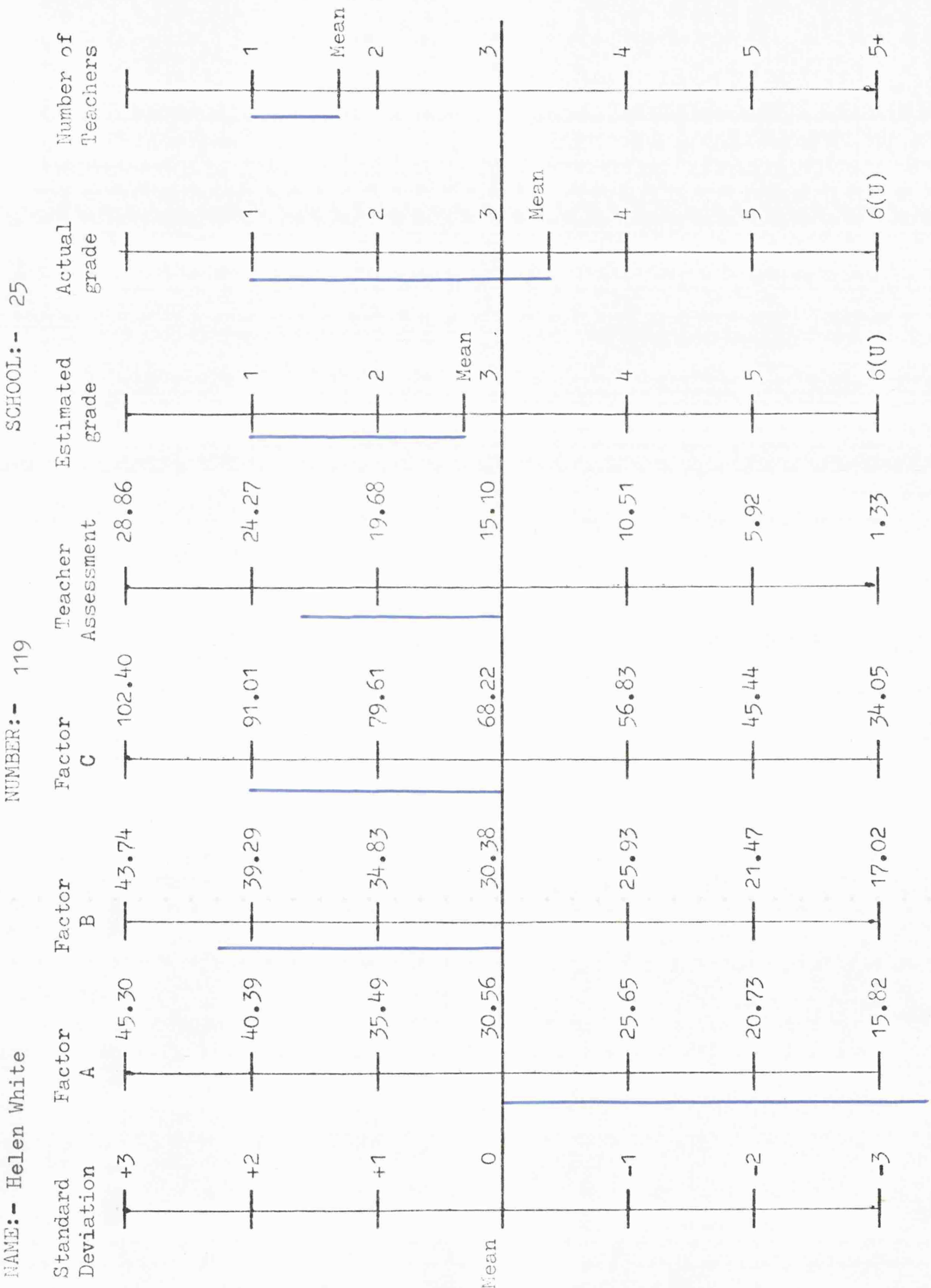
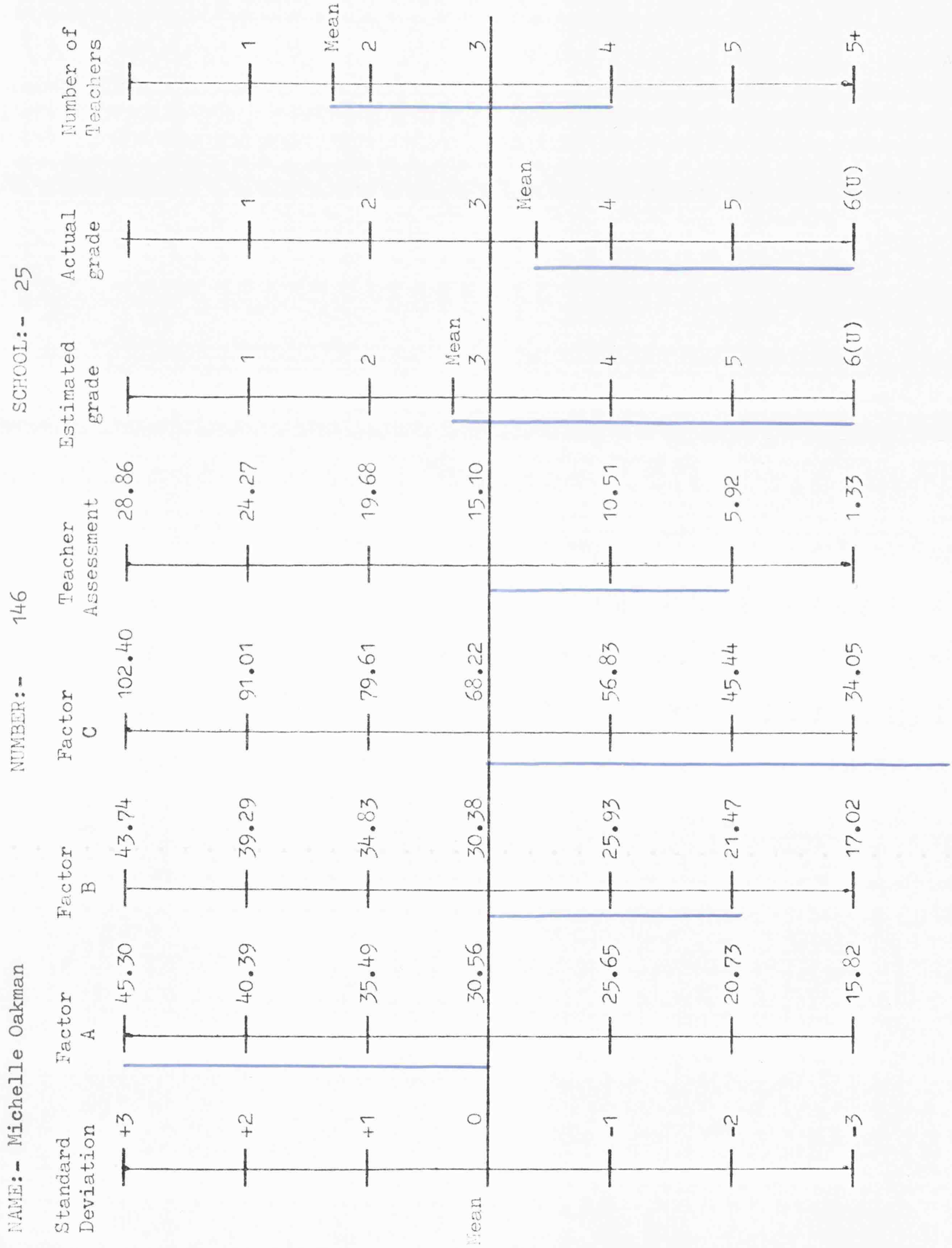


Table 5.

Affective behaviour profile of candidate 25146



The final pair of profiles show the similarity between two candidates and the interpretation calls for finer judgement than in the previous cases. Table 6 and Table 7 show the picture of affective behaviour for candiates 04050 and 16054 respectively. Both students gained a grade 4 in the examination. Candidate 04050 received tuition from four teachers during the period of two years whereas 16054 had only one teacher during this time.

For Factors A and B the profiles show the behaviour lying in the same direction, although in each case 16054 has a lower score. The major difference occurs in Factor C: 04050 shows a score above the mean whereas 16054 approaches a score lying nearly 2 S.D. below the mean. Although there was a significant correlation between teacher assessment and Factor C, the case in question is an exception. The explanation almost certainly lies in 04050 having four teachers which has been shown to produce a significant lowering of the assessment. If the need arose to discriminate between these two students, the profiles would show that 04050 is less mechanical and considerably more interested than 16054.

It is difficult to determine the extent to which the profile can be justified in defining individual differences within affective behaviour. In the examples given, the minimum level of acceptable difference has been taken as one standard deviation.

Table 6.

Affective behaviour profile of candidate 04050

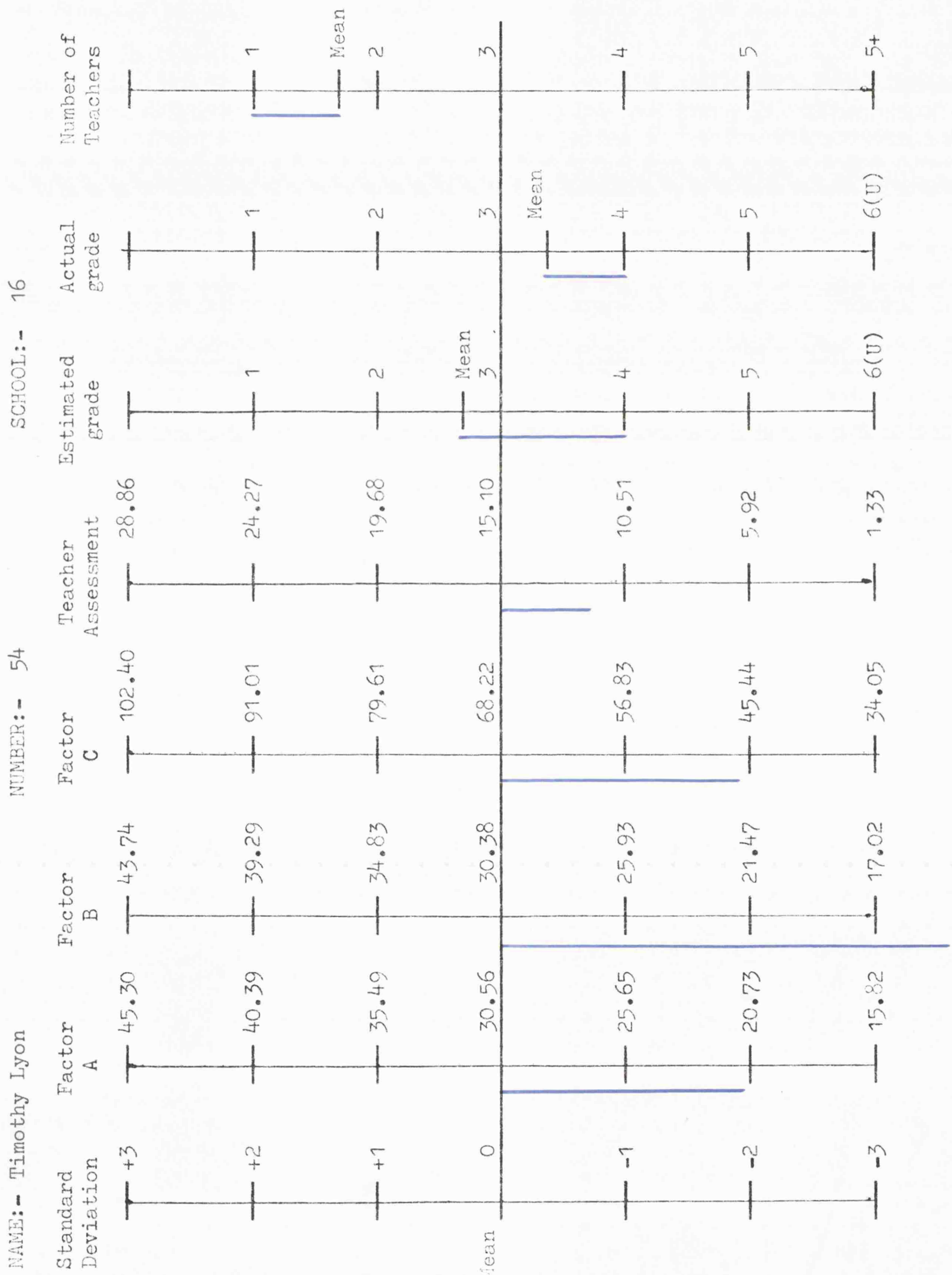
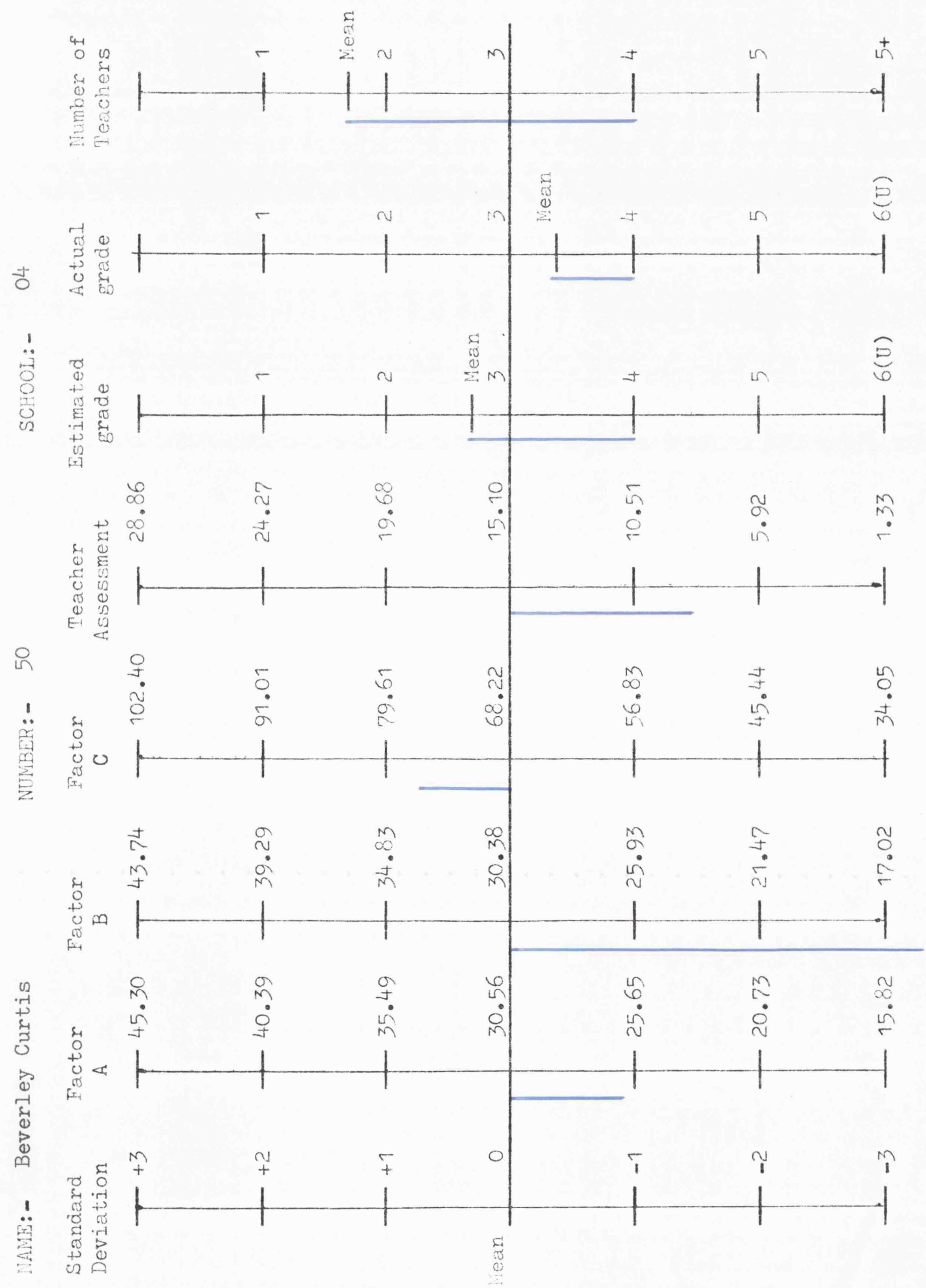


Table 7.

Affective behaviour profile of candidate 16054



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C H A P T E R   V I I

DISCUSSION AND SUMMARY OF RESULTS

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The factor analysis of the original survey produced an inventory of forty items which divided into three categories. The definition of the three factors was stated as:

<u>Factor A</u>: tending to see mathematics as an algorithmic, mechanical and somewhat stereotyped subject;

<u>Factor B</u>: tending to see mathematics in an open-ended, intuitive and heuristic setting;

<u>Factor C</u>: representing commitment, interest and application to mathematics.

The items were revalidated as appertaining to a particular factor.

Conclusions drawn from the data obtained relate to the basic framework of the research outlined above. Chapter 1 stated 'there should be a sense of urgency to provide a scheme which can help teachers to quantify affective behaviour'. This, it is hoped, is the outcome of the work.

In reviewing the literature and current research, it was found impossible to divorce the teacher from any affective measurement. Although the results demonstrate that the form of the teacher assessment used in the field trial had value, it became clear that the relationship between teacher and pupil in the development of affective behaviour is far more complex than can be measured by a rating sheet of the type used.

Bearing in mind the nature of the inventory and the limitation of the teacher-assessment, it is possible to draw some definitive conclusion from the field trial. The analysis of the data in Chapter 5 corroborated much that is already known to the mathematics teacher[1]. This result in itself gave confidence to the use of the inventory and greater authority to other results that

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1. Girls see mathematics in a rather restricted and predictable environment. The level of interest and commitment is significantly lower than for males. Boys show a greater appreciation of the variety of approaches and situations to be found in mathematics; they are likely to be more intuitive.

the field trial produced. The differences between the sexes[1] draws attention to the need for careful consideration of the content and learning experiences offered to girls. The findings seem to indicate a need for the mathematical experience to be directly related to the environment of the female adolescent. As a result the pupil should benefit from an increased awareness of the contribution of mathematics to everyday life which, in turn, will encourage a higher level of motivation.

The assessment of affective attainment creates problems for the mathematics teacher. The syllabus should no longer represent solely cognitive knowledge and skills but state affective outcomes which the pupil should attain. The planning of learning experiences to achieve specific directions of affective attainment is extremely complex and, at present, virtually unexplored.

The inter-relationship between the affective and cognitive domains was explored in the literature review. As far as possible the inventory was confined to the affective realm of behaviour but inevitably the outcomes were related to cognitive skills[2]. The individual profiles add to the view expressed in Chapter 2 that 'improved affective behaviour raises the level of cognitive performance and so any assessment of cognitive attainment may be taking account of affective outcomes'. The first part of this statement is shown by the results of the field trial to be accurate but doubt is cast on the latter part of the statement. The profiles show that children with the same grade can have very different affective attainments. The danger of leaving the measurement of affective behaviour to a purely cognitive instrument is evident.

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2. (i) The cognitive skill of a student is indirectly related to his score on the algorithmic scale and directly related to his interest and commitment.

   (ii) The teacher assessment is directly related to cognitive skill.

The environmental situation of the school has often been considered in a social context. Previous investigators have usually viewed the curriculum from the wider issues of educational objectives derived from society. The research reported in this study has uncovered data[3] concerning the school environment. The starting point in this case has been a subject within the curriculum. The field trial has shown that the affective and cognitive domains of a subject and its content[3] overlap. The reasons for these significant differences are obviously many and complex in origin. In addition to the environment of the semi-urban school, which often involves modern schools in new and developing areas, the geographical situation of these schools appeals more to the teacher that that of the city school.

Children in rural schools would appear not to see the relevance of mathematics as clearly as other students. The outcome is decreased motivation and a lowering of the levels of interest, enthusiasm and commitment. A comparable study of other subjects in the rural school curriculum would be likely to find increased levels of motivation in subjects where the relevance appears to be more important to the child.

The mathematical climate within a school is important to the affective development of the student. The field of study has added to the findings of the Birmingham research, reported in Chapter 2. The width of mathematical experience offered has value to the child's overall view of the subject[4]. Much of the width of experience may be second-hand and only absorbed through inter-communication between pupils. There are some students who take 'O' level, mode 1 and mode 3 but these are a small minority. The field sample

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3. City children see mathematics in a more mechanical and stereotyped way and are less interested and committed to mathematics. Rural children are also significantly less interested.

4. Children within a mode 1, mode 3 and 'O' level situation appear to see mathematics in a wider aspect of application than students in other situations.

shows that students who are involved in only one of these forms of examination differ significantly and to do this at the 1 per cent level there must be an increase in performance throughout the group that is not shown by students taking a similar course in a one mode school.

A criticism that has long been levelled at curriculum innovation and change is that there is so little evidence that the new is superior to the old. The field sample has added some further knowledge about the effect of the S.M.P. course[5]. The affective development of students undertaking this course appears to be significantly different from pupils following traditional courses. The inventory identifies these changes and it is for teachers and educators to comment on the desirable directions or qualities that it is pertinent to develop. The instrument can be used to evaluate aspects of affective behaviour in any mathematics course designed for children of C.S.E. and 'O' level age and ability. As reported earlier, the numbers of schools and children taking other nationally developed syllabuses was not large enough to provide satisfactory means for comparison.

As greater sophistication is developed in assessment techniques so there will be a need for those responsible for developing courses in mathematics to state their objectives clearly and concisely. The affective measures developed within this research have shown the affective attainments of pupils following a particular course[5]. As teachers become familiar with the techniques employed in curriculum development and with the variety of evaluation instruments available, so will they be able to construct and validate their courses in the light of the objectives they themselves have evolved.

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5. The results of pupils taking the S.M.P. course do seem to be significantly different from the norm. The level of Factor B mean score indicates these pupils see mathematics in a wider context of application, that they have a more strongly developed sense of intuition and their approach to problems allows greater flexibility. The level of commitment and interest is significantly lower.

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C H A P T E R   V I I I

CONCLUSION

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Much has been written on the development of affective objectives and their evaluation. The consensus of current opinion indicates that an assessment of the affective development of the child is not realistic and likely to be inaccurate. Krathwohl writes:

> 'in original statements of objectives there was frequently as much emphasis given to affective objectives as to cognitive objectives. . . . we found a rather rapid dropping of the affective objectives from the statements about the course and an almost complete disappearance of efforts at appraisal of student growth in this domain.'[1]

Against this background, the research reported in this study built on earlier work[2], which had identified affective objectives, in an attempt to assess affective behaviour. The success of the inventory which was finally developed must be judged on the acceptance of two crucial points. Firstly, that the factor analysis sifted the original ten variables related to affective behaviour into three distinct and identifiable factors. Secondly, the need for mathematicians to be able to agree on the placing of each of the forty items into a category. The successful outcome of these analyses enabled the research to go forward.

The identification of three factors of affective behaviour in mathematics is only a start. Such a complex structure cannot be simplified so easily. Indeed the definition of Factor B is extremely wide, covering, as it does, the manner in which a student sees the setting for mathematics. This will, no doubt, be challenged and later subdivided. Nevertheless the contribution of three distinct features of affective development could assist teachers and employers in 'assessment' procedures. Furthermore it suggests enormous

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1. Krathwohl, D.R. op. cit. p. 16.
2. Preston, M. op. cit.

scope for future developments both in mathematics and other related subjects.

Considerable information has been provided by the data, notably in two main areas. It produced conclusive evidence of behaviour in group situations and provides material for the teachers of mathematics to assimilate and discuss. The primary consideration must be of the qualities themselves and the direction of affective behaviour in which the individual child moves. The mean scores for the sample represent the position the average child holds in the development of a specific quality. Future discussions may well centre round the point at which this mean should be fixed for each quality. The nature of the experience that should be offered to influence development in any one of the factors is further subject for experiment. Some indication of how movement may be achieved has been given in the field trial by the results for the S.M.P. course.

At one stage the preceding paragraph requires the recognition of individual children's needs in relation to affective development. It is in this second area that the inventory can also make a notable contribution. The profile sheets give an easily interpretable graphic picture of the affective development of the child together with his cognitive development as expressed by a C.S.E. or 'O' level grade. The uses of the profile in terms of differentiation between pupils have already been discussed. Another application is in the analysis of the child's individual differences and needs. This further information provides the teacher with another piece of background with which to plan the individual student's course.

The results produced from the three samples, totalling over 3,000 students, have provided a means of affective appraisal of both child and course. The original objective has thus been achieved although it must be recognised that this is only a beginning in a very complex area of evaluation.

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APPENDICES

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Table A.

Attitude statements relating to specific categories

Algorithmic		Weighting
1.	Maths demands the following of a strict order of events.	-3
2.	Maths is like a machine, it demands an inflexible method.	-3
3.	Maths is a series of rules.	-1
4.	Maths follows a pattern of set directions.	-1
5.	Maths does not allow you any individuality.	-2
6.	If you follow the signposts you can do maths.	-2
7.	Maths is like a road map, follow the right route and the answer arrives.	-1
8.	The way of doing maths is always marked out.	-2
9.	Maths is purely mechanical.	-3
10.	There is a fixed routine to mathematics.	-2 (-20)

Heuristic		
1.	Maths is a process of analysis, i.e. sorting out.	+2
2.	I see maths as much a developing science as physics or chemistry.	+3
3.	Maths is a means of investigation.	+2
4.	Problems can be examined by using the science of maths.	+1
5.	Information can be processed by using mathematics.	+2
6.	Maths is a fact finding science.	+1
7.	I use maths to investigate a problem.	+2
8.	One way of understanding data is to use maths.	+3
9.	Maths is an exploring science.	+3
10.	Maths has many applications and is a wide and varied subject.	+1 (+20)

Table A continued

Logical development	Weighting
1. Maths is valuable as it proceeds in a set pattern	+1
2. Good administrators should study maths as it helps a person to organise his thoughts.	+1
3. Maths helps you to reason things out.	+1
4. Maths is logical.	+3
5. I think maths helps you to organise problems.	+2
6. A study of maths enables you to see the solution of some problems without working them.	+2
7. The more maths you do the clearer the picture becomes of how to approach problems.	+2
8. Maths helps you to direct your thinking.	+3
9. Working maths develops guide lines for problem solving.	+2
10. All children should study maths as it helps wider understanding.	+3 (20)

Methodology	
1. Individual project work is a good way to learn maths.	+2
2. I think maths should arise naturally through studying other subjects.	+3
3. I enjoy doing practical maths - experiments and investigations.	+2
4. I prefer working from a textbook in the classroom.	-3
5. Maths is the language of science.	+1
6. Group project work in maths is good fun.	+2
7. Finding out by doing is the best way of learning maths.	+2
8. I find the best way to learn maths is for the teacher to work examples and then for me to practice.	-2
9. I find working in small groups helps my progress in maths.	+1
10. Maths is so unlike any other subject it should be kept by itself.	-2

Table A continued

Affective development		Weighting
1.	I feel that I can realise some of my ambitions by studying maths.	+2
2.	I am usually eager to get to maths.	+1
3.	I am always willing to listen in maths.	+1
4.	Maths commands my attention.	+1
5.	I like to ask questions in maths.	+2
6.	Doing maths gives me satisfaction.	+3
7.	I feel maths is a worthwhile subject.	+2
8.	It is important that I succeed in maths.	+3
9.	The certainty and infallibility of maths is pleasing.	+2
10.	I have an appetite for maths.	+3 (+20)

Cognitive development		
1.	The way to learn maths is finding it out for yourself.	+3
2.	You need to understand the basic relationships of maths.	+1
3.	To progress in maths I need to master the basic rules.	+1
4.	I understand the way in which maths work.	+2
5.	Applying the rules of maths provides the answers.	+1
6.	Maths helps to break down a problem and help in its solution.	+2
7.	If you collect the data that maths can provide it will lead to understanding how to solve the particular problem.	+3
8.	Maths is a means of judging a situation.	+2
9.	Maths is a process of understanding and applying relationships.	+3
10.	An assessment of a situation can often be made mathematically.	+2 (+20)

Table A continued

Disinterestedness		Weighting
1.	I find maths destestable.	-3
2.	Children generally find maths unpopular.	-2
3.	I find mathematics boring.	-2
4.	Pupils find maths tedious.	-1
5.	The content of maths is stodgy.	-1
6.	Monotony and maths go hand in hand.	-2
7.	I think maths is as dry as dust.	-2
8.	Tiresome and aggravating thats maths.	-3
9.	Most children find maths dull.	-2
10.	Frankly I dislike maths.	-2 (-20)

Commitment		
1.	There is something attractive about maths.	+1
2.	Time passes quickly in maths.	+1
3.	The content of maths is exciting.	+3
4.	I look forward to maths as it is stimulating	+2
5.	Maths is an interesting subject.	+2
6.	Refreshing thats what I call maths.	+1
7.	I enjoy mathematics.	+3
8.	The more maths I do the more I want to do.	+3
9.	There's something fascinating about maths.	+2
10.	I get a good deal of pleasure from maths.	+2 (+20)

Table A continued

Positive evaluation	Weighting	
1. I think the study of maths is worthwhile.	+1	
2. The course in maths was valuable.	+2	
3. My maths course has prepared me for life out of school	+2	
4. If I had a chance I would like to go on studying maths.	+3	
5. Very useful best describes my maths course.	+2	
6. I find maths to be sensible and related to life.	+2	
7. Maths is an essential part of my education.	+3	
8. Although some students do not like maths I think it is advisable for them to study it.	+1	
9. I aim to be capable in maths.	+2	
10. I am satisfied with my maths course.	+2	(+20)

Rejection		
1. I feel incompetent when doing maths.	-2	
2. I feel that my maths course was poor.	-2	
3. The maths course was not relevant to everyday life.	-1	
4. Continuing the study of maths is unnecessary.	-3	
5. The sooner I stop studying maths the better.	-3	
6. My education has little need for mathematics.	-2	
7. I felt my course in maths to be worthless.	-2	
8. Rather useless best describes my maths course.	-1	
9. Maths means nothing to me.	-3	
10. Only those that can do maths should study it.	-1	(-20)

Table B.

Category and attitude statement placings

Category	Questions
1. Algorithmic values	91, 15, 72, 23, 36, 70, 11, 4, 76, 66.
2. Heuristic values.	33, 43, 61, 3, 80, 21, 93, 63, 16, 75.
3. Disinterestedness.	85, 7, 81, 10, 94, 6, 42, 24, 54, 96.
4. Commitment.	69, 59, 62, 28, 41, 40, 52, 99, 2, 89.
5. Logical attitude.	20, 95, 98, 35, 29, 44, 77, 84, 90, 1.
6. Methodological attitude.	17, 48, 83, 64, 18, 60, 25, 47, 74, 45.
7. Affective realisation.	53, 32, 92, 19, 34, 55, 26, 68, 56, 46.
8. Cognitive realisation.	13, 12, 79, 9, 8, 88, 51, 97, 50, 86.
9. Positive evaluation.	14, 58, 57, 73, 37, 30, 78, 87, 49, 27.
10. Rejection.	100, 5, 67, 31, 71, 58, 65, 39, 22, 82.

What do you really think about Maths?

These questions are attempting to find out the answer to this question.

All you have to do is place a tick in one of the columns; for example in answer to the item "Mathematics is purely mechanical" you have to answer in one of the columns which are headed:-

Strongly agree   agree   not sure   disagree   strongly disagree

If you agree with the statement, a tick would be placed thus:-

Strongly agree	agree	not sure	disagree	strongly disagree
	✓			

if, on the other hand you strongly disagree the tick would be placed thus:-

Strongly agree	agree	not sure	disagree	strongly disagree
				✓

Please work quickly and put your first reaction down as the answer.

Some of the statements are very similar, so please do NOT look back or change any answer.

If you understand these instructions please turn over and complete the details on the next page.

If you do not understand please ask the member of staff any question you wish.

Name

Age:- ________________ years ________________ months

please underline correct answer

1) Male/Female

2) Boys/Girls/Mixed School

3) Secondary Modern, Grammar, Comprehensive, Bilateral, Other

4) Number of teachers who have taught you maths. in the last two years

1, 2, 3, 4, 5, more than 5

5) I am taking

CSE. GCE 'O' level. Internal Leaving Certificate No exams.

please turn over and work through remaining pages

	strongly agree	agree	not sure	dis-agree	strongly disagree
1. All children should study mathematics as it helps wider understanding.					
2. There's something fascinating about maths.					
3. Problems can be examined by using the science of mathematics.					
4. There is a fixed routine to mathematics.					
5. I feel that my maths course was poor.					
6. Monotony and maths go hand in hand.					
7. Children generally find mathematics unpopular.					
8. Applying the rules of maths provides the answers.					
9. I understand the way in which maths work.					
10. Pupils find mathematics tedious.					
11. Maths is like a road-map, follow the right route and the answer arrives.					
12. You need to understand the basic relationship of maths.					
13. The way to learn maths is finding it out for yourself.					
14. I think the study of maths is worthwhile.					
15. Mathematics is like a machine it demands an inflexible method.					
16. Mathematics is an exploring science.					

		SA	A	NS	D	SD
17.	Individual project work is a good way to learn maths.					
18.	Mathematics is the language of science.					
19.	Maths commands my attention.					
20.	Mathematics is valuable as it proceeds in a set pattern.					
21.	Mathematics is a fact finding science.					
22.	Maths means nothing to me.					
23.	Mathematics follows a pattern of set directions.					
24.	Tiresome and aggravating that's mathematics.					
25.	Finding out by doing is the best way of learning maths.					
26.	I feel maths is a worthwhile subject.					
27.	I aim to be capable in mathematics.					
28.	I look forward to maths as it is stimulating.					
29.	I think mathematics helps you to organise problems.					
30.	Very useful best describes my maths course.					
31.	Continuing the study of maths is unnecessary.					
32.	I am usually eager to get to maths.					
33.	Mathematics is a process of analysis i.e. sorting out.					
34.	I like to ask questions in maths.					
35.	Maths is logical.					
36.	Mathematics does not allow any individuality.					
37.	If I had the chance I would like to go on studying maths.					
38.	I am satisfied with my maths course.					
39.	Rather useless best describes my maths course.					

	SA	A	NS	D	SD
40. Refreshing that's what I call maths.					
41. Mathematics is an interesting subject.					
42. I see maths as much a developing science as physics or chemistry.					
44. A study of maths enables you to see the solution of some problems without working them.					
45. Maths is so unlike other subjects that it should be kept by itself.					
46. I have an appetite for maths.					
47. I find the best way to learn maths is for the teacher to work examples and then for me to practice.					
48. I think maths should arise naturally through studying other subjects.					
49. Although some students do not like mathematics I think it is advisable for them to study it.					
50. Mathematics is a process of understanding and applying relationships.					
51. If you collect the data that maths can provide it will lead to understanding how to solve the particular problem.					
52. I enjoy mathematics.					
53. I feel that I can realise some of my ambitions by studying maths.					
54. Most children find mathematics dull.					
55. Doing maths gives me satisfaction.					
56. The certainty and infallability of maths is pleasing.					
57. The course in mathematics was valuable.					
58. My education has little need for maths.					
59. Time passes quickly in maths.					
60. Group project work in maths is good fun.					
61. Mathematics is a means of investigation.					

	SA	A	NS	D	SD
62. The content of mathematics is exciting.					
63. One way of understanding data is to use mathematics.					
64. I prefer working from a textbook in the classroom.					
65. I felt my course in maths to be worthless.					
66. Mathematics is purely mechanical.					
67. The maths course was not relevant to everyday life.					
68. It is important that I should succeed in maths.					
69. There is something attractive about mathematics.					
70. If you follow the 'signposts' you can do maths.					
71. The sooner I stop studying maths the better.					
72. Mathematics is a series of rules.					
73. My maths course has prepared me for life out of school.					
74. I find working in a small group helps my progress in mathematics.					
75. Mathematics has many applications and is therefore a wide and varied subject.					
76. The way of doing maths is always marked out.					
77. The more maths you do the clearer the picture becomes of how to approach problems.					
78. I find maths to be sensible and related to life.					
79. To progress in maths I need to master the basic rules.					
80. Information can be processed by using maths.					
81. I find mathematics boring.					
82. Only those that can do maths should study it.					

		SA	A	NS	D	SD
83.	I enjoy doing practical maths - i.e. experiments and investigations.					
84.	Mathematics helps you direct your thinking.					
85.	I find mathematics detestable.					
86.	An assessment of a situation can often be made mathematically.					
87.	Mathematics is an essential part of my education.					
88.	Maths helps to break down a problem and help in its solution.					
89.	I get a good deal of pleasure from maths.					
90.	Working maths develops guide lines for problem solving.					
91.	Maths demands the following of a strict order of events.					
92.	I am always willing to listen in maths.					
93.	I do use maths to investigate a problem.					
94.	The content of maths is stodgy.					
95.	Good administrators should study mathematics as it helps a person to organise his thoughts.					
96.	Frankly, I dislike maths.					
97.	Maths is a means of judging a situation.					
98.	Mathematics helps you reason things out.					
99.	The more maths I do the more I want to do.					
100.	I feel incompetent when doing maths.					

Table C.

Pupil Rating Sheet No. 1

Scoring

		Strongly	Fairly	Average	Fairly	Strongly	
1	Intuitive	+20	+10	0	-10	-20	Mechanical
2	Uninterested	-20	-10	0	+10	+20	Enthusiastic
3	Irrational	-7	-3	0	+10	+20	Logical
4	Practical	+20	+10	0	+10	+20	Theoretical
5	Good mathematician	+20	+10	0	-10	-20	Poor mathematician

Table D.

Pupil Rating Sheet No. 2

NAME OF STUDENT: ____________________

The following qualities may be descriptive of this student. Please underline ONE OR MORE in EACH group.

+4 per item	A. Intuitive Instinctive Insightful Impulsive Impressionistic	None of these
-4 per item	B. Mechanical Pedantic Exacting Precise Inflexible	None of these
+4 per item	C. Progressive Enterprising Incisive Forward-looking Assured	None of these
+4 per item	D. Content Satisfied Secure Voracious Aspiring	None of these
+4 per item	E. Logical Conformable Conventional Orthodox Consistent	None of these
+12/ -8	F. Practical (+4) Formal (-4) Individualistic (+4) Gregarious (-4) Adaptable (+4)	None of these
+4 per item	G. Enthusiastic Zealous Willing Active Cooperative	None of these
-4 per item	H. Indifferent Unwilling Impassive Inactive Lax	None of these
+4 per item	I. Acquiescent Approving Positive Assertive Insistent	None of these
-4 per item	J. Rejecting Uncompliant Resistant Begrudging Negative	None of these

CATEGORY REFERENCE

A - Heuristic

B - Algorithmic

C - Cognitive realisation

D - Affective realisation

E - Logical attitude

F - Methodological attitude

G - Commitment

H - Disinterestedness

I - Positive evaluation

J - Rejection

Table E.

Test no.	Attitude scores 1	2	3	4	5	6	7	8	9	10	Total score	Teacher assess.	No. of Teacher	Exam. Grade	Sex
01	49	56	26	12	53	41	22	47	33	27	366	57(128)	2	O	F
02	44	60	51	46	57	40	48	48	65	47	506	67(140)	2	O	M
03	55	48	44	40	57	50	58	54	63	59	528	100(132)	1	O	F
04	50	53	61	54	61	49	46	57	66	77	574	150(176)	1	O	F
05	66	75	54	53	67	51	52	61	49	61	589	73(140)	1	C	F
06	66	48	59	44	63	42	43	58	62	58	543	150(68)	1	C	M
07	47	62	61	59	66	60	58	65	63	75	616	170(164)	4	C	M
08	58	40	19	22	39	39	22	65	37	46	387	67(144)	2	C	F
09	46	58	47	29	59	68	49	57	51	53	527	150(124)	2	C	M
10	45	61	42	27	67	51	42	70	66	54	525	100(132)	2	C	M
11	73	74	76	70	75	44	76	65	76	80	711	190(200)	3	A	M
12	49	75	66	69	75	55	61	69	73	73	665	90(128)	3	A	M
13	45	53	60	49	65	44	63	54	66	67	576	140(148)	1	A	M
14	65	77	81	70	78	61	65	75	69	80	712	200(136)	3	A	M
15	47	70	56	47	62	51	54	65	57	60	569	150(184)	1	A	M
16	46	68	77	75	75	79	80	79	82	81	746	130(168)	3	A	F
17	55	55	45	45	60	56	40	63	47	61	527	90(104)	2	C	M
18	40	55	61	44	56	51	52	52	63	66	540	100(168)	1	C	M
19	40	60	52	38	65	56	48	54	54	54	521	90(124)	1	C	F
20	49	57	56	38	55	54	45	49	48	45	506	150(132)	3	C	F

Table E continued

Test no.	Attitude scores 1	2	3	4	5	6	7	8	9	10	Total Score	Teacher assess.	No. of Teacher	Exam. Grade	Sex
21	56	68	63	54	65	57	61	55	66	67	612	200(200)	1	O	M
22	49	60	63	48	62	53	50	51	61	65	536	150(176)	1	O	F
23	55	76	58	52	78	48	54	72	70	73	636	150(84)	1	O	M
24	51	60	66	52	64	51	50	55	67	69	585	80(140)	1	O/C	F
25	49	57	63	49	55	52	51	56	64	65	561	100(124)	1	O	F
26	81	78	81	64	70	60	75	62	76	78	719	150(192)	1	O	M
27	42	63	37	34	66	51	35	63	63	61	515	120(124)	2	O	M
28	45	58	68	65	67	49	62	73	65	57	609	100(148)	1	O	F
29	55	52	48	38	43	57	49	55	51	53	501	117(112)	1	O	F
30	56	73	54	50	73	56	74	67	76	82	675	150(164)	1	O	M
31	52	72	58	66	68	60	68	60	67	71	641	150(164)	1	O	M
32	48	64	62	66	64	69	81	72	63	80	676	120(184)	5+	O	M
33	51	56	60	52	61	48	62	56	75	81	602	43(144)	3	O/C	M
34	48	37	43	45	62	70	52	69	71	71	568	120(148)	1	O	M
35	56	58	73	62	75	57	57	63	81	62	657	97(132)	1	O/C	M
36	29	72	64	67	74	49	70	71	77	80	659	160(76)	4	O	M
37	46	63	61	44	58	55	50	55	57	72	561	130(124)	2	O	M
38	46	47	56	54	57	57	53	60	51	61	540	80(128)	4	C	M
39	52	59	45	50	69	66	58	64	65	69	597	150(188)	2	C	M
40	50	66	55	39	65	55	47	51	58	61	547	80(108)	2	C	M

Table E continued

Test no.	Attitude scores 1	2	3	4	5	6	7	8	9	10	Total score	Teacher assess.	No. of Teacher	Exam. Grade	Sex
41	57	56	57	59	65	60	60	55	68	61	598	80(124)	2	C	M
42	61	65	55	41	69	63	49	59	60	73	595	107(100)	2	C	M
43	50	65	76	70	65	56	55	72	71	81	660	160(164)	3	O/C	M
44	55	54	45	34	68	59	42	64	60	59	540	200(192)	1	O	M
45	41	87	64	72	74	53	67	74	84	70	686	150(72)	1	O	M
46	48	58	60	48	60	57	53	60	58	69	571	90(144)	1	O	M
47	44	63	58	59	62	54	57	59	68	64	588	67(124)	1	O	F
48	42	52	40	31	64	52	66	59	58	63	527	200(156)	1	O	M
49	48	67	53	57	62	51	57	62	57	60	574	90(108)	1	O	F
50	68	72	66	51	73	55	53	62	73	78	590	150(192)	1	O/C	F
51	51	67	65	51	69	58	43	70	52	68	594	121(136)	2	C-1	M
52	37	47	46	29	66	42	50	48	55	52	472	110(164)	5	O/C-4	M
53	38	55	47	30	47	63	46	43	59	61	489	130(156)	2	O	M
54	62	64	45	38	63	62	52	60	55	40	541	77(112)	2	O/C-3	M
55	34	68	52	70	77	68	61	69	70	66	635	130(128)	2	O/C-2	M
56	61	50	41	35	64	42	45	47	49	58	492	120(128)	3	O/C-4	M
57	62	66	48	30	60	57	48	54	64	63	552	110(140)	4	O	M
58	41	61	48	54	54	49	59	61	56	46	529	121(136)	3	O/C-2	F
59	46	63	52	33	56	57	44	58	54	56	519	107(96)	3	O/C-2	M
60	48	70	31	30	65	56	48	62	52	65	527	110(128)	3	O/C-3	M

Table E continued

Test no.	Attitude scores 1	2	3	4	5	6	7	8	9	10	Total score	Teacher assess.	No. of Teacher	Exam. Grade	Sex
61	50	55	61	60	60	47	57	48	64	61	563	120(120)	2	0-8	F
62	32	50	40	35	44	61	33	48	33	42	418	130(148)	2	0	F
63	57	55	60	54	54	54	52	53	60	58	557	110(148)	2	0-8	F
64	51	49	38	30	54	50	33	46	33	39	422	121(136)	2	0-4	F
65	39	52	32	33	56	51	58	51	56	57	485	90(124)	2	0/C-3	M
66	56	50	73	38	58	48	50	42	64	60	539	150(148)	2	0-6	M
67	66	52	58	52	57	52	52	63	59	63	574	117(132)	2	0/C-2	F
68	46	59	73	63	61	50	53	57	63	73	598	110(144)	2	0/C-2	F
69	44	58	55	39	51	57	56	53	58	65	536	110(148)	2	0/C-3	F
70	59	45	57	20	47	57	42	46	44	61	478	121(136)	2	C-5	F
71	71	71	78	57	63	64	64	63	87	83	701	120(164)	2	0	F
72	53	65	62	42	57	55	54	55	60	55	558	107(136)	2	0/C-3	F
73	32	72	72	69	87	65	67	74	62	74	674	87(128)	3	0/C-4	M
74	50	77	80	74	76	49	73	67	78	81	705	100(124)	4	0-8/C-3	M
75	54	67	71	56	65	60	63	64	71	70	641	120(140)	3	C-1	M
76	48	65	77	57	69	69	61	61	68	81	656	120(116)	3	0	M
77	40	69	60	60	74	76	63	74	64	66	646	97(124)	3	0-4/C-2	M
78	61	59	86	84	66	56	81	55	66	73	687	180(148)	3	0-3	M
79	63	59	63	54	60	42	53	52	61	60	567	120(116)	3	0-6	M
80	55	60	57	55	65	47	63	59	58	62	581	130(116)	3	0-6	F

Table E continued

Test no.	Attitude scores 1	2	3	4	5	6	7	8	9	10	Total score	Teacher Assess.	No. of Teacher	Exam. Grade	Sex
81	61	63	74	69	64	60	72	60	63	69	655	150(136)	3	0-6	F
82	54	65	36	23	65	53	47	58	47	60	488	121(124)	1	C	F
83	58	64	64	59	71	54	66	67	71	76	650	120(108)	1	0	M
84	51	57	60	56	55	55	47	52	59	66	558	100(120)	1	0	F
85	36	63	67	55	68	49	50	56	65	69	578	77(132)	1	0	F
86	42	66	57	49	67	52	51	70	63	68	587	120(144)	1	0	F
87	71	52	74	57	52	48	51	56	69	78	608	110(124)	1	0	F
88	57	65	66	64	63	55	59	64	66	75	634	180(156)	1	0	F
89	59	65	62	55	69	61	53	58	57	68	607	100(120)	1	0	M
90	50	63	53	37	64	52	53	67	68	63	570	100(136)	1	0	M
91	47	64	81	75	63	57	68	66	70	79	670	120(104)	1	0	M
92	53	57	65	56	64	54	61	67	70	68	605	110(128)	4	0	F
93	57	60	72	61	68	60	64	63	70	79	654	110(128)	2	0	M
94	43	70	72	70	73	36	64	62	70	69	629	190(140)	1	0	F
95	50	48	28	28	46	68	45	56	36	45	450	121(136)	2	0	M
96	54	68	83	77	71	57	68	62	70	78	688	200(166)	1	0	F
97	54	59	30	30	70	50	44	57	54	63	511	77(112)	1	0	F
98	48	64	58	68	60	44	60	65	66	74	607	87(116)	4	0	M
99	49	59	31	21	35	50	38	46	30	42	401	97(120)	1	0	F
100	37	62	68	35	62	49	43	56	55	62	529	120(160)	4	0	M

Table E continued

Test no.	Attitude scores 1	2	3	4	5	6	7	8	9	10	Total score	Teacher Assess.	No. of Teacher	Exam. Grade	Sex
101	56	56	79	60	65	58	63	65	73	64	649	77(108)	2	0	M
102	50	74	55	58	72	54	57	52	57	55	584	110(116)	1	0	M
103	45	68	76	54	66	36	58	63	62	68	596	140(120)	1	0	F
104	33	64	59	40	66	53	56	50	52	64	544	160(144)	1	0	F
105	43	51	44	32	48	55	44	48	54	52	471	90(132)	2	0	F
106	62	51	66	59	64	60	60	60	60	61	603	90(124)	2	0	F
107	55	62	51	49	61	52	49	56	62	73	570	77(104)	3	0	M
108	46	64	47	38	64	58	53	66	53	52	541	73(116)	1	0	F
109	47	70	62	65	70	58	64	68	70	69	643	170(116)	1	0	M
110	52	62	69	68	64	52	62	75	64	72	640	190(148)	1	0	F
111	64	75	80	70	58	63	62	51	77	87	687	160(128)	2	0	F
112	57	58	68	59	69	56	56	55	66	63	607	200(140)	1	0	F
113	72	72	80	72	79	60	70	67	68	81	721	120(156)	1	0	M
114	50	63	67	63	63	57	54	66	60	74	617	140(132)	1	0	M
115	47	71	42	41	65	71	67	68	66	67	605	57(112)	2	0	M
116	78	71	81	70	64	61	75	56	77	79	712	160(168)	2	0	F

Table F.

Correlation matrix for Variables, Total score, Teacher assessments
(1 - 10) (11) (12 and 13)

	1	2	3	4	5	6	7	8	9	10	11	12	13	
1	1.0000	0.0989	0.2943	0.1843	0.0522	0.0192	0.1709	-0.0109	0.2095	0.2528	0.2432	0.1423	0.1663	1
2	0.0989	1.0000	0.4346	0.5103	0.6448	0.1714	0.5207	0.4799	0.4927	0.4851	0.5742	0.1489	-0.0077	2
3	0.2943	0.4346	1.0000	0.8160	0.4733	0.1173	0.6650	0.2922	0.6936	0.7217	0.7224	0.2372	0.1628	3
4	0.1843	0.5103	0.8160	1.0000	0.5771	0.1728	0.7835	0.5171	0.7118	0.7114	0.7697	0.2245	0.0820	4
5	0.0522	0.6448	0.4733	0.5771	1.0000	0.1746	0.5797	0.6179	0.6232	0.5635	0.6062	0.2175	0.0339	5
6	0.0192	0.1714	0.1173	0.1728	0.1746	1.0000	0.3063	0.3108	0.1631	0.2558	0.3091	0.0206	0.1228	6
7	0.1709	0.5207	0.6650	0.7835	0.5797	0.3063	1.0000	0.4693	0.7264	0.6955	0.7257	0.2682	0.1868	7
8	-0.0109	0.4799	0.2922	0.5171	0.6179	0.3108	0.4693	1.0000	0.4854	0.4975	0.5165	0.1529	-0.0165	8
9	0.2095	0.4927	0.6936	0.7118	0.6232	0.1631	0.7264	0.4854	1.0000	0.7795	0.7193	0.2099	0.1269	9
10	0.2528	0.4851	0.7217	0.7114	0.5635	0.2558	0.6955	0.4975	0.7795	1.0000	0.7131	0.2758	0.1984	10
11	0.2432	0.5742	0.7224	0.7697	0.6062	0.3091	0.7257	0.5165	0.7193	0.7131	1.0000	-0.1813	0.1534	11
12	0.1423	0.1489	0.2372	0.2245	0.2175	0.0206	0.2682	0.1529	0.2099	0.2758	-0.1813	1.0000	0.1870	12
13	0.1663	-0.0077	0.1628	0.0820	0.0339	0.1228	0.1868	-0.0165	0.1269	0.1984	0.1534	0.1870	1.0000	13

	Mean score of variables	Standard deviations		Mean score of variables	Standard deviations
1.	51.3879	9.5536	8.	59.8276	7.8677
2.	61.6293	8.5838	9.	61.9483	10.5576
3.	58.6293	13.8748	10.	65.2759	10.9738
4.	50.6810	14.8873	11.	578.3707	83.5834
5.	63.3276	8.3890	12.	125.9052	60.4515
6.	54.7672	7.6331	13.	136.0517	25.1512
7.	55.3448	10.8866			

Table G.

Factor Analysis

PRINCIPAL COMPONENTS

	I	II	III
1.	0.2439	0.6947	0.3767
2.	0.6912	-0.2302	-0.1959
3.	0.8060	0.3740	-0.0368
4.	0.8800	0.1322	-0.0736
5.	0.7722	-0.2869	-0.2317
6.	0.3092	-0.4273	0.8228
7.	0.8590	0.0303	0.0732
8.	0.6592	-0.4863	0.0022
9.	0.8634	0.1211	-0.0745
10.	0.8617	0.1340	0.0723

Table G_1.

VARIMAX LOADINGS

	I'	II'	III'
1.	0.0460	0.8249	0.0380
2.	0.7405	-0.1236	0.0738
3.	0.7346	0.4981	-0.0564
4.	0.8438	0.2890	0.0417
5.	0.8344	-0.1696	0.0855
6.	0.1167	0.0563	0.9687
7.	0.7951	0.2589	0.2122
8.	0.6852	-0.2684	0.3599
9.	0.8296	0.2750	0.0430
10.	0.7857	0.3494	0.1624

VARIANCE

1.	49.1906
2.	13.9597
3.	11.6032

Power of N 4

PROMAX LOADINGS

	I''	II''	III''
1.	-0.0952	0.8575	0.1051
2.	0.7996	-0.2490	-0.0495
3.	0.7084	0.3887	-0.1287
4.	0.8453	0.1611	-0.0625
5.	0.9056	-0.3119	-0.0560
6.	-0.0312	0.1338	0.9921
7.	0.7726	0.1548	0.1194
8.	0.7218	-0.3626	0.2431
9.	0.8323	0.1491	-0.0601
10.	0.7550	0.2460	0.0772

CORRELATIONS BETWEEN PROMAX FACTORS

1.	1.0000	0.2819	0.2482
2.	0.2819	1.0000	-0.1134
3.	0.2482	-0.1134	1.0000

What do you really think about Maths?

These questions are attempting to find out the answer to this question.

All you have to do is place a tick in one of the columns; for example in answer to the item "Mathematics is purely mechanical" you have to answer in one of the columns which are headed:-

Strongly agree	agree	not sure	disagree	strongly disagree

If you agree with the statement, a tick would be placed thus:-

Strongly agree	agree	not sure	disagree	strongly disagree
	✓			

if, on the other hand you strongly disagree the tick would be placed thus:-

Strongly agree	agree	not sure	disagree	strongly disagree
				✓

Please work quickly and put your first reaction down as the answer.

Some of the statements are very similar, so please do NOT look back or change any answer.

If you understand these instructions please turn over and complete the details on the next page.

If you do not understand please ask the member of staff any question you wish.

Name ____

Age:- ____________ years ____________ months

Please underline correct answer

1. Male/Female

2. Boys/Girls/Mixed school

3. Secondary modern, Grammar, Comprehensive, Bilateral, Other

4. Number of teachers who have taught you maths, in the last 2 years

1, 2, 3, 4, 5, more than 5

5. I am taking:-

CSE. GCE 'O' level Internal Leaving Certificate no exams

Please turn over and work through remaining pages

		SA	A	NS	D	SD
1.	Maths demands rigid thinking along set lines.					
2.	Maths was an essential part of my primary school but not my secondary school.					
3.	Group project work in maths is good fun and successful in teaching me mathematics.					
4.	Time passes quickly in maths.					
5.	Maths is such an important subject that I really work hard.					
6.	Maths is a science and should be learnt experimentally.					
7.	Doing maths gives me satisfaction.					
8.	I find working in a small group helps my progress in maths.					
9.	Maths is an exploring science.					
10.	Individual project work is a good way to learn maths.					
11.	My maths course has prepared me for life out of school.					
12.	Maths is logical and purposeful.					
13.	Mathematics is like a machine it demands an inflexible method.					
14.	Mathematics helps you direct your thinking.					
15.	I have an appetite for maths.					
16.	Monotony and mathematics go hand in hand.					
17.	I felt my maths course to be worthless.					
18.	Maths follows a pattern of set directions and laws.					
19.	Maths is fascinating.					
20.	I can't really get on with maths.					

		SA	A	NS	D	SD
21.	Mathematics demands a set sequence in solving problems.					
22.	The course in mathematics was valuable.					
23.	There is something attractive about mathematics.					
24.	Maths does not allow any individuality.					
25.	The best way to teach maths is for the teacher to work examples and for me to practice.					
26.	I think mathematics is as dry as dust.					
27.	There is a fixed routine in mathematics.					
28.	Maths is so different from other subjects that it should be taught entirely on its own.					
29.	Applying the rules of maths provides the answers.					
30.	Only those that can do maths should study it.					
31.	Mathematics is purely mechanical.					
32.	Maths is a useful subject as it helps in life outside school.					
33.	I find the best way to learn maths is using it in other subjects.					
34.	I don't really understand or care for mathematics.					
35.	I prefer class teaching and working from a textbook.					
36.	Learning maths by finding out for yourself is an interesting task.					
37.	Maths commands my attention.					
38.	I enjoy doing practical maths - experiments and investigations; it is a good way of learning maths.					
39.	I think maths helps you to organise all sorts of problems.					
40.	Finding out by yourself is the best way of learning mathematics.					

Table H.

Table H_1

Facility, Discrimination and Item Variance - Factor A

Item	Facility	Discrimination	Item Variance
1	59	46	24
13	41	61	24
16	32	66	22
18	61	59	24
21	67	51	22
24	16**	61	13
26	30	76	21
27	46	69	25
29	58	34	24
31	19**	37	15

** Indicates "Use with caution" *** Indicates "Unsatisfactory"

Table H_2

Facility, Discrimination and Item Variance - Factor B

Item	Facility	Discrimination	Item Variance
3	41	46	24
7	30	44	21
8	69	29	21
10	38	40	24
25	21**	52	17
28	41	39	24
33	41	31	24
35	32	48	22
38	50	61	25
40	26	38	19

Table H_3

Facility, Discrimination and Item Variance - Factor C

Item	Facility	Discrimination	Item Variance
2	79**	68	17
4	43	86	25
5	41	53	24
6	37	00***	23
9	45	24**	25
11	30	76	21
12	72	62	20
14	50	61	25
15	28	52	20
17	68	78	22
19	45	67	25
20	50	68	25
22	63	56	23
23	28	62	20
30	61	59	24
32	65	45	23
34	48	79	25
36	43	34	25
37	58	56	24
39	48	52	25

** Indicates "Use with caution" *** Indicates "Unsatisfactory"

Table H_4

Standard Deviations

		S.D.
A	=	4.888
B	=	4.406
C	=	10.450
TA	=	4.231

Table I.

Details of Field Sample.

School No.	Type of School	Area	Mode of C.S.E.	Further details.
1.	Comprehensive	Urban	I,III,'O'.	Mode III includes oral exam and affective assessmt.
2.	Comprehensive	City	I	M.M.E.scheme.
3.	Comprehensive	Semi-urban	I,III,'O'	III & 'O' follow S.M.P.
4.	Comprehensive	Semi-rural	I,III	Modern maths.Ltd. grade mode 3.
5.	Grammar	Semi-rural	I,'O'	Single sex-girls.
6.	Comprehensive	City	I,III.	S.M.P.scheme.
7.	Comprehensive	Semi-urban	I	Traditional
8.	Sec.Modern	City	I	Single sex-girls
9.	Sec.Modern	Semi-rural	I,III.	III - Maths for the Majority.
10.	Comprehensive	Rural	I,'O'.	S.M.P.scheme.
11.	Grammar	Semi-rural	I,'O'.	Traditional
12.	SecModern	Semi-urban	III,'O'.	S.M.P.scheme
13.	Independent	Semi-rural	I,'O'	S.M.P.scheme
14.	Comprehensive	Semi-rural	I,'O'	Traditional
15.	Grammar	Semi-rural	I,'O'	Westminster scheme.
16.	Selective Sec.	City	I	Single sex - boys.
17.	Sec.Modern	Rural	I,'O'	Traditional
18.	Selective Sec.	Urban	I	Single sex - boys.
19.	Sec.Modern	Rural	III	Mixed ability groups.
20.	Bilateral	Rural	III,S.M.P'O'.	Single sex- girls.
21.	Comprehensive	Urban	I	Single sex - boys.
22.	Comprehensive	City	I	Modern maths.
23.	Grammar	Semi-rural	I,'O'	Single sex - boys.
24.	Sec.Modern	Semi-rural	I	Traditional

School No.	Type of school	Area	Mode of C.S.E.	Further details.
25.	Comprehensive	Semi-urban	I,'O'	Traditional
26.	Sec.Modern	Semi-rural	I	Single sex - boys.
27.	Sec.Modern	Semi-urban	I,III	Mode III practical.
28.	Sec.Modern	Semi-urban	I,'O'	Single sex - boys.
29.	Sec.Modern	Rural	I,III,'O'	Traditional
30.	Sec.Modern	City	I	Single sex- girls.
31.	Comprehensive	Urban	III,'O'	Traditional and modern maths.
32.	Sec.Modern	Semi-urban	III	Scottish maths.
33.	Sec.Modern	Semi-urban	I	SMP,single sex - girls.
34.	Comprehensive	Semi-urban	III	Scottish maths
35.	Comprehensive	Semi-urban	I,III,'O'	S.M.P. and modern maths.

Table J.

Correlation Matrix for complete sample

Number of variables 7
Number of subjects 2690

MEANS

1.	A.	30.5613
2.	B.	30.3810
3.	C.	68.2242
4.	Total.	129.1428
5.	TA.	15.0956
6.	Est.	2.7926
7.	Act.	3.0584

STANDARD DEVIATIONS

1.	4.9145
2.	4.4534
3.	11.3907
4.	12.4203
5.	4.5889
6.	1.6331
7.	1.8608

CORRELATIONS

1.	1.0000	-0.1397	-0.3742	-0.0074	-0.2671	0.2264	0.2201
2.	-0.1397	1.0000	0.2657	0.5441	0.0452	0.0083	0.0276
3.	-0.3742	0.2657	1.0000	0.8611	0.3819	-0.3542	-0.3386
4.	-0.0074	0.5441	0.8611	1.0000	0.2621	-0.2354	-0.2096
5.	-0.2671	0.0452	0.3819	0.2621	1.0000	-0.5919	-0.5106
6.	0.2264	0.0083	-0.3542	-0.2354	-0.5919	1.0000	0.8557
7.	0.2201	0.0276	-0.3386	-0.2096	-0.5106	0.8557	1.0000

Table J continued

Correlation Matrix for the Male Sample

Number of Variables 7
Number of Subjects 1450

MEANS

A.	30.5028
B.	30.7303
C.	71.0628
Total.	132.2683
TA.	15.3483
Est.	2.7428
Act.	2.9283

STANDARD DEVIATIONS

1.	4.9052
2.	4.5408
3.	10.8155
4.	12.2881
5.	4.4862
6.	1.6140
7.	1.8361

CORRELATIONS

1.	1.0000	-0.1184	-0.3132	0.0769	-0.2519	0.2444	0.2388
2.	-0.1184	1.0000	0.2497	0.5413	0.0234	0.0105	0.0243
3.	-0.3132	0.2497	1.0000	0.8501	0.3709	-0.3507	-0.3405
4.	0.0769	0.5413	0.8501	1.0000	0.2361	-0.2126	-0.1984
5.	-0.2519	0.0234	0.3709	0.2361	1.0000	-0.5941	-0.5299
6.	0.2444	0.0105	-0.3507	-0.2126	-0.5941	1.0000	0.8574
7.	0.2388	0.0243	-0.3405	-0.1984	-0.5299	0.8574	1.0000

Table J continued

Correlation Matrix for the Female Sample

Number of Variables 7
Number of Subjects 1240

MEANS

A.	30.6298
B.	29.9726
C.	64.9048
Total.	125.4879
TA.	14.8000
Est.	2.8508
Act.	3.2105

STANDARD DEVIATIONS

1.	4.9253
2.	4.3473
3.	12.0598
4.	12.5658
5.	4.6989
6.	1.6518
7.	1.8884

CORRELATIONS

1.	1.0000	-0.1784	-0.4454	-0.0910	-0.2851	0.2098	0.1988
2.	-0.1784	1.0000	0.2843	0.5455	0.0687	0.0028	0.0335
3.	-0.4454	0.2843	1.0000	0.8723	0.3951	-0.3635	-0.3321
4.	-0.0910	0.5455	0.8723	1.000	0.2812	-0.2594	-0.2231
5.	-0.2851	0.0687	0.3951	0.2812	1.0000	-0.5878	-0.4868
6.	0.2098	0.0028	-0.3635	-0.2594	-0.5878	1.0000	0.8526
7.	0.1988	0.0335	-0.3321	-0.2231	-0.4868	0.8526	1.0000

Table J. continued

Group 4 1 Teacher

Number of variables 7
Number of subjects 1270

MEANS

A.	30.2000
B.	30.3945
C.	68.4606
Total.	129.2134
TA.	15.5748
Est.	2.5197
Act.	2.7614

STANDARD DEVIATION

1.	5.0591
2.	4.4509
3.	11.8599
4.	12.6236
5.	4.8593
6.	1.5223
7.	1.7718

CORRELATIONS

1.	1.0000	-0.1028	-0.2837	0.0444	-0.2645	0.2068	0.1930
2.	-0.1028	1.0000	0.2519	0.5322	0.0679	0.0105	0.0382
3.	-0.2837	0.2519	1.0000	0.8357	0.4217	-0.3383	-0.3229
4.	0.0444	0.5322	0.8357	1.0000	0.3033	-0.2256	-0.2100
5.	-0.2646	0.0679	0.4217	0.3033	1.0000	-0.6249	-0.5345
6.	0.2068	0.0105	-0.3383	-0.2256	-0.6249	1.0000	0.8520
7.	0.1930	0.0382	-0.3229	-0.2100	-0.5345	0.8520	1.0000

Table J continued

Group 5 2 Teachers

Number of variables 7
Number of subjects 944

MEANS

A.	30.3771
B.	30.1430
C.	68.4841
Total.	128.9650
TA.	15.0169
Est.	2.7542
Act.	2.9280

STANDARD DEVIATIONS

1.	4.8481
2.	4.4103
3.	12.2067
4.	13.3605
5.	4.4953
6.	1.7188
7.	1.8802

CORRELATIONS

1.	1.0000	-0.1439	-0.3755	-0.0294	-0.2676	0.2232	0.2174
2.	-0.1439	1.0000	0.3251	0.5744	0.0484	-0.0416	-0.0285
3.	-0.3755	0.3251	1.0000	0.8816	0.3587	-0.3639	-0.3566
4.	-0.0294	0.5744	0.8816	1.0000	0.2457	-0.2631	-0.2506
5.	-0.2676	0.0484	0.3587	0.2457	1.0000	-0.5405	-0.4612
6.	0.2232	-0.0416	-0.3639	-0.2631	-0.5405	1.0000	0.8753
7.	0.2174	-0.0285	-0.3566	-0.2506	-0.4612	0.8753	1.0000

Table J continued

Group 6 3 Teachers

Number of Variables 7
Number of subjects 364

MEANS

A.	31.6786
B.	30.8242
C.	66.1484
Total.	128.6621
TA.	13.8681
Est.	3.6621
Act.	4.1978

STANDARD DEVIATIONS

1.	4.9618
2.	4.5491
3.	11.4987
4.	12.6029
5.	3.7357
6.	1.5150
7.	1.7350

CORRELATIONS

1.	1.0000	-0.2407	-0.3304	0.0157	-0.1438	0.1314	0.1152
2.	-0.2407	1.0000	0.2775	0.5214	0.0321	0.0193	-0.0095
3.	-0.3304	0.2775	1.0000	0.8762	0.2551	-0.3333	-0.3132
4.	0.0157	0.5214	0.8762	1.0000	0.1875	-0.2453	-0.2387
5.	-0.1438	0.0321	0.2551	0.1875	1.0000	-0.5409	-0.4669
6.	0.1314	0.0193	-0.3333	-0.2453	-0.5409	1.0000	0.7529
7.	0.1152	-0.0095	-0.3132	-0.2387	-0.4669	0.7529	1.0000

Table J continued

Group 7 4 or more teachers

Number of variables 7
Number of subjects 111

MEANS

A.	31.9550
B.	30.5225
C.	68.1351
Total.	130.5946
TA.	14.2252
Est.	3.3876
Act.	3.8198

STANDARD DEVIATION

1.	4.6623
2.	5.3235
3.	13.1570
4.	14.8787
5.	3.9471
6.	1.3095
7.	1.5837

CORRELATIONS

1.	1.0000	-0.0891	-0.3938	-0.0668	-0.1894	0.2404	0.2271
2.	-0.0891	1.0000	0.3397	0.6288	0.0176	0.1131	0.1319
3.	-0.3938	0.3387	1.0000	0.8869	0.3478	-0.3016	-0.3663
4.	-0.0668	0.6288	0.8869	1.0000	0.2530	-0.1441	-0.2034
5.	-0.1894	0.0176	0.3478	0.2530	1.0000	-0.6966	-0.6017
6.	0.2404	0.1131	-0.3016	-0.1441	-0.6966	1.0000	0.7591
7.	0.2271	0.1319	-0.3663	-0.2034	-0.6017	0.7591	1.0000

Table J continued

Group 8 'O' levels

Number of variables 7
Number of subjects 691

MEANS

A.	29.1852
B.	29.9493
C.	71.4009
Total.	130.5268
TA.	17.8061
Est.	1.0145
Act.	1.0116

STANDARD DEVIATIONS

1.	5.4137
2.	4.4035
3.	10.8231
4.	12.2145
5.	5.1143
6.	0.1934
7.	0.1781

CORRELATIONS

1.	1.0000	-0.1234	-0.3551	0.0892	-0.2551	0.0389	0.0083
2.	-0.1234	1.0000	0.2723	0.5401	0.0288	0.0586	0.0672
3.	-0.3551	0.2723	1.0000	0.8348	0.3089	0.0415	0.0629
4.	0.0892	0.5401	0.8348	1.0000	0.1621	0.0752	0.0837
5.	-0.2551	0.0288	0.3089	0.1621	1.0000	-0.0542	-0.0389
6.	0.0389	0.0586	0.0415	0.0752	-0.0542	1.0000	0.8775
7.	0.0083	0.0672	0.0629	0.0837	-0.0389	0.8775	1.0000

Table J continued

Group 9 'O' level and C.S.E.

Number of variables 7
Number of subjects 281

MEANS

A.	29.9644
B.	30.6050
C.	69.6406
Total.	130.2028
TA.	15.6050
Est.	2.3416
Act.	2.8968

STANDARD DEVIATION

1.	4.7528
2.	4.5943
3.	11.3956
4.	13.1381
5.	4.5035
6.	1.3221
7.	1.5918

CORRELATIONS

1.	1.0000	-0.1429	-0.2532	0.0903	-0.1993	0.1565	0.1641
2.	-0.1429	1.0000	0.3215	0.5728	0.0759	-0.0633	-0.0353
3.	-0.2532	0.3215	1.0000	0.8812	0.4122	-0.3386	-0.3907
4.	0.0903	0.5728	0.8812	1.0000	0.3169	-0.2556	-0.2898
5.	-0.1993	0.0759	0.4122	0.3169	1.0000	-0.5798	-0.4679
6.	0.1565	-0.0633	-0.3386	-0.2556	-0.5798	1.0000	0.7117
7.	0.1641	-0.0353	-0.3907	-0.2898	-0.4679	0.7117	1.0000

Table J continued

Group 10 C.S.E.

Number of variables 7
Number of subjects 1606

MEANS

A.	31.1426
B.	30.5535
C.	67.2671
Total.	128.9240
TA.	14.0455
Est.	3.4384
Act.	3.7870

STANDARD DEVIATIONS

1.	4.5789
2.	4.4864
3.	11.7157
4.	12.8675
5.	3.7720
6.	1.2829
7.	1.5665

CORRELATIONS

1.	1.0000	-0.1716	-0.3512	-0.0234	-0.1916	0.1556	0.1468
2.	-0.1716	1.0000	0.2948	0.5561	0.0859	-0.0301	-0.0041
3.	-0.3512	0.2948	1.0000	0.8798	0.3418	-0.3254	-0.3085
4.	-0.0234	0.5561	0.8798	1.0000	0.2688	-0.2515	-0.2275
5.	-0.1916	0.0859	0.3418	0.2688	1.0000	-0.6616	-0.4773
6.	0.1556	-0.0301	-0.3254	-0.2515	-0.6616	1.0000	0.7008
7.	0.1468	-0.0041	-0.3085	-0.2275	-0.4773	0.7008	1.0000

Table J continued

Group 11 No Exams.

Number of variables 7
Number of subjects 104

MEANS

A.	32.7115
B.	29.7788
C.	56.9904
Total.	119.5481
TA.	11.4712
Est.	5.9904
Act.	6.0000

STANDARD DEVIATIONS

1.	4.4043
2.	4.1113
3.	11.3141
4.	12.1219
5.	3.7824
6.	0.2593
7.	0.0000

CORRELATIONS

1.	1.0000	-0.1825	-0.3208	0.0026	-0.1281	0.0481	0.0000
2.	-0.1825	1.0000	0.2027	0.4695	0.1427	-0.0832	0.0000
3.	-0.3208	0.2027	1.0000	0.8876	0.2983	-0.2000	0.0000
4.	0.0026	0.4695	0.8876	1.0000	0.2783	-0.2003	0.0000
5.	-0.1281	0.1427	0.2983	0.2783	1.0000	-0.1032	0.0000
6.	0.0481	-0.0832	-0.2000	-0.2003	-0.1032	1.0000	0.0000
7.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000

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M. PRESTON Ph.D. Thesis 1972

"THE MEASUREMENT OF AFFECTIVE BEHAVIOUR IN C.S.E. MATHEMATICS"

Initially, the research stemmed from previous work which had clarified the objectives of C.S.E. mathematics courses. A number of objectives had been classified as relating to the affective domain and, in terms of C.S.E., were not being evaluated. This study set out to identify affective behaviour and, if possible, to rectify the absence of any affective measures.

The work developed in three distinct phases. The first concerned itself with recognising traits of affective behaviour in C.S.E. children. The method used employed a questionnaire technique which was evaluated by factor analysis. The varimax and promax analyses resulted in three definable affective factors. These related to (i) an attitude identified as tending to see mathematics as an algorithmic, mechanical and stereotyped subject; (ii) an attitude recognising an intuitive, open-ended and heuristic approach; (iii) an attitude representing commitment, interest and application to mathematics.

The second phase involved restructuring the initial instrument and narrowing it to relate only to the three defined factors. An improved questionnaire was then used in a pilot trial consisting of four schools with 358 candidates. The evaluation of this trial produced evidence on the affective behaviour of the children involved and also information on the acceptability of the instrument. Before proceeding further, a revalidation of the content of the test was undertaken.

The third and final phase consisted of a field trial involving 2690 candidates in a wide variety of schools. The outcome of the results has contributed to two major areas; namely knowledge concerning individual children's affective behaviour and information concerning attitudes to fields of study and content of courses. In terms of the qualities involved, and the effect of

courses upon them, the research provides some very challenging questions to mathematicians. The individual pupil profiles which were developed within the study and which combine affective and cognitive behaviour, should be useful both to teacher and employer if taken in conjunction with the other information normally available.

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Submission for Ph.D.

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