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AN INVESTIGATION INTO THE USE OF THE STANDARD 7 YEAR-END MATHEMATICS RESULTS AS A PREDICTOR OF THE MARK OBTAINED IN THE FINAL CAPE SENIOR CERTIFICATE EXAMINATION

RICHARD ANTONY VILJOEN B.Sc. B.Ed.

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GLOSSARY

1.	Academic High Schools	The Cape Education Department uses the term 'ordinary' high school. These schools offer a general range of subjects as distinct from schools such as Technical High Schools, Commercial High Schools which offer more vocationally orientated courses.
2.	Cape Senior Certificate Examination	The School-leaving Certificate written by Standard 10 pupils in schools administered by the Cape Education Department. Depending on combination and grades of subjects, a pass can be :- a) with Matriculation Exemption which entitles the school-leaver to apply for admission to a University; b) without Matriculation Exemption which does not entitle the school-leaver to attend a University.
3.	Mathematics Higher Grade	Mathematics offered in the Senior Secondary Phase and the marks calculated out of 400 in the final examination. The syllabus is more extensive than for Standard Grade. Marks are only given as symbols in the final Cape Senior Certificate examination.
4.	Mathematics Standard Grade	Mathematics offered in the Senior Secondary Phase and the marks calculated out of 300 in the final examination. Marks are only given as symbols in the final Cape Senior Certificate examination.
5.	Marks	These are all expressed as percentages for the purpose of this investigation.

6. Senior Secondary Phase	This comprises Standards 8, 9 and 10. The pupil has to make a choice of four subjects (the two official languages being compulsory) at the end of Standard 7. Each school is free to decide on the various subject combinations they wish to have.

AN INVESTIGATION INTO THE RELIABILITY OF THE STANDARD 7 YEAR-END MATHEMATICS RESULTS AS A PREDICTOR OF THE MARK OBTAINED IN THE FINAL CAPE SENIOR CERTIFICATE EXAMINATION.

INTRODUCTION

As the headmaster of a large coeducational High School in East London, I have to counsel Standard 7 pupils at the end of each year with regard to their subject choices for the Senior Secondary phase. In consultation with the teacher-psychologists and the Standard 7 teachers, one has to make decisions with regard to subjects which could have far-reaching effects on the pupil. Year after year the greatest discussion and most difficult decisions concern whether or not to continue with mathematics.

At the end of the Standard 7 year, the pupil is faced with a choice of subjects, one of which is usually mathematics. Depending on the school, this choice is often wide and the average Standard 7 pupil can, in spite of careful counselling and advice, still be bewildered and confused.

One of the best methods of objectively predicting pupil performance is through the use of various standardised tests. Although some norm-based tests exist, very few schools apply these tests to help predict mathematics performance in the Senior Secondary Course.

To aid the pupil in deciding whether or not mathematics should be taken in Standards 8, 9 and 10 it would be extremely useful if there were some guide or predictor on which this decision

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could be based, as it is generally accepted amongst teachers that mathematics can be a stumbling block in the Cape Senior Certificate, particularly by the weaker candidate.

If it could be shown that the Standard 7 year-end mathematics mark could be used to help predict whether :-

... the pupil would be likely to pass or fail mathematics in the Cape Senior Certificate;

... what symbol the pupil would obtain;

a decision as to whether or not he should continue with the subject could be made at this stage, and, depending on his Standard 7 mark, what the likely consequences of this decision would be.

In the United Kingdom in particular, the use of A-level examination results have been used as predictors in subsequent educational courses and this has been the subject of fairly extensive research during the 1970's.

The extent to which O-level examination results are predictive of A-level achievement has, however, received very little attention. The situation in South Africa is very similar and very little, if any, work has been done in assessing the effectiveness of using school marks in the lower standards of high school to predict marks in the upper standards. It is difficult to suggest a reason for this as such work would be of inestimable value in providing information for use in the counselling and selection of subjects for pupils embarking on the Senior Secondary Course.

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CHAPTER 1

RESEARCH LITERATURE ON PREDICTION STUDIES: PREDICTION STUDIES IN GENERAL: GENERAL DEVELOPMENT OF THE CHILD: BOY-GIRL DIFFERENCES.

This chapter is divided into four sections. Firstly, an overview is given of the research literature used in the investigation. Secondly, prediction studies, techniques used in these studies and the problems that arise from them are discussed. Thirdly, the general development of the child encompassing the cognitive, social, physical and career aspects of development are brought into focus and finally, boy-girl differences are discussed with regard to mathematical ability, attitude towards mathematics, socialisation influences and impact of schooling and the effect they have on a pupil's performance in the subject.

The reader is reminded that very little work has been done in this country on using school year-end examination results in the lower standards to predict Matriculation results. Most of the research to date in this field has involved using school-leaving results to predict future success at college or university.

1. RESEARCH LITERATURE ON PREDICTION STUDIES

A study of the research literature on prediction investigation reveals that both cognitive and affective variables affect predictions to a greater or lesser degree. In general, researchers have shown that the former, usually in the form of year-end marks, has a greater predictive value than affective variables such as motivation, confidence in learning mathematics, perceived usefulness of mathematics, etc.

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Sherman (1979) in her investigation 'Predicting Mathematics Performance in High School Girls and Boys' used three cognitive tests and eight Fennema-Sherman Attitude Scales to predict the mathematical performance of 305 9th Grade pupils, 157 girls and 148 boys, three years later. She found that spatial visualisation was an important variable, significantly predicting geometry grades for girls, but not for boys. Apart from mathematical achievement, spatial visualisation was the only other significant variable in predicting mathematical problem-solving scores for girls over the three-year period.

Wick (1965) in his study on how effectively success in first year college mathematics could be predicted from the information normally available from schools, found that the students' high school mathematics record was consistently the best predictor of success. The mathematics average over grades 10 - 12 gave the highest correlations with success in college algebra courses.

Both Wick, Sherman and Morgan (1970) found that the use of multiple regression techniques were a considerable improvement over single predictor variables. Wick found the use of these multiple correlations coefficients was high enough to warrant the use of predictions based on multiple regression equations for the selection and placement of students. He also stated that the use of Frequency/Probability tables was an effective way of using predicted grades when counselling individual students.

Chapman et al (1977) in his investigation used ratings by pupils to predict high and low achievers in a personalised system of instruction. They investigated the degree to which student ratings of teacher behaviour and classroom activity contributed to the prediction of students' level of course achievement over and above the contribution of previous academic performance at school. Using the high school grade point average, they found that overall high school performance was the best predictor.

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Aiken (1976) stated that in any prediction study which involved affective variables such as attitude towards mathematics, a separate analysis of sex should always be used. He found that when attitude scores are used as predictors of achievement in mathematics, a low but significant positive correlation is usually found. This is true at all levels of education; primary, secondary, graduate or diploma, postgraduate. Affective variables as predictors of success were investigated by numerous researchers in the early 1970's. The conclusion reached again was that, although attitudes towards mathematics can be an important predictor, they are usually secondary to ability (as measured by the end-of-year examination) as a forecaster of achievement.

The research mentioned so far has taken place in the United States of America, but as the educational system in England corresponds more closely to ours than that of any other Western country, the rest of this section on research literature concentrates on investigations that have taken place in schools in England.

From an exploratory study involving a sample of seventeen schools in Britain, Shoesmith (1970) reported correlations ranging from 0,19 to 0,68 between O- and A-level grades in a range of arts and science subjects. Massey (1978) studied the O- and A-level Nuffield Physics examinations and reported a correlation of 0,73 between the marks obtained by candidates sitting the O-level examination in that subject in 1973 and then going on to do A-level in 1975. In addition, he suggested two reasons which in all probability reduced the value of this correlation, viz the restricted range of marks obtained by those candidates who were selected to go on to do A-level and the unreliability of A-level marks.

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By using methods for correcting correlation estimates suggested by Guilford and Fruchter (1973) and an optimistic estimate, derived from Nuttal and Willmott (1972) of 0,96 as the estimated reliability of A-level marks, he obtained a corrected correlation coefficient of 0,84, from which he concluded it was ... 'likely that O-level performance accounts for approximately 70 per cent of the variance in A-level performance' in that subject.

A study in England by Miles (1979) using 6229 A-level candidates showed that O-level grades in the same subject are by far the best single predictor of A-level performance. He reported correlations between O-level and A-level grades of between 0,38 and 0,73, depending on the subject and on which Boards' results were included in the analysis. He concluded that O-level grades were only able to account for 42,6% of the variance in the candidates A-level grades that he was not able to explain by other factors, such as sex, social class and school type.

Both the studies of Shoesmith (1970) and Massey (1978) illustrate some of the difficulties of research in this area. With reference to the present investigation, marks are readily available for Standard 7 pupils, but the Cape Senior Certificate results are only given as symbols: An A symbol being equivalent to 80% or more, a B symbol being equivalent to a percentage between 70 and 79, etc. (see appendix 1). The approximate nature of these symbols is likely to affect the correlation coefficient by approximating it; further, a time interval of three years between the year-end Standard 7 examination and that of the Cape Senior Certificate must also have a similar effect on the correlation coefficient, particularly as factors such as maturation, teacher competence, remedial teaching could also play a significant part in either raising or depressing the correlation. It would thus be unrealistic to expect the relationship between Standard 7 mathematics marks and the Cape Senior Certificate symbols to be more than moderately high, because of all the different factors that can play a part in determining either of them.

Although not pertinent to this investigation, it is of interest to note that Murphy (1979) compared GCE results with teachers' prediction of the grade each pupil would obtain in the examination. He found that there was a reasonably high level of agreement between the grade predictions of teachers and the grades pupils obtained in the GCE examination. 40% of the predictions were completely accurate and 80% were accurate to within one grade of the predicted grade.

Whilst researchers accept that other factors apart from achievement should be taken into account when undertaking prediction studies of the kind under investigation, they all agree that achievement is the most important factor and the one that carries the most weight in a study such as this.

Two questions are raised immediately. Firstly, if achievement is the major factor in prediction studies, then how valid and reliable are the examinations on which the prediction is based. Secondly, if other factors are going to be taken into account, how are they going to be incorporated in the prediction assessment to make it more meaningful.

Researchers over the past fifty years, Valentine (1932) and Malherbe (1977) all agree that examinations have a low coefficient of reliability, which adds to the problems of research in prediction studies. Apart from recognising and acknowledging this fact, very little has been done about it, although Guilford and Fruchter (1973) have devised a method for correcting correlation coefficients, provided the reliability coefficient of an examination is known. Examination Boards do overcome this low reliability to a limited extent by adjusting

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a candidate's marks to fit an accepted norm, usually based on the results of the previous five years. This can be done relatively easily for external examinations such as the Cape Senior Certificate where there are large numbers of candidates for each subject, and these numbers lend statistical significance to the adjustment. For internal examinations such as the Standard 7 year-end one, however, the picture is somewhat different. There is no overall norm accepted by the individual schools and naturally the numbers involved are far less, which tends to make any adjustment rather arbitrary.

Tied closely to reliability is the validity of an examination. Strictly speaking, year-end examinations test achievement only, and as such should only be used for predicting this in the subject. Practice, however, reveals that they are in fact used for other purposes; selection for careers or tertiary education probably being the most common use after achievement.

The second question now follows: how can assessment therefore be made more meaningful? Wain (1978) feels that examinations should not only be concerned with whether the syllabus has been covered, but rather that questions should be set to test the required cognitive levels of ability, e.g. if one was applying Bloom's taxonomy then questions should cover the areas of knowledge, comprehension, application, analysis and synthesis to make the examination a valid one.

Numerous researchers, Overson (1980), Broadfoot (1977), Osborn (1983), Scopes (1973) have 'fleshed out' the achievement mark by adding various other affective variables which give an overall profile of the pupil's ability, both in a specific subject and in general. Overson makes use of polargrams which present either the pupil's assessment profile or the group assessment profile in a diagrammatic way; this does away with the customary columns or rows of figures (Appendix 4). General trends in performance can be identified at an early stage and remedial action can be taken if necessary. The methods of Broadfoot, Osborn and Scopes are discussed in greater detail in the next section of this chapter.

2. PREDICTION STUDIES IN GENERAL: TECHNIQUES USED AND PROBLEMS INVOLVED

This section deals with three important aspects of the present investigation.

2.1. Predictions themselves.

2.2. Techniques used in handling data and making predictions.

2.3. Problems involved in prediction studies.

Although each of these are dealt with in broad outline, the difficulties and problems which they generate and which affect the outcome of the investigation are highlighted.

2.1. Prediction

The social sciences, such as education and psychology, are concerned with prediction, particularly with regard to traits such as learning capacity, potential growth, success, achievement and adjustment. If man's ability to foretell human behaviour under certain prescribed conditions can be increased, science makes it possible for man to make decisions about courses of action which have a greater probability of fulfilling his goals.

Predictions in the field of education are important. Decisions with regard to homogenous or heterogeneous grouping of pupils, selection of college applicants, determining appropriate educational and vocational choices, whether pupils should be promoted or whether they should fail, what subjects they should take and on what level they should take these subjects, all illustrate the varied need for prediction.

2.1.1. Types of Prediction Problems

Problems involving prediction can be classified into three broad categories: selection, classification and guidance.

In selection, the aim is to obtain an individual or group of individuals whose average probability of success is higher than that of the typical applicant. Examples of selection decisions are the hiring of individuals for a given job from amongst a group of applicants, or selecting students for further study in tertiary education. No further decisions are made concerning those who have been rejected.

On the other hand, classification involves both those who have been chosen to continue with a specified course or subjects and also those who are rejected. The latter must be provided for by some other kind of instruction. The greatest number of prediction problems fall under this heading, and they include; assigning of students to special classes for remedial or advanced work, promotions, grouping, predictions of achievement in different courses of study. Classification decisions can only be improved on to the extent that it is possible to predict the outcome for each individual under all possible assignments.

Vocational and educational guidance have much in common with classification, the essential difference being that any decision as to what course of action should be followed is made by the person in question rather than by the one making the prediction.

Many types of data can be used for making predictions. School marks, teachers' ratings or assessments, achievement and proficiency tests have all been found to be useful for predicting success in college or in certain occupations. Intelligence tests are widely used in schools where aptitudes such as verbal skill, memory, reasoning ability, spatial and perceptual abilities

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and numerical facility can be determined. Interest and preference inventories have also been found to be useful for prediction, whilst self-reporting and the projective type of personality tests have, in some cases, been found to increase predictive efficiency.

In spite of the types of data available for prediction it does,in the final analysis, very often boil down to the fact that in schools the year-end examination, which is basically an achievement test, is used to predict traits for which it is not designed. This has to be accepted as a 'fait accompli' in most schools.

2.2. Techniques

The techniques used depend to a large degree on the kind of decision problem for which the prediction is intended, as well as the nature of the predictors and of the criterion used.

The majority of prediction techniques developed to date assume that what is to be predicted can be predicted along a single continuum. If several criteria are available, they are combined with appropriate weights into a single composite score with which to validate potential predictors. It is assumed that when criterion measures are averaged, the different aspects measured are of equal importance. This would be the case if, for example, marks in several courses are averaged to obtain a single measure of academic success.

The easiest and most direct method of dealing with prediction data is to tabulate the scores in the form of an expectancy or frequency table (see Chapter 4). From such a table it is usually possible to determine whether or not a relationship exists between the scores.

With the scores expressed in categories, the probability of a pupil within a given test score interval obtaining any particular score can be calculated from the table.

Another common technique is to calculate the 'line of best fit'. This method yields a correlation coefficient which is the measure of the efficiency of prediction of the scores, using a regression equation. Such an equation can be used to predict the expected mark for a pupil in the population from which the sample was obtained.

2.2.1. The Reliability and Validity of Examinations

One of the fundamental problems with any examination is its poor reliability and validity: this fact has been acknowledged by virtually every researcher in the past seventy years who has undertaken an investigation in this field, e.g. Valentine (1932), Malherbe (1974).

Reliability is defined as the degree to which marks obtained in an examination at one time agree with marks obtained by the same pupil in an equivalent examination at another time. Neither the Standard 7 examination nor the Cape Senior Certificate examination measure the same pupil from year to year, but the assumption can be made that large groups of pupils, particularly in the latter of the two examinations mentioned, would not differ much in either preparation or ability from one year to the next. This fact has been shown to be true when standardised intelligence tests have been applied to pupils who have shown that there is no significant measured variation in their ability between one year and the next.

One must therefore assume the constancy of the examinees in training and ability, and thus any variation in examination results in two successive years has to be attributed to the examination itself.

With regard to reliability, therefore, the best that can be done is to reduce the factors which contribute to measurement error and so depress reliability. These are :-

... actual changes in the examinee's mental and physical states which affect examination performance;

... inadequate sampling of the examinee's knowledge and ability by the particular questions set;

... inconsistencies in the standard of marking, either by different examiners or by the examiner on different occasions;

... differences in the standard of teaching at the different schools;

... a change in syllabus;

... a new approach in respect of the nature of the paper.

To overcome some of these factors the marks, particularly in the Cape Senior Certificate examination, are often adjusted to 'fit' a standard norm. Although this is not an ideal solution to the problem of annual fluctuation, it is fairer than merely accepting marks without any adjustment.

Both the two examinations under consideration are basically achievement tests and yet these results are frequently used for other purposes, such as selection procedures, either for determining whether or not a pupil should continue with the subject, or for further education or employment. Strictly speaking, these are not valid uses of the examination scores unless the examination has been designed to fulfil these purposes.

Although achievement and ability are closely linked, excellent achievement is not necessarily a criterion of excellent ability or vice-versa, and the question of mathematical ability and the best means of assessing it is now discussed.

2.3. Assessment

If one accepts the unreliability of examinations and the fact that their validity only really extends to measuring achievement, then the whole question of what kind of assessment is both valid and reliable is raised.

Assessment performs a number of roles in an educational system, ranging from the provision of information with regard to the standards schools achieve, to giving both pupils and teacher feedback on the day-to-day progress. Ideally assessment should be useful to all interested parties; pupils, teachers, parents, tertiary staff and prospective employers. All too frequently however a particular subject is only assessed at the lower cognitive levels. Pupil achievement is either given as a mark or symbol, sometimes accompanied by a terse comment, such as 'could do better'.

This kind of assessment is of little help or value to the pupil, his parents or his guidance teacher; nor does a single mark tell an employer what he most wants to know. To a certain degree, mathematics appears to have an advantage over most other subjects in that assessment appears to be easier. Firstly, the solving of problems, simple or complicated, is an essential feature of mathematics; secondly, considering how good a particular answer is to a mathematical question, it is possible to be relatively objective. A marking memorandum can be devised in which the assessment of a section of mathematical work is virtually independent of the assessor.

Nevertheless, the limitations of assessment stated earlier are evident. Recognising this, the Scottish Education Department funded a development and evaluation study, carried out by the Scottish Council for Research in Education, into a profile assessment system which would allow teachers to contribute their varied knowledge of a pupil in a structured way.

P.M. Broadfoot (1977) in 'Trends in Assessment : A Scottish Contribution to the Debate' states :-

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> "The independent assessment for each individual pupil by each of his teachers could then be collated into an overall picture of a pupil, produced perhaps twice a year, would ... give some insight into the affective factors influencing his progress. This series of frames from the film of continuing, largely subjective, teacher assessment would culminate in the leaving report, on which would be reported the whole range of the pupil's achievement in school."

Teachers can therefore enter on a class assessment form, using a four-point scale, their knowledge of a pupil's oral and written skills, visual, numeric and motor skills. It also allows for the assessment of enterprise and perseverance, two affective variables which have been shown by research to have high predictive validity when assessed by teachers. Blank, optional assessment categories are provided to be labelled as appropriate for each activity. The assessments made by each teacher are collated to form a pupil profile, and the school-leaving report is a condensed summary of this information which provides a description of the pupil's basic skills, his personal qualities, his involvement in formal and informal activities, as well as the traditional rating for subject achievement.

With regard to a specific subject such as mathematics, Osborn (1983) in his article 'The Assessment of Mathematical Abilities' states that experience has both suggested and shown that a single mark (grade) for the assessment of mathematical ability is not sufficient. Using the hypothesis that the thinking involved in mathematical activity could be resolved into four distinct, but overlapping, components, viz computational operations (C), pattern recognition (P), logical reasoning (L) and symbolic manipulation of abstract qualities (S) (See appendix 2), a test was devised and given to pupils in fifth forms of seven secondary schools in the London area, a few months prior to their GCE or CSE examinations in mathematics.

From the scores gained, a profile of each candidate tested was obtained. A comparison of the profile and the vectors obtained from them with the grades obtained in the examination enable some important, albeit tentative, observations to be made on the structure of mathematics examinations and the teaching of this subject in schools.

The results showed that the greatest difference between the most and least able pupils as indicated in their examination results lay in the S component. Although the mean value of such a profile may give an indication of possible examination results, it showed that it was not necessarily a safe predictor. Rather, an indicator of the strength of the L and S components, particularly the latter, proved to be a more certain indicator of success than the strength of the C and P components.

This brings to light the fact that people differ in mental processes to arrive at the same conclusion or perform the same mathematical operation. Teachers also have individual profiles which affect the way they acquire or have acquired their knowledge, and the way that this knowledge will be communicated to the pupils.

The findings of this test have reinforced the conviction that the methodology of teaching adopted by a teacher is influenced by hisown profile and is liable to favour the understanding of and communication to pupils with similar profiles. By not allowing for such differences, it could be to the disadvantage of pupils with strengths in other components. This is particularly noticeable in computational as opposed to pattern and spatial approaches.

It would therefore seem important, for teaching to be effective, for the mathematics teacher to be aware of :-

... his own profile, or at least in which components he is strong or weak;

... his pupil's profile, particularly if it is significantly different in its strengths and weaknesses; and

... any alternative approaches that he is following in any mathematical topic.

The profile arrived at by Osborn should not be seen as an alternative but rather as a supplementary indicator where guidance is desired.

If it is accepted that a single mark is not really the answer for prediction, what then should a Standard 7 mathematics teacher devise, or have at his disposal, so that he can give advice or guidance for the ensuing Senior Secondary Course?

The work that the pupils do, and a written record of the work they produce, should be assigned for a variety of different reasons, and assessment should ideally relate to these reasons and not simply to an 'order of merit' list. One tries to build up a profile of a pupil under various headings which will draw attention to both strengths and weaknesses, and to help the pupil come to realise his own strength and short-comings with regard to mathematics.

A profile form that has been used with more than a modicum of success is one where the headings under which assessments are made are as follows : Knowledge, Understanding, Skills, Originality, Neatness, Oral, Co-operation, Perseverance, Self-understanding. (See appendix 3).

Such a completed form for each subject which takes both cognitive and affective factors into account would give the parent an invaluable insight into the progress (or lack of it) of his child. It would give a much broader base for pupil, parent and teacher to reach a decision on whether or not mathematics should be continued after Standard 7, but it must be admitted however that very few schools in the Cape Province go to such lengths to build up a profile - usually the only category that is assessed for parental perusal is Knowledge.

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3. GENERAL DEVELOPMENT OF THE CHILD

3.1. Cognitive Development

It would be useful if the teacher who is involved in predicting future performance was aware and was able to recognise the general stages of intellectual development of a pupil, each stage representing a characteristic mode of reasoning and a range of the types of task with which the pupils are capable of dealing.

Piaget can be considered the foremost developer of this theory and the classical Piagetian position is that the modes of reasoning which children use pass through the following four broad stages :-

... 0 - 2 years	a sensori-motor stage		
... 2 - 6 years	a preoperational stage		
... 6 - 11 years	2a	early	concrete operational stage
	2b	late	
... 11 - 16 years	3a	early	formal operational stage
	3b	late	

Both the Standard 7 pupil and the Standard 10 pupil fall into the formal operational stage, but there is no doubt that a number of Standard 7 pupils are still at the concrete operational stage, depending on the task being done.

This may assist the teacher in reaching an understanding why accurate prediction is so difficult. Individuals mature at different rates and thus reach the different Piagetian stages/ levels at different times, e.g. some Standard 7 pupils may only be at stage 2b, others at 3a, whilst others again have already reached 3b.

In Piaget's words, "the concrete operational thinker collects results, classifies and orders them, and establishes correspondence" (Inhelder & Piaget, 1958). By contrast, the formal operational thinker is able to reason by forming and testing hypotheses.

By way of an example, given a pendulum formed by strings of various lengths and with weights of different magnitudes and asked to find what determines the frequency of the swing, the formal thinker has an anticipatory scheme which ensures that each variable is tested, while others are kept constant, whereas the concrete thinker is unable to achieve this separation and changes two or more variables at once.

Collis (1975) calls stage 3a (early formal operations 13 - 15 years) the concrete generalisation stage. The majority of Standard 7 pupils would fall into this category and the pupil tends to be satisfied when he has verified his hypothesis on a single case; he does not yet look for a general law. In his mathematical items Collis observed that at this level pupils work on the basis of concrete generalisations, where only a few specific instances are enough to satisfy them on the reliability of a rule. Also, the rules can only be applied in cases where the operations are recognised as being performable to give a unique result, e.g. $383 \times \frac{743}{383} = 672 \times \frac{743}{672}$ is likely to be understood by a Standard 7 pupil, but not necessarily the generalisation on which it is based, i.e. $\frac{ma}{m} = \frac{na}{n}$.

(Bell et al, 1983, p.56)

Stage 3b, the late formal operational one, occurs at 15+ years and here Collis has shown that the pupils are not necessarily satisfied with one or two specific cases from which to generalise. They can conceive of an operation such as $a * b = a + 2b$, whereas the younger pupils tend to regard an operation such as $*$ being necessarily one of the known operations $+$; $-$; x or $\div$.

To summarise, the dimensions of development include (Bell et al, p.56) :-

3.1.1. Centration on one operation (stage 2a) leading to ability to co-ordinate two operations (2a/3b) and then to co-ordination of more than two (stage 3b) (in proportion, the relations among <u>three</u> elements have to be co-ordinated simultaneously);

3.1.2. General idea of dependence (stage 2a), leads up to qualitative correspondence, (if A goes up, B does down) (2b), and then to quantitative relationship (3b);

3.1.3. A law recognized over a limited range or tested on a few cases (3a), leads to a fully generalised law, with explanation and/or justification sought (3b).

Ideally therefore it would seem that because of differences of maturation, the range of cognitive development varies widely above and below each level. It would therefore be extremely important to try to ascertain the level of the individual pupil and match the level of instruction from this point. Regrettably, however, it must be admitted that teachers (and also certain text book authours) lose sight of this fact.

Any interpretation of the Standard 7 mathematics mark for prediction should therefore also take the cognitive development of the pupil into account.

It should be noted, however, that Piaget is not without his critics, but the fact of the matter is that no impressive alternative theory has emerged to date, although specific aspects of his theory have been modified. Piaget's position is that an individual will always operate at the maximum level of logical development that he or she has attained. This is obviously not the case, as most individuals :-

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> 'operate at all intellectual levels, and may only operate at the highest level on certain occasions'. (Travers, 1982).

Two further criticisms are that Piaget does not allow for individual differences and that the capacity to perform logical operations is highly tied to situations that are very familiar, as one tends to be at one's best intellectually in areas where one has had a great deal of experience and, conversely, one is least adequate in unfamiliar situations.

Critics have also questioned whether the stages in Piaget's theory show the sharp transitions as clear differentiations rather than a more gradual transition from one stage to the other.

Nevertheless, in spite of these criticisms Piaget remains a giant in the field of intellectual development, and his theory has become the focal point for rethinking educational practices.

The cognitive development of a pupil does not take place in a vacuum; it is interwoven with social, physical and career development. The throes of puberty affect different individuals in different ways, but at the Standard 7 level the fourteen or fifteen year old adolescent has not only to cope with scholastic, physical and social pressures, but also has to make subject choice decisions which could affect his career in later life. Prediction of future success, both at school and later, therefore plays a part in these decisions and the effect that social, physical and career development is likely to have on prediction is discussed briefly in the following sections.

3.2. Social Development

The Standard 7 pupil has reached the stage of adolescence where he is starting to develop social habits which will remain with him for life. His interest in the opposite sex becomes more pronounced and boys and girls who were figuratively at daggers drawn a few months earlier find each other's company attractive and enjoyable. They may even develop a 'crush' on a teacher. Although they start thinking for themselves and become independent they still very much want to belong to a group and do what the group wants.

The latter two facts do at times give rise to problems when the pupil is faced with a choice of subjects. The pupil wants to take a subject because his friends are taking it, or he wants to continue with a subject because he likes the teacher, even if he has no ability or aptitude for it.

Here careful counselling and parental pressure, aided by prediction studies showing what would be likely to happen in three years' time, could indicate to the pupil the consequences of making an incorrect choice.

3.3. Physical Development

While growth is orderly and continuous, individual development takes place in spurts with general bodily development during pre-school years, then slows down, only to increase rapidly again during adolescence. During this period of rapid growth, the child must constantly make new adjustments and this necessity to adapt and adjust is likely to be disturbing and emotion-provoking, especially in the classroom where individuals, though chronologically the same age, may differ physically.

The average girl reaches puberty approximately two years before the average boy, but differences in attaining the age of puberty may run as high as four years in the same sex. Variations in physical maturity are related to variations in social, emotional and cognitive maturity. It is therefore unreasonable for a teacher to have the same expectations for a boy of thirteen who is short and slight and who speaks with a soprano voice, that one has for a girl of the same age who could pass for an eighteen year old.

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3.4. Career Development

One of the big drawbacks of having to choose subjects at the end of Standard 7 is the relative lack of maturity of the pupil at this stage. It is a rather early age to have to decide on a career. As pupils develop and mature, their interests may change, which subsequently could have an effect on their career choice.

Often at this stage the pupil has an unrealistic choice of career in mind when related to his ability. A pupil whose mathematics and science marks are very average, will, for example, wish to follow a career in medicine or veterinary science or a pupil who is extremely weak at mathematics (obtaining in the region of 20%) will indicate that he wishes to become a chartered accountant on leaving school.

Time and again, mathematics proves to be the key subject in any future decision about careers. A pass in mathematics in Standard 10 is virtually an open sesame to any career, provided the pupil attains the requisite standard needed. On the other hand, a failure in the subject or not having taken the subject at all after Standard 7 tends to limit the choice of careers considerably.

Once again, a prediction of his Standard 10 mathematics mark based on his Standard 7 year-end result could thus prove most beneficial to the pupil. A weak pass mark, or even a failure in Standard 7, could result in remedial mathematics being started early in his Senior Certificate Course. Provided that this is commenced early enough and the pupil is in earnest about improving his mark, a dramatic improvement in results is not beyond the bounds of possibility.

The results in Chapter 4 show that a pupil who achieves well in Standard 7 usually has no real problems in obtaining good, or at least satisfactory, results three years later.

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Thus, although one cannot assess social, physical or career development by marks, the teacher should be aware of the effects they can have on the adolescent at the end of his Standard 7 year as they could affect the prediction of the pupil's mark at the end of Standard 10.

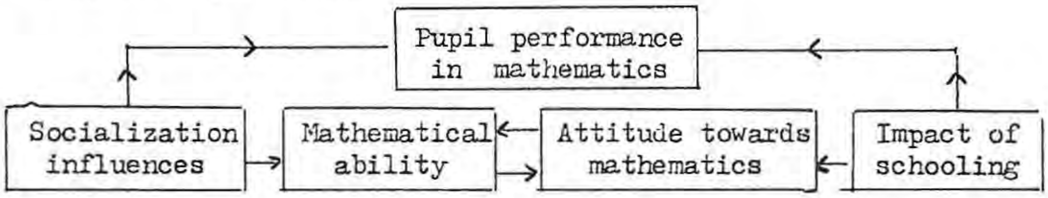
4. BOY-GIRL DIFFERENCES TOWARDS MATHEMATICS

Although sex differences are not taken into account in this investigation because of various factors (Chapter 4), previous research in this regard has shown that :-

> 'in the end, few definite conclusions can be drawn. It is not possible to single out one factor as the prime cause for such differences. Instead there seems to be a constellation of factors which influence performance to a varying degree'. (Badger, 1981).

A counsellor should therefore be aware of the differences, particularly as girls are the ones who are more likely to want to give up mathematics after Standard 7 even though their achievement indicates that they should continue with the subject.

The following diagram and explanations (Noble, 1982) shows the interrelationship between pupil performance in mathematics and contributing factors.



To what extent these factors play a part in the pupils' choice whether or not they should continue with mathematics after Standard 7 is difficult to assess, but it would seem safe to assume that they exert some influence. Each will be discussed briefly.

4.1. Mathematical Ability

Girls perform better on average than boys on verbal, clerical and arithmetical tasks, whilst boys, on the other hand, have the edge on girls in spatial, mechanical and visual tasks and in tasks involving judgement. This is very noticeable during adolescence and affects geometry, measurement and proportionality. In the context of the schools involved in this investigation, geometry is likely to be most affected as Standard 7 is the first year where it is introduced formally, as opposed to intuitively, into the mathematics syllabus.

Two of the areas where the differences are particularly noticeable are spatial visualisation and problem solving. In both cases boys have the edge over girls.

Spatial ability which involves the visual imagery of three-dimensional objects and the movement of these objects or properties (i.e. translation, rotation or reflection) has brought to light the following differences between the sexes :-

4.1.1. The context plays an important role, e.g. in problems involving blocks, boys are better, but no difference was observed in paper-folding;

4.1.2. Spatial ability is an important prediction in the mathematical advancement of girls. A correlation coefficient as high as 0,5 has been found between spatial ability and mathematical achievement (Fennema and Sherman, 1971; Sherman, 1980).

4.1.3. Sex difference in spatial ability can diminish with training and practice.

It has been argued that boys' greater success in problem-solving is due to their greater ability to visualise; this allows them greater ability in the solution of problems. Girls, on the other hand, are better at rote memorisation, which in turn inhibits their problem-solving abilities.

4.2. Socialisation Influences

Parents have clear ideas how boys and girls should grow up and the roles they should fill as adults; girls tend to be mothered, whilst boys have to adapt to be men.

> 'They are constantly challenged to face change - an ability necessary in the learning of mathematics'. (Noble, 1982).

Boys are repeatedly told by their parents that they must 'have' mathematics. This fact is brought across time and again when interviewing parents at the end of their child's Standard 7 year with regard to subject choice. Many feel that, no matter how poor the mark obtained, it is absolutely essential that their son continues with mathematics, whereas in the case of a daughter they are not nearly as insistent.

The opposite problem also arises. A girl who has achieved well at mathematics in Standard 7 wants to discontinue it in the Senior Secondary Phase because she is 'going to work in an office and won't need mathematics'.

In both cases the counsellor has a problem; in the former, to persuade the parent/boy to select another subject, in the latter to persuade the parent/girl to continue with mathematics.

This highlights the important role counselling plays at this level in ensuring that pupils choose subjects for which they have both ability and aptitude.

The media also plays an important role. Careers in science and engineering and architecture are usually pictured as male preserves and very few women are ever seen working with complex machinery.

Thus, at a very impressionable stage of adolescence girls gain the impression that these mathematically orientated careers are for men only; mathematics is not thought of as so important for them and therefore they are more likely to opt out of choosing the subject after Standard 7.

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4.3. Attitude Towards Mathematics

Fennema and Sherman (1977) showed that between the ages of thirteen and sixteen years boys showed a consistently greater degree of self-confidence in their ability to learn mathematics than did girls. The fact that this is evident before they showed any signs of poorer performance tends to confirm the influence of this variable on performance.

A significant factor that distinguishes the difference between boys and girls attitudes towards mathematics is the girls lower estimation of their own ability. There is also some indication that a girl's relative success in mathematics occurs when she refuses to regard mathematics as part of a masculine domain.

Fennema and Sherman (1977) also found that both expectations and attributions for success (or failure) show differences between the two sexes. Girls show a persistent tendency to underestimate their performance, while boys tend to overestimate theirs. Girls attribute success to 'luck' and failure to 'lack of ability'. By contrast boys attribute success to 'ability' and failure to 'lack of effort'. Many teachers unwittingly tend to reinforce these attitudes.

4.4. Impact of Schooling

Boys take subjects which play no part in a girl's curriculum like woodwork and technical drawing where spatial visualisation is important. Text books and teacher-materials are usually biassed in favour of boys, e.g. the majority of illustrations involve boys doing things.

In coeducational schools, boys are likely to be in the majority in the mathematics classes in the Senior Secondary Phase and teachers' expectations differ with regard to boys and girls with, at times, a devastating effect on the girls.

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With the advance of feminism in the past decade, where more and more women are successfully doing jobs and following careers that previously were only thought fit for males, many of the factors mentioned in this section are gradually 'levelling out' and presumably the differences between the performances of boys and girls will lessen considerably in the future.

CHAPTER 2

METHODOLOGY

The latter part of Chapter 1 has given a broad overview and indicated some of the general problems faced by the pupil over which he has no real control during adolescence. The teacher or counsellor should be acutely aware of these intellectual, social and physical developments and any advice offered to a Standard 7 pupil should be given with this developmental background in mind.

The next four chapters deal with the investigation under consideration, i.e. using Standard 7 mathematics marks to predict future performance in Standard 10, its results and conclusions.

1. EX POST FACTO RESEARCH

Like a number of educational investigations in which the independent variables lie outside the researcher's control, this study is an example of ex post facto research. In this instance it is a co-relational study - sometimes termed causal research.

Kerlinger (1970) defines ex post facto research as one in which the independent variable(s) have already occurred and in which the researcher starts with an observation of a dependent variable or variables.

The researcher thus examines retrospectively the effects of an event (in this case year-end examinations) on a subsequent outcome with a view to establishing a causal link between them.

The most distinctive feature of this kind of study is that the data is collected after the events have occurred. In contrast

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to true experimental research, ex post facto research has two weaknesses, viz control of the independent variable is not possible and neither is randomisation. It must be accepted that the evidence obtained in the investigation merely illustrates a hypothesis; it does not test it as hypotheses cannot be tested on the same data from which they are derived. Another limitation in this kind of research is that no single factor may be the cause, rather there may be multiple causes affecting the correlation of Standard 7 and Standard 10 marks.

Nevertheless ex post facto research meets an important need in that in a situation such as the one under investigation a more rigorous approach is not really possible; an experimental approach in this case would introduce a note of artificiality into the research. Further, in this particular instance the investigation is appropriate as it does give a sense of direction and provides a more fruitful source of hypotheses which could subsequently be tested by more rigorous methods.

2. THE PREDICTION STUDY

The purpose of the investigation is to assess the predictive value of the Standard 7 year-end mathematics marks, particularly with regard to the mark that will be obtained in the Cape Senior Certificate examination three years later. The choice of a criterion is important in any predictive study and the problem is compounded by choosing examination performance as the criterion. The different schools may have different norms, particularly at the Standard 7 level, and as has been shown by a number of investigators in the past, examinations have low reliability and validity which 'create problems for the researcher' (Malherbe, 1974).

At school level, examinations are, for all practical purposes, the only meaningful measures of achievement, yet they are also used for other purposes, e.g. selection procedures to name but one. This has meant that marks have had to be used as they are the only measurable criteria available. This highlights two other problems :-

... the form in which the Cape Senior Certificate results appear are as symbols on a 10 point scale in which an arbitrary average has had to be taken and used for each pupil (see appendix 1);

... these results have almost certainly been adjusted to fit the provincial normal distribution over the preceding five years.

There is however no more accurate means of prediction, although the criterion is neither completely accurate or reliable. This implies that the correlations obtained are relative to this situation.

School examinations are usually set only at the cognitive level and thus the affective and psycho-motor domains will play a minor role in the empirical section of this study.

3. SAMPLE AND DATA COLLECTION

The data for the investigation under consideration was drawn from the seven academic high schools in East London. Five of the schools are coeducational, one is a boys school and one a girls school. The symbols of those writing mathematics in these schools on both the Higher and Standard Grades in the Cape Senior Certificate in the years 1980, 1981 and 1982 were traced back to their corresponding marks for this subject in 1977, 1978 and 1979 respectively. Both Higher Grade and Standard Grade symbols were recorded and then converted to percentages (see appendix 1).

893 pupils from the seven schools, comprising 353 Higher Grade and 540 Standard Grade candidates, were used in the investigation. The following table gives the breakdown of numbers :-

	1980	1981	1982	Total
Higher Grade Candidates	115	117	121	353
Standard Grade Candidates	183	155	202	540
Total:	298	272	323	893

The sample clearly did not take the following into account :-

... pupils who did not continue with mathematics after Standard 7;

... pupils who failed either Standard 7, 8 or 9;

... pupils who changed schools after Standard 7;

... pupils who left school after Standard 7.

These factors must have implied a bias which will be discussed at a later stage.

Using the Chi-squared test a pilot study in two of the larger high schools was carried out to test the Null hypothesis that :-

> 'there was no difference between the frequency distributions of the marks of boys and girls'.

Because of the small numbers in each cell in the case of Higher Grade, this could only be done for the Standard Grade pupils. This was done for each of the years 1977 - 1980, 1978 - 1981 and 1979 - 1982, and then also for the three years combined, giving 16 results in all. (Tables 1 and 2, Chapter 4). With the exception of two results the Null hypothesis was accepted at a level in most cases of $p > 0,1$.

In spite of the exceptions no distinction was made between the sexes of the pupils, particularly as two of the remaining schools in the investigation were single sex schools and the Null hypothesis would not apply to them. The total number from all the schools in each grade was also used to test the Null hypothesis that :-

> 'there was no difference in the distribution of scores between Standard 7 and Standard 10'.

The Chi-squared test was again used and this hypothesis was rejected in both Higher and Standard Grade at a level of $p < 0{,}001$. (Table 3, Chapter 4).

The reason for this difference in the distribution of scores between Standard 7 and Standard 10 when the schools were combined is not easy to pinpoint. The major factor however does seem likely to be the low reliability and validity of both these examinations. The Standard 10 examination has almost certainly been adjusted to fit the provincial norm over the past five years, whereas it is highly likely that the Standard 7 marks have remained unaltered, or at most received nothing more than a minor adjustment. There is certainly no particular norm they have to fit, and each school would have made any adjustment they deemed necessary without consulting one another. Further, the scope of this investigation does not include determining how affective factors such as motivation, teacher competence, perseverance, maturation, etc. may affect the result.

4. RESEARCH DESIGN

The study investigates relationships between pupils' performance in the final Standard 7 mathematics examination and that of their performance in mathematics in the Cape Senior Certificate examination three years later.

It was intended :-

3.1. To see :-

3.1.1. whether the Standard 7 mark could be used to help predict whether a pupil would be likely to pass or fail mathematics in the Cape Senior Certificate examination three years later;

3.1.2. whether the Standard 7 mark could be used to make a decision whether or not the pupil should continue with mathematics in the Senior Secondary Phase (i.e. Standards 8, 9 and 10).

3.2. To predict what symbol the pupil would obtain in the Cape Senior Certificate if he continued with mathematics after Standard 7.

The importance of the correct choice at the end of Standard 7 cannot be overemphasised, as there can be no doubt whatever that mathematics is one of the key subjects in any curriculum, particularly in this scientifically orientated and technological age. As already stated, the ability to do mathematics enables the pupil to enter any career he wishes, whereas a Standard 10 pass without the subject closes the doors to many careers such as engineering, chartered accountancy, medicine, systems analysts, etc. The report of the de Lange Commission on Education in the RSA repeatedly stresses the importance of both mathematics and science in this country.

On the other hand, if a pupil does not show mathematical ability as indicated by his Standard 7 marks and then continues with mathematics in the Senior Secondary Phase it is virtually certain that, not only will he struggle with the subject, but that it is highly likely that he will fail it, very often with disastrous consequences for himself; either by failing to obtain a Matriculation Exemption pass, or by failing the examination outright, something which could have serious implications in the choice of a future career. If, however,

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mathematics had been replaced by another subject in which he showed more interest and ability, there would be the strong likelihood that this situation could have been avoided and that he could have coped with the examination as a whole.

A further result of taking mathematics as a wrong choice is that the examination aggregate could also be affected adversely. The symbol obtained in mathematics would almost certainly be lower than in another subject (year after year Senior Certificate statistics show that mathematics is one of the two subjects which have the highest failure rate, i.e. the number of FF symbols and less is in greater proportion than any other subject, with the possible exception of shorthand) and this would depress the aggregate more than if another subject was taken in its place.

4. PROCEDURE

As is the case in most prediction studies, two methods of presenting the prediction results were employed.

4.1. Frequency distribution tables were drawn up for each school for each grade in mathematics for each of the three years under review. The three years were then combined to give an overall frequency distribution table for the school in each grade over this period. Because of the comparatively small numbers, these tables are not shown.

Secondly, the frequency distribution tables from each school were combined to give an overall view of each grade for each of the 1980, 1981 and 1982 years (Tables 4 - 11, Chapter 4).

Thirdly, the three years were combined, giving a global picture for each grade over the three years (Tables 7, 11, Chapter 4).

4.2. Each pupil's Cape Senior Certificate symbol in mathematics was converted to a percentage (see appendix 1). The Pearson product-moment correlation coefficient between the pupil's Standard 7 mathematics percentage and that of the corresponding Cape Senior Certificate percentage for both the Higher and Standard Grade was calculated for each school, for each corresponding year, i.e. 1977 - 1980, 1978 - 1981 and 1979 - 1982 (Tables 12 and 13, Chapter 4).

The product-moment correlation coefficient was also calculated for the combined schools - Higher Grade and Standard Grade separately - for each of these years. Finally, all three years were combined - again the grades of instruction separately - and the product-moment coefficient calculated for the 353 Higher Grade and 540 Standard Grade pupils (Tables 12 and 13, Chapter 4).

Regression equations were also calculated in every case, but only the equations where statistically significant correlation coefficients were found are given in Chapter 4 (Tables 14 and 15, Chapter 4).

The use of a parametric measure such as r could be justified in this investigation as the conditions for its implementation were satisfied, viz :-

... the observations (marks) were independent;

... it can be assumed that the pupils of the seven schools under investigation were normally distributed;

... the examination marks were on an interval scale;

... the variances in each of the groups being compared were similar;

... a study of the correlation grids indicates linearity of distribution.

A selection of groups was made and the standard deviation for each group was calculated, yielding the following results :-

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	Year	Grade	Std.	Std. Deviation
School A:	1980	HG	10	11,3
			7	9,9
	1980	SG	10	13,9
			7	15,8
School B:	1981	HG	10	11,9
			7	9,7
School C:	1982	SG	10	12,9
			7	10,8
School E:	1980	HG	10	19,4
			7	17,7
School G:	1982	HG	10	11,8
			7	11,5

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CHAPTER 3

EMPIRICAL RESEARCH

The data for this research study was obtained by tracing the Cape Senior Certificate mathematics results of 893 pupils (483 boys, 410 girls) in the Standard 7 examination set three years previously.

The two pilot studies indicated in Chapter 2 using the Chi-squared test showed that sex differences could be ignored, but that there was a significant difference in the distribution of symbols between Standard 7 and Standard 10. The possible reasons for this difference were also given in the last chapter.

The 893 pupils were drawn from the seven academic high schools in East London. Five of the schools are coeducational, one is a boys school and one a girls school. The symbols of those writing the Cape Senior Certificate mathematics examination in these schools on both the Higher and Standard Grades in the years 1980, 1981 and 1982 were converted to percentages (see appendix 1) and traced back to the corresponding Standard 7 marks in 1977, 1978 and 1979 respectively. Table 1 gives the breakdown of numbers taking mathematics at the seven academic high schools.

TABLE 1

Pupils writing Cape Senior Certificate Mathematics

	1980		1981		1982		Total	
	HG	SG	HG	SG	HG	SG	HG	SG
School A	20	54	16	38	16	39	52	131
B	19	36	17	29	26	37	62	102
C	6	19	7	13	4	25	17	57
D	-	7	1	3	-	7	1	17
E	53	27	57	12	48	29	158	68
F	11	29	8	30	13	31	32	90
G	6	11	11	30	14	34	31	75
Total:	115	183	117	155	121	202	353	540

Table 1: Number taking mathematics in the Cape Senior Certificate in the various schools.

Of the 353 Higher Grade pupils, 226 were boys and 127 girls. The 540 Standard Grade pupils comprised 257 boys and 283 girls. In the pilot study sex difference was found not to be significant, and thus there was no distinction made between the marks of boys and those of girls in the rest of the study.

Table 2 gives the percentage of those taking Higher Grade mathematics in each school for the years 1980, 1981 and 1982 in relation to the total number taking mathematics in the schools.

TABLE 2

	1980	1981	1982	Total
School A	27,0	29,6	29,1	28,6
B	34,5	36,9	41,2	37,8
C	24,0	35,0	13,8	23,0
D	-	25,0	-	5,9
E	66,3	82,6	62,3	69,9
F	27,5	21,1	29,5	26,2
G	35,3	26,8	29,2	29,2
Total:	38,6	43,0	37,5	39,5

Table 2: Number of candidates taking mathematics Higher Grade for the Cape Senior Certificate examination expressed as a percentage of the total taking mathematics for this examination.

Reference to this table shows that, apart from one school, approximately 30% of the pupils who take mathematics, take it on the Higher Grade. From experience, since the introduction of differentiated education in 1974, this figure seems justified.

It must also be born in mind that the following conditions for passing/failing apply to subjects taken on the Higher Grade in the Cape Senior Certificate :-

... 40% and above : a pass on the Higher Grade;

... 25 - 39% : a failure on the Higher Grade but converted to a pass on the Standard Grade;

... below 25% : an outright failure.

For the Standard Grade a pass is 33 1/3% and above.

It is clear that the schools counsel and select their Higher Grade mathematics candidates rigorously. With the exception of one school which had a total of 8 outright failures in mathematics Higher Grade over the three years under review, no other school had any outright failures at all. A further 27 candidates obtained a 'converted to Standard Grade' pass. These 27 pupils came from two schools only, one being the school which had the 8 failures.

Table 3 gives the lowest mark, given as a percentage, that a pupil obtained in Standard 7 in each school, and who then took mathematics on the Higher Grade for the Cape Senior Certificate. The subsequent mark obtained in this latter examination is also indicated.

Table 4 is similar to Table 3, except that the highest mark instead of the lowest obtained by a Standard 7 pupil is indicated, and also the subsequent mark obtained three years later.

TABLE 3

	Std. 7 1977	Std. 10 1980	Std. 7 1978	Std. 10 1981	Std. 7 1979	Std. 10 1982
School A	52	45	67	30	59	30
B	56	55	48	65	55	65
C	52	45	65	45	76	45
D	-	-	74	45	-	-
E	33	55	30	22,5	46	37,5
F	61	65	57	55	67	55
G	65	55	54	45	50	55

Table 3: Lowest Standard 7 mark, expressed as a percentage, of a pupil taking mathematics Higher Grade in each school compared with the corresponding mark obtained in the Cape Senior Certificate three years later.

TABLE 4

	Std. 7 1977	Std. 10 1980	Std. 7 1978	Std. 10 1981	Std. 7 1979	Std. 10 1982
School A	97	55	91	45	94	55
B	96	90	90	90	93	90
C	94	90	91	75	90	75
D	-	-	74	45	-	-
E	90	90	93	90	96	90
F	93	65	92	75	99	65
G	79	45	98	90	97	90

Table 4: Highest Standard 7 mark, expressed as a percentage, of a pupil taking mathematics Higher Grade in each school compared with the corresponding mark obtained in the Cape Senior Certificate three years later.

A comparison of the two tables highlights the difficulty of accurate prediction. In school A, two pupils who achieved a highly satisfactory pass in Standard 7, failed mathematics on the Higher Grade three years later, and in fact only 'scraped' a Standard Grade pass. School B, on the other hand, had two pupils whose marks improved significantly three years later, enabling them to obtain a highly satisfactory 65% on the Higher Grade. School E had two pupils who actually failed mathematics in Standard 7, and then proceeded with mathematics Higher Grade. The 1977 pupil raised his mark by approximately 20% to obtain a 55% pass, whilst the 1978 pupil fell even further back with 22,5% and thus a failure in mathematics.

It is also significant that the pupils indicated in Table 3 did not necessarily obtain the lowest mark of those taking mathematics Higher Grade in their school three years later.

Reference to Table 4 shows that the pupil who achieves well at mathematics in Standard 7 usually maintains a high level of achievement three years later. In only three cases does this level slip below 50%, in the majority of cases it remains in the region of 75% and above. The possible reasons for these fluctuations were discussed in Chapter 2.

The selection and counselling with respect to the Standard Grade pupils, whilst not as stringent as that of the Higher Grade, is nevertheless also fairly rigid. Of the 540 pupils who wrote the Cape Senior Certificate Standard Grade mathematics papers over the three years, there were only 71 outright failures (i.e. the candidates obtained less than the required 33 1/3% pass mark - Table 11, Chapter 4).

Frequency tables for each of the grades for the years 1980, 1981 and 1982 were also drawn up (Chapter 4). Although these results must be treated with caution, and the counsellor must be aware of their limitations, they nevertheless serve a useful purpose in counselling as they enable both the counsellor and counsellee to see at a glance what the chances are of a Standard 7 pupil obtaining a particular symbol in the Cape Senior Certificate three years later.

Each of the 893 pupils' Cape Senior Certificate symbol for mathematics over the three years was converted to a percentage (see appendix 1). Using the Pearson product-moment method of correlation, these percentages were then correlated with the pupil's Standard 7 mark (also expressed as a percentage) three years previously.

The following correlations were calculated, each of the Grades, Higher and Standard, being taken separately :-

... where $n \geqslant 20$, r was calculated in each school, for each Grade, for each year. To test whether r was statistically significant a t-test was applied in each of these cases. It was felt that in cases where $n < 20$ it would be highly unlikely that the marks would be normally distributed, thus no test of significance was applied.

... the number of candidates in each school for each Grade was then added together and r calculated. The only exception being School D which only had 1 Higher Grade candidate and a total of 17 Standard Grade candidates over the three years.

... all seven schools were then combined for each of the three years and r calculated for 1980, 1981 and 1982 for each of the Grades.

... finally the numbers from all the schools were combined over the three years and r calculated for the 353 Higher Grade candidates and also the 540 Standard Grade candidates.

... where $n \geqslant 20$, the resulting regression equations were also calculated in the cases where the t-tests were significant.

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CHAPTER 4

RESULTS

1. PILOT STUDIES

Two pilot studies were undertaken, viz :-

... to test whether the sex of the candidate played any part in the distribution of marks, and

... to test whether there was any difference in the distribution of marks between Standard 7 and Standard 10.

The Chi-squared test was applied in each case.

1.1. To see whether sex differences played any part in the investigation, schools A and F were used to test the Null hypothesis that :-

> 'there was no difference between the frequency distribution of the marks of boys and those of girls'.

Schools A and F were chosen because they had a larger number of candidates than the other coeducational schools where the numbers were significantly smaller, and where it would have been impossible for $n \geqslant 5$ in each cell.

Even in spite of this, n was too small in these two schools when Higher Grade candidates were considered, and thus the Chi-squared calculation was only determined for the Standard Grade candidates.

This calculation was performed for each of Standards 7 and 10 for each of the three years under review. The Standard 7 marks were firstly converted to symbols as per appendix 1 and for ensuring that $n \geqslant 5$ in each cell, the symbols were grouped into the three categories : ABC; D; E and lower.

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In school A, $p > 0{,}1$ in every case, whilst school F gave $p < 0{,}01$ in Standard 7 in 1982 and $0{,}05 > p > 0{,}02$ in the same standard in 1981, indicating that sex did play a role in the distribution of marks here. In the other calculations either $p > 0{,}05$ or, as in school A, $p > 0{,}1$.

TABLE 1

School A		n	df	x^2	p
1977	Std. 7	28 boys	2	1,5	$p > 0{,}1$
1980	Std. 10	26 girls	2	1,2	$p > 0{,}1$
1978	Std. 7	21 boys	2	1,4	$p > 0{,}1$
1981	Std. 10	17 girls	2	2,6	$p > 0{,}1$
1979	Std. 7	25 boys	2	3,7	$p > 0{,}1$
1982	Std. 10	14 girls	2	2,6	$p > 0{,}1$

School F		n	df	x^2	p
1977	Std. 7	16 boys	2	3,85	$p > 0{,}1$
1980	Std. 10	13 girls	2	0,65	$p > 0{,}1$
1978	Std. 7	16 boys	2	6,3	$0{,}05 > p > 0{,}02$
1981	Std. 10	14 girls	2	1,55	$p > 0{,}1$
1979	Std. 7	19 boys	2	10,7	$p < 0{,}01$
1982	Std. 10	12 girls	2	5,7	$p > 0{,}05$

Table 1: Chi-squared test for Standard Grade in each of the three years.

With the exception of the Standard 7 in 1979, the Null hypothesis was accepted and thus no difference was made between the marks of boys and those of girls. An added factor in ignoring the differences of sex was the fact that two of the remaining schools in the investigation were single sex schools and the Null hypothesis could therefore not apply in their case.

The combination of the three years indicated once again that in School A the sex of the candidate made no difference to the distribution of marks as $p > 0,1$ in every case, whilst in School F the difference in sex played a role at the Standard 7 level, but not at the Standard 10 level.

TABLE 2

School A	n		df	x^2	p
1980, 81, 82 combined	Std. 7	74 boys	2	4,0	$p > 0,1$
	Std. 10	57 girls	2	0,8	$p > 0,1$
School F	**n**		**df**	**x^2**	**p**
1980, 81 82 combined	Std. 7	51 boys	2	9,7	$p < 0,01$
	Std. 10	39 girls	2	5,5	$0,1 > p > 0,05$

Table 2: Chi-squared test for Standard Grade for the three years combined.

1.2. The Chi-squared test was again used in the second pilot study. Here the total number of each grade (Higher and Standard) was used to test the Null hypothesis that :-

> 'there was no difference in the distribution of scores between Standard 7 and Standard 10'.

In both cases this hypothesis was rejected at a level of $p < 0,001$. The likely reasons for the rejection of the hypothesis were given in Chapter 2. (Page 33)

TABLE 3

	n	df	x^2	p
Higher Grade	353	15	80,0	$p < 0{,}001$
Standard Grade	540	15	120,9	$p < 0{,}001$

Table 3: Chi-squared test for total in each grade.

2. FREQUENCY TABLES

For counselling pupils, frequency tables are most useful as the possibility of obtaining a particular result can be seen at a glance and the pupil would be fully aware of the probability of obtaining any specific mathematics mark in the Standard 10 examination, based on his Standard 7 achievement.

Four tables for each of Higher and Standard Grade are given. Firstly the frequency tables for each of the three years are shown, and then the combined table for the three years together.

The number of pupils obtaining each symbol is given in each cell with the probability being indicated directly below this number.

A careful study of the tables once again focusses attention on the difficulty of accurate prediction. Having obtained an A (80% +) for mathematics in Standard 7, the probability of obtaining an A on the Higher Grade in Standard 10 (according to the Tables 4, 5 or 6) varies from .14 to .39. It does, however, lead to the conclusion that one could, with reasonable certainty, advise a pupil who obtained an A in Standard 7 that it would seem certain that, if he continued with mathematics on the Higher Grade, he would pass the subject in Standard 10.

If, however, he obtained a B (70 - 79%) in Standard 7 and then took mathematics on the Higher Grade, there would be a chance of 1 in 20 (probability .05) that he would fail on the Higher Grade, but that his mark would be converted to a pass on the Standard Grade (Table 7).

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Reference to Table 11 brings to light another interesting fact. If a pupil obtains an A for mathematics in Standard 7 and then takes it on the Standard Grade, the probability of him obtaining an E symbol is .20. Now, an E on the Standard Grade is equivalent to an F or FF on the Higher Grade, i.e. it would actually pay him to take the subject on the Higher Grade where, according to Table 7, the lowest symbol he would be likely to obtain would be an E, which is equivalent to a D or C on the Standard Grade. This illustrates very clearly that one can ill afford to be dogmatic when predicting mathematics results!

This example once again highlights the part that factors such as the reliability and validity of examinations and affective variables such as motivation, maturation, the effect of remedial teaching and teacher competence could play in prediction.

Table 7 illustrates the fact that the great majority of Standard 10 mathematics Higher Grade pupils obtained a D symbol or better in Standard 7. This is not really surprising, as the pupils are usually carefully counselled at this level before deciding on their choice of subjects and the grade on which they should be taken. Reference to Table 11 shows pupils who obtained D, E and F symbols in Standard 7 having a good chance of improving on this result if they take mathematics on the Standard Grade in Standard 10. This should be interpreted rather cautiously, as in the case of Higher Grade there are strong selection factors involved before pupils are allowed to continue with mathematics. This finding supports both Murphy (1978) in his investigation of O-level grades as predictors of A-level grades and the Scottish Certificate of Education Examination Board in a study where they compared O-grade results with H-grade results and found that students with low O-grade marks who went on to do H-grade had a better chance of obtaining good grades than students with somewhat better O-grade marks (Dunning Report 1977).

FREQUENCY TABLES

Distribution of symbols for all seven schools for each of the three years.

TABLE 4

HIGHER GRADE

	Std. 10 (1980)										
Std. 7 (1977)	A	B	C	D	E	F	FF	G	GG	H	Total
A - No. Prob.	13 .39	7 .21	7 .21	5 .15	1 .03						33
B - No. Prob.	1 .03	6 .17	11 .31	10 .29	6 .17	1 .03					35
C - No. Prob.	2 .10	2 .10	3 .15	9 .45	1 .05	2 .10			1 .05		20
D - No. Prob.		2 .13	1 .07	4 .27	7 .47				1 .07		15
E - No. Prob.		1 .13		5 .63	2 .25						8
F - No. Prob.			1 .33	1 .33		1 .33					3
FF- No. Prob.				1 1.00							1
G - No. Prob.											
GG- No. Prob.											
H - No. Prob.											
Total:	16	18	23	35	17	4	-	-	2	-	115

TABLE 5

HIGHER GRADE

	Std. 10 (1981)										
Std. 7 (1978)	A	B	C	D	E	F	FF	G	GG	H	Total
A – No.	6	6	8	13	10						43
Prob.	.14	.14	.19	.30	.23						
B – No.		4	6	11	8	2					31
Prob.		.13	.19	.35	.29	.06					
C – No.			4	6	12	2	1			1	26
Prob.			.15	.23	.46	.08	.04			.04	
D – No.				4	5	1		1			11
Prob.				.36	.45	.09		.09			
E – No.			1			1			2		4
Prob.			.25			.25			.50		
F – No.								1			1
Prob.								1.00			
FF– No.									1		1
Prob.									1.00		
G – No.											
Prob.											
GG– No.											
Prob.											
H – No.											
Prob.											
Total:	6	10	19	34	35	6	1	2	3	1	117

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TABLE 6

HIGHER GRADE

	Std. 10 (1982)										
Std. 7 (1979)	A	B	C	D	E	F	FF	G	GG	H	Total
A - No. Prob.	11 .20	17 .31	8 .15	15 .27	4 .07						55
B - No. Prob.			10 .33	11 .37	7 .23	1 .03	1 .03				30
C - No. Prob.	1 .04		2 .07	8 .30	5 .19	6 .22	1 .04	1 .04	2 .07	1 .04	27
D - No. Prob.			1 .11	1 .11	3 .33	1 .11	2 .22	1 .11			9
E - No. Prob.											
F - No. Prob.											
FF- No. Prob.											
G - No. Prob.											
GG- No. Prob.											
H - No. Prob.											
Total:	12	17	21	35	19	8	4	2	2	1	121

TABLE 7

Distribution of symbols for all seven schools for the three years combined.

HIGHER GRADE

	Std. 10										
Std. 7	A	B	C	D	E	F	FF	G	GG	H	Total
A - No.	30	30	23	33	15						131
Prob.	.23	.23	.18	.25	.11						
B - No.	1	10	27	32	21	4	1				96
Prob.	.01	.10	.28	.33	.22	.04	.01				
C - No.	3	2	9	23	18	10	2	1	3	2	73
Prob.	.04	.03	.12	.32	.25	.14	.03	.01	.04	.03	
D - No.		2	2	9	15	2	2	2	1		35
Prob.		.06	.06	.26	.43	.06	.06	.06	.03		
E - No.		1	1	5	2	1			2		12
Prob.		.08	.08	.42	.17	.08			.17		
F - No.			1	1		1		1			4
Prob.			.25	.25		.25		.25			
FF- No.				1					1		2
Prob.				.50					.50		
G - No.											
Prob.											
GG- No.											
Prob.											
H - No.											
Prob.											
Total:	34	45	63	104	71	18	5	4	7	2	353

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Distribution of symbols for all seven schools for each of the three years.

TABLE 8

STANDARD GRADE

	Std. 10 (1980)										
Std. 7 (1977)	A	B	C	D	E	F	FF	G	GG	H	Total
A - No.	2	1	2	2	1						8
Prob.	.25	.13	.25	.25	.13						
B - No.	1	4	6	4	1						16
Prob.	.06	.25	.38	.25	.06						
C - No.	1	4	9	16	7	2		1	1		41
Prob.	.02	.10	.22	.39	.17	.05		.02	.02		
D - No.		11	9	7	16	5	2				50
Prob.		.22	.18	.14	.32	.10	.04				
E - No.	2	3	3	9	9	5	1	4	1	2	39
Prob.	.05	.08	.08	.23	.23	.13	.03	.10	.03	.05	
F - No.			1	3	5	4		3	1	1	18
Prob.			.06	.17	.28	.22		.17	.06	.06	
FF- No.				1	1	1	1				4
Prob.				.25	.25	.25	.25				
G - No.			1		1	3		1			6
Prob.			.17		.17	.50		.17			
GG- No.											
Prob.											
H - No.										1	1
Prob.										1.00	
Total:	6	23	31	42	41	20	4	9	3	4	183

TABLE 9

STANDARD GRADE

	Std. 10 (1981)										
Std. 7 (1978)	A	B	C	D	E	F	FF	G	GG	H	Total
A - No.	1	2	1		1						5
Prob.	.20	.40	.20		.20						
B - No.	3	3	4	3	1						14
Prob.	.21	.21	.29	.21	.07						
C - No.		8	11	11	11	2					43
Prob.		.19	.26	.26	.26	.05					
D - No.	4	2	6	8	10	2	4	3	1		40
Prob.	.10	.05	.15	.20	.25	.05	.10	.08	.03		
E - No.			4	6	14	4	1	1	3	2	35
Prob.			.11	.17	.40	.11	.03	.03	.09	.06	
F - No.				1	3	1	2		2	1	10
Prob.				.10	.30	.10	.20		.20	.10	
FF- No.			1			1		2		1	5
Prob.			.20			.20		.40		.20	
G - No.				1	1				1		3
Prob.				.33	.33				.33		
GG- No.											
Prob.											
H - No.											
Prob.											
Total:	8	15	27	30	41	10	7	6	7	4	155

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TABLE 10

STANDARD GRADE

	Std. 10 (1982)										
Std. 7 (1979)	A	B	C	D	E	F	FF	G	GG	H	Total
A - No.	1	1	1	2	2						7
Prob.	.14	.14	.14	.28	.28						
B - No.	3	8	11	10	8						40
Prob.	.08	.20	.28	.25	.20						
C - No.	2	5	11	21	9	5	2	1	1		57
Prob.	.04	.09	.19	.37	.16	.09	.04	.02	.02		
D - No.		2	9	11	13	7	2	2	2	1	49
Prob.		.04	.18	.22	.27	.14	.04	.04	.04	.02	
E - No.		1		5	10	9	2	3	1	2	33
Prob.		.03		.15	.30	.27	.06	.09	.03	.06	
F - No.					4	2		3	1	2	12
Prob.					.33	.17		.25	.08	.17	
FF- No.					2			1	1		4
Prob.					.50			.25	.25		
G - No.											
Prob.											
GG- No.											
Prob.											
H - No.											
Prob.											
Total:	6	17	32	49	48	23	6	10	6	5	202

TABLE 11

Distribution of symbols for all seven schools for the three years combined.

STANDARD GRADE

Std. 7	Std. 10 A	B	C	D	E	F	FF	G	GG	H	Total
A - No.	4	4	4	4	4						20
Prob.	.20	.20	.20	.20	.20						
B - No.	7	15	21	17	10	2					72
Prob.	.10	.21	.29	.24	.14	.03					
C - No.	3	17	31	48	27	12	2	2	2		144
Prob.	.02	.12	.22	.33	.19	.08	.01	.01	.01		
D - No.	6	15	24	26	39	14	8	5	3	1	141
Prob.	.04	.11	.17	.18	.28	.10	.06	.04	.02	.07	
E - No.		4	7	20	33	17	4	8	5	6	104
Prob.		.04	.07	.19	.32	.16	.04	.08	.05	.06	
F - No.			1	4	12	4	2	6	4	4	37
Prob.			.03	.11	.32	.11	.05	.16	.11	.11	
FF- No.			1	1	3	4	1	3	1	1	15
Prob.			.07	.07	.20	.27	.07	.20	.07	.07	
G - No.			1	1	2			1	1		6
Prob.			.17	.17	.33			.17	.17		
GG- No.											
Prob.											
H - No.										1	1
Prob.										1.00	
Total:	20	55	90	121	130	53	17	25	16	13	540

3. PEARSON PRODUCT-MOMENT CORRELATIONS

The Pearson product-moment correlation coefficient between the Standard 7 year-end marks of each pupil and the corresponding mark in the Cape Senior Certificate are provided in the table below for each of the schools for each of the years 1980, 1981 and 1982. As indicated in Chapter 1, the Cape Senior Certificate symbol had to be converted to a percentage.

Although r was calculated in each case, two factors to test its statistical significance were taken into account :-

... if $n < 20$, it was felt that the population would be highly unlikely to be normally distributed and therefore the Pearson correlation coefficient would be inappropriate;

... if $n \geqslant 20$, the cell was tested for significance using a t-test.

It can readily be seen that on the Higher Grade only relatively few cells meet the criteria of $n \geqslant 20$, on the other hand the majority of coefficients are statistically significant on the Standard Grade.

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TABLE 12

HIGHER GRADE

	1980		1981		1982		Total for the 3 years	
	n	r	n	r	n	r	n	r
School A	20	0,46*	16	ns	16	ns	52	0,54**
B	19	ns	17	ns	26	0,65**	62	0,42**
C	6	ns	7	ns	4	ns	17	ns
D	–	ns	1	ns	–	ns	1	ns
E	53	0,70**	57	0,78**	48	0,66**	158	0,64**
F	11	ns	8	ns	13	ns	32	0,20
G	6	ns	11	ns	14	ns	31	0,35
Total for each year	115	0,62**	117	0,58**	121	0,62**	353	0,57**

* $p < 0{,}05$: ** $p < 0{,}01$: ns = statistically not significant

Table 12: Pearson product-moment correlation between Standard 7 and the corresponding Standard 10 mathematics mark.

TABLE 13

STANDARD GRADE

	1980		1981		1982		Total for the 3 years	
	n	r	n	r	n	r	n	r
School A	54	0,58**	38	0,78**	39	0,72**	131	0,67**
B	36	0,42**	29	0,55**	37	0,60**	102	0,51**
C	19	ns	13	ns	25	0,53**	57	0,33**
D	7	ns	3	ns	7	ns	17	ns
E	27	0,24	12	ns	29	0,67**	68	0,41**
F	29	0,71**	30	0,39**	31	0,63**	90	0,68**
G	11	ns	30	0,43**	34	0,62**	75	0,40**
Total for each year	183	0,45**	155	0,51**	202	0,66**	540	0,53**

** $p < 0{,}01$: ns = statistically not significant

Table 13: Pearson product-moment correlation coefficient between Standard 7 and the corresponding Standard 10 mathematics mark.

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The corresponding regression equations are also given in the case of the statistically significant cells.

TABLE 14

HIGHER GRADE

	1980	1981	1982	Total for the 3 years
School A	y=0,42x+55,4	ns	ns	y=0,82x-10
B	ns	ns	y=0,95x-7,8	y=0,73x-8,1
C	ns	ns	ns	y=0,88x-7,5
D	ns	ns	ns	ns
E	y=0,83x+6,2	y=1,0x-13,5	y=1,04x-22,6	y=0,83x-0,9
F	ns	ns	ns	y=0,25x+45
G	ns	ns	ns	y=0,35x+30,9
Total for each year	y=0,69x+13,2	y=0,69x+4,4	y=0,92x-12,8	y=0,71x+6

ns = statistically not significant

Table 14: Regression equations for the statistically significant cells.

TABLE 15

STANDARD GRADE

	1980	1981	1982	Total for the 3 years
School A	y=0,58x+15,9	y=0,93x-9,4	y=0,73x-0,88	y=0,74x+2,7
B	y=0,5x+34	y=0,87x+8,2	y=0,85x+13,1	y=0,71x+20,6
C	ns	ns	y=0,63x+15	y=0,33x+33
D	ns	ns	ns	ns
E	y=0,30x+40	ns	y=0,75x+8	y=0,48x+26,6
F	y=1,81x-22,9	y=0,42x+35,6	y=0,69x+11,3	y=0,82x+6,3
G	ns	y=0,69x+19,5	y=0,62x+9,8	y=0,44x+25,7
Total for each year	y=o,53x+24,2	y=0,72x+12,3	y=0,79x+4,6	y=0,65x+15,5

ns = statistically not significant

Table 15: Regression equations for the statistically significant cells.

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Using previous investigations on prediction studies as a basis, the values of r obtained in this study are in line with previous results. It should be realised, however, that at least two factors affect r and thus depress it.

Of those taking the Higher Grade, only six pupils obtained below 40% in Standard 7 and, of those, two failed the subject by obtaining less than 33 1/3%. Of those taking the Standard Grade, twenty two pupils failed mathematics in Standard 7 outright by obtaining less than 33 1/3% and thirty nine obtained between 33 1/3% and 40%, i.e. obtained a 'weak' pass.

The effect of this is to reduce the correlation coefficient as, when candidates from this restricted range only are considered, some predictive power in the variable on which selection has occurred has been used in that selection process. The Guilford and Fruchter (1973) correction for this restriction of range would give a higher correlation, but as in practice most schools would not apply this, it has not been used in this investigation.
Also, according to Massey (1978), the assumption that selection is only on the basis of Standard 7 year-end results may underestimate the restriction, as selection on the basis of other related variables occurs and will also restrict the correlation. It is also inevitable that in any examination errors of measurement are also present.

The overall effect of these is to lower the correlation between Standard 7 and the Cape Senior Certificate examinations. As the Standard 7 year-end examination is being viewed as a predictor of Cape Senior Certificate performance, its own unreliability reduces its capacity to predict.

It must also be recognised that the Cape Senior Certificate examination itself is anything but infallible and the unreliability and lack of validity of this examination also reduces

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the correlation suggesting that the Standard 7 year-end examination is a less efficient predictor than it actually is.

Again, Guilford and Fruchter provide a method for correcting this reduced correlation coefficient, but in order to apply the correction the reliability of the Cape Senior Certificate examination must be known. As this is unknown, the reduced correlation figure has to be accepted.

In the case of Higher Grade, r is virtually constant at 0,6 over each of the three years. With regard to Standard Grade, however, r has shown a gradual increase which again highlights the unanswered question of the reliability and validity of examinations.

It is of interest to compare the individual school's r for the three years with that of the 'total' r for each of 1980, 1981 and 1982. With respect to the Higher Grade (Table 7), schools A and E have correlation coefficients which are virtually the same as that for each of the three years, the other three schools having a much lower r.

Probably because of the larger number of pupils involved in the Standard Grade, the values of r for the individual schools over the three years are, with one exception, greater than 0,4, which falls well within the range of previous predictions of this kind.

In comparison with the results of other prediction studies, the overall picture in this study is very similar. The results obtained in Standard 7 are useful in aiding a pupil making a choice of whether or not he should continue with mathematics, provided :-

... they are treated with caution;

... it is realised that there are also other factors which play a part and which affect predictions that use marks only.

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CHAPTER 5

SUMMARY AND CONCLUSIONS

The main conclusions to be drawn from this investigation are that there is a moderate level of agreement between the Standard 7 mathematics marks and Standard 10 Cape Senior Certificate marks by the pupils from the seven East London high schools used in the study.

According to van Dalen (1973), if a correlation or prediction study is used to determine the magnitude of the relationship that exists between the variables, the results may be interpreted (with reservations) as follows :-

$r = \pm 0{,}0$ to $\pm 0{,}2$, negligible relationship
$r = \pm 0{,}2$ to $\pm 0{,}4$, low relationship
$r = \pm 0{,}4$ to $\pm 0{,}7$, marked relationship
$r = \pm 0{,}7$ to $\pm 1{,}0$, high to very high relationship

This classification is a useful, albeit tentative,guide. A correlation coefficient is relative and should be interpreted in terms of the variables correlated. Rochford (1983) lists in more detail common mistakes that occur in the interpretation of correlation coefficients (see appendix 5).

In three of the eleven cases where the total correlations for the three years for each school could be used (Tables 12 and 13, Chapter 4) r was less than 0,4, in the other cases it varied from 0,4 to 0,7. When the totals for each year were considered, r was only less than 0,5 in one of the eight cases. This compares extremely favourably with similar previous investigations on predictions where the typical correlation coefficient is of the order of 0,4 or 0,5. The application of the Guilford and Fruchter correction generally increases this to 0,7 or 0,8; even higher correlations have been obtained with suitable combinations of predictors and criteria.

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Although the levels of the correlations in this investigation could be enhanced by applying the Guilford and Fruchter correction, this has not been done as those counsellors who would use the Standard 7 marks for predictive purposes are in no way in any position to measure the unreliability of the examination, one of the major stumbling blocks that face those who attempt to predict future examination performances.

The only criterion used in the prediction study is mathematical achievement as distinct from all other achievement. Further, the full extent of the correlation has in all probability been lowered :-

... because of the three year gap between Standard 7 and Standard 10. According to Cattell and Butcher (1968) a time-lag of this nature can affect the correlation;

... very little is known about the reliability of either of the examinations;

... a final factor that is likely to depress the correlation is that a 'select' group has been involved in the study, i.e. only those pupils who continued with mathematics after Standard 7 and virtually all of whom had passed the subject were the subjects of this investigation.

Ideally, therefore, more than achievement tests should be used as an assessment for prediction. As Anastasi (1954) puts it :-

> 'Like any other type of test, achievement tests should be regarded as tools, not goals. Moreover it must be remembered that they provide only partial information, and need to be supplemented by other observations.'

To be totally realistic, however, one must accept the fact that schools are extremely unlikely to use anything but achievement tests on which to base predictions. In the sample of 893 pupils this can be considered to have worked reasonably well, as only 80 pupils (9 Higher Grade and 71 Standard Grade) failed mathematics outright in Standard 10; of these 80, 10 had already failed in Standard 7.

To try to limit the unreliability of the Standard 7 examination, it would be advisable for each school to either :-

(a) Adjust the marks so that they fit the school's normal distribution for Standard 7 mathematics marks over the past five years, as is done with the Cape Senior Certificate marks. The restricted numbers do however severely limit this method and it would only have statistical significance in schools where the Standard 7 numbers are 'large', i.e. say more than 100 pupils.

(b) A more acceptable method would be to adjust the Standard 7 marks to standard scores. With schools acquiring computers, this calculation would not be onerous and would apply whether the number of Standard 7 pupils in a school was large or small.

To what extent, then, has this investigation answered the questions posed in Chapter 2, viz as a result of his Standard 7 mark :-

... would a pupil be likely to pass or fail mathematics in the Cape Senior Certificate?

... what symbol would he obtain?

... should he in fact continue with mathematics after Standard 7?

With regard to the likelihood of passing or failing, and with reference to the frequency tables (Chapter 4) and based on its results, one could give a reasonably accurate answer whether or not he would pass or fail.

If, however, one has to predict what symbol the pupil would be likely to obtain, any answer would have to be tempered with extreme caution. Again, the frequency tables and the fairly even spread of marks make this caution obvious. Further, 14 pupils out of the total of 24 who failed mathematics in

Standard 7 passed it three years later in the Cape Senior Certificate.

Counselling at the end of Standard 7 is often subjective, and the only norm used is the pupil's actual mark. By showing the pupil the frequency table, he could see for himself what the likely consequences of taking mathematics in the Senior Secondary phase would be. This would lead to a more objective appraisal of his chances by both counsellor and counsellee and could affect the decision whether or not to continue with the subject.

Although the results obtained are only applicable to the academic high schools in East London, it would seem that this sample would be fairly representative of similar academic schools in the Cape Province as a whole. Further studies on a larger scale, however, and with more representative sampling will be necessary for greater generalization.

To summarise then, the correlation coefficient is not really high enough to make the Standard 7 mark a particularly accurate predictor, and as such they should never be treated as more than a rough guide to one of the factors involved. Nevertheless, the frequency tables given in Chapter 4 can have considerable practical value in counselling, as they do give the pupil embarking on the Senior Secondary Phase in mathematics some idea what to expect in the Senior Certificate examination.

It has also to be accepted that factors such as reliability and validity of examinations, late maturation of the pupil, perseverance, motivation, teacher competence in teaching mathematics, remedial teaching, etc. can all play a part in affecting the prediction. Each of these, in their way, could form a topic for further study in the prediction of mathematical achievement using Standard 7 marks.

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CHAPTER 6

FUTURE RESEARCH AND RECOMMENDATIONS

1. FUTURE RESEARCH

Prediction and all its inherent problems have been highlighted in the previous chapters. What then can be done at the Standard 7 level to make counselling with respect to choice of subjects for the Senior Secondary Phase more meaningful, particularly with regard to mathematics.

It can be accepted that very few, if any, schools set examinations which test both the cognitive and affective domain. Teachers consider the latter too 'vague' and difficult to assess, and yet here is an area where factors such as motivation, maturation, perseverance, etc. could be explored in far greater detail than they are at present to see whether they affect marks in any way.

Teachers should also make far more use of profiles (Chapter 1). These could be developed either by the individual schools to suit their particular needs or by the Cape Education Department, and would be particularly useful in both the mid-year and final examinations, particularly at the Standard 6 and 7 level when the pupil is faced with a choice of subjects. They would also prove invaluable in Standards 8 and 9 when the pupil and parent would benefit from assessment on a broader front than purely marks.

Teachers in general have an aversion to administrative, clerical work, so the profile sheet should be designed in such a way that it is both easy to complete and easy to understand. Research in the design and compilation of such a profile sheet is an area which could be profitably explored by a future researcher.

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Another area of research in this country could be to see whether factors such as mathematical ability, attitude towards schooling and socialisation influences have any effect on the choice of the subject after Standard 7 and, further, to what extent these factors are governed by the difference between the sexes.

2. RECOMMENDATIONS

It is clear then that, in a study of this nature where one is trying to predict what mark a pupil will obtain three years later, far more attention should be given in Standard 7 to all aspects of assessment, not only achievement; an overall assessment would enable the counsellor to base his advice on a broader front than one based only on marks.

In mathematics the commonest forms of tests used in schools are probably achievement tests and diagnostic tests. Of the two, the achievement test is by far the most commonly used, periodically as checks on progress during the year, in end-of-term examinations and at the end of the year as a final indicator whether or not a pupil has passed mathematics.

Professor B.S. Bloom (1956) in his 'Taxonomy of Educational Objectives' organised the objectives in such a way that each category is built upon and depends upon its predecessor.

The objectives of instruction should be stated concisely, each objective should be :-

... described in operational terms

... observable

... verifiable

... assessable by a pencil and paper test or by some other means

Others building on his work have tried to simplify the classification and in an international evaluation of achievement study the five categories of objectives adopted were (International Study of Achievement in Mathematics (1967), edited by Torsten - Vol. 1, Chapter 4) :-

Level 1: A. Knowledge and Information: recall of definitions, notations, concepts.

Level 2: B. Techniques and Skills: computation, manipulation of symbols.

Level 3: C. Comprehension: capacity to understand problems, to translate symbolic forms, to follow and extend reasoning.

Level 4: D. Application of appropriate concepts to unfamiliar mathematical situations.

Level 5: E. Inventiveness: reasoning creatively in mathematics.

Schools emphasise testing situations in the cognitive domain, in fact the means of assessing these are usually limited exclusively to paper-and-pencil quizzes, tests or examinations. Several other ways can be used to obtain evidence of achievement of this kind of objective, two of which are oral or written reports on research or projects which can be assessed for evidence of learning. The focus in what follows will however be on making the best use of the pencil-and-paper approach.

Whatever the kind of test used, the pupils must have a set of clear directions so that their answers reflect an understanding of the content being tested rather than on their skill in guessing the nature of the task. In any test a major advantage of short response items is the ease and speed of scoring and therefore the different kinds of questions of this kind will be discussed first.

True-False Questions. The only advantage of this type of question is that it can be scored quickly. As there are only two alternatives, guessing often plays an important part. The test items test only recall of specific facts and/or contain

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key words which give pupils a clue toward the correct responses. Pupils soon learn that words such as 'may', 'generally', 'probably' relate to true statements whilst 'never', 'none', 'always' indicate false statements about mathematics.

Modified True-False Questions. Here a pupil must do more than just circle T or F, but good items in this category are not easy to construct and pupils show a lack of experience with this type of item. Points to bear in mind would be to :-

... use the same number of true as false statements;

... make all statements approximately the same length;

... avoid negative statements;

... avoid the use of specific determiners.

Fill-in-the-Blank Questions. These virtually allow pupils a carte blanche of filling in what they please. It also is difficult to write items of this kind beyond level 2 of the cognitive taxonomy. Another serious limitation is the difficulty in writing unambiguous items. This method is not recommended.

Multiple Choice Questions. This kind of question finds greatest favour when constructing objective tests and multiple choice questions are usually always preferred to the types of questions mentioned previously.

Well-structured multiple choice questions can effectively assess many of the lower level outcomes often measured by other short response items. Additionally this item-type can also measure a variety of objectives at level 3 and above of the cognitive domain. Obvious advantages inherent in the use of multiple choice questions include the sampling of many objectives in a short time, speed and ease of scoring, considerable reduction of the guessing factor. Also the fact that a pupil has been attracted to a particular distractor has a diagnostic value.

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Because items in multiple choice questions can be pre-tested fairly easily, the correlation between each individual item and the total results can be computed, and thus the validity and the reliability of the test can, to a certain extent, be controlled. This control and, if necessary, improvement of validity and reliability would go a long way to improving any prediction based on marks.

Multiple choice tests are still viewed with suspicion by many teachers, mainly for two reasons :-

(1) firstly, such questions cannot test certain things, such as the power to reason logically, neatness, drawing ability, and so on;

(ii) secondly, they encourage guessing. This is particularly true of true/false questions where there is a fifty-fifty chance of getting the answer right. True/false questions are however usually avoided, and when there are three or four distractors in each question, guessing can be discouraged by penalising wrong answers (e.g. in a test with five choices for each item, each correct answer is worth 1 mark, each incorrect answer is worth - 1/2 and a candidate scores 0 if the question is omitted).

Although multiple choice items cannot test all skills, various authors have shown considerable ingenuity in devising questions which test a wide range of mathematical skills.

It is therefore strongly recommended that a Standard 7 teacher draw up his own 'bank' of mathematical questions, which he can pre-test to improve validity and reliability, e.g. if the correlation between an item and the total is sufficiently high - this usually means $r \geqslant 0,3$ - the item is assumed to be reasonably valid and retained; if $r < 0,3$, it is discarded.

These multiple choice questions could then be included in the year-end examination and thus improve its reliability and validity.

Matching Questions. Apart from quick and easy scoring, there are not really any other advantages of this type of question. If, however, it is used, the columns should be of unequal length, the shorter column consisting of five to seven items and the longer one a maximum of ten alternatives.

Long Response (Essay) Questions. Essay type questions are needed to test important objectives that are difficult or impossible to assess by means of short-response items. They also give feedback on the pupils' ability to function at the highest level of the cognitive domain. This method is not really applicable to testing school mathematics.

Assessment of Affective Objectives. Affective objectives are not nearly so easily evaluated, and therefore teachers usually avoid assessing these objectives. How does one measure such qualities as: complying, choosing to participate, exhibiting stable and consistent attitudes? The two most useful types of assessment have proved to be :-

1. Self-evaluation forms where the pupils reflect their belief, attitudes and opinions towards mathematics;

2. Observation instruments.

It is considered useful to sample aspects of the same aspect by means of several items on an inventory. All pupils have to do is circle the numeral representing the extent to which one of two polar words represents their attitude. The following illustrates an attitude test towards mathematics (Systematic Instruction in Mathematics for the Middle and High School Years, Farrell & Farmer, p. 230) :-

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'I THINK MATHEMATICS IS ....

Simple	1 2 3 4 5	Complex
Easy to learn	1 2 3 4 5	Difficult to learn
Boring	1 2 3 4 5	Interesting
Impractical	1 2 3 4 5	Practical
For everyone	1 2 3 4 5	For scholars only
About real things	1 2 3 4 5	About theories
Valuable to society	1 2 3 4 5	Worthless to society
Worthless to me	1 2 3 4 5	Valuable to me
Related to biology	1 2 3 4 5	Unrelated to biology
Related to physics	1 2 3 4 5	Unrelated to physics
Unrelated to art	1 2 3 4 5	Related to art'

The results can assist the teacher, although research has indicated that attitudes are not easily changed.

Another type of pupil self-evaluation of attitudes involves writing open-ended essays such as 'What Mathematics Means to Me". Essay statements can be used in structured small-group discussions or expanded on by the teacher. A teacher who has specified objectives dealing with attitudes on the structure of mathematics can use phrases from those objectives as topics, topic sentences or questions. The essay used this way becomes a powerful technique for getting feedback and for using that feedback in subsequent instruction. This is a good example in which the cognitive domain is closely meshed with the affective domain.

The second kind of assessment is observation. Systematic observation shares with essay technique the ability to focus on higher-level affective objectives. Observation also has the advantage because actual behaviour rather than perceptions of likely behaviour can be identified and recorded.

Systematic observation is the only valid way of assessing psychomotor objectives - the teacher has to observe the pupil performing the motor skill. The teacher would have to set up a practical test in such a way that he could observe and record behaviour.

Later writers such as Avital and Shuttleworth have adapted Bloom's ideas to more specialised areas. In their classification of objectives for mathematics teaching they identify three distinct levels of mathematical thinking.

The first and 'lowest' of these is recall (recognition) of material exactly as it was taught, e.g. a pupil is required to recall the formula for the area of a circle.

The second level is algorithmic thinking which includes the beginnings of generalization. Here a pupil is expected to apply well-defined and familiar procedures, but not precisely, to a situation that he has previously met.

The third level is open search; here ideas and methods are rearranged to produce new results or solve new problems. The essential point here is that the learner is producing something which he has not seen before and is not merely reproducing other people's ideas.

The first level, recall and recognition, corresponds to Bloom's first category 'knowledge'. The second level, algorithmic thinking covers the categories 'comprehension' and 'application'. The third level, open search, covers the fourth and fifth categories 'analysis' and 'synthesis'.

These classifications are illustrated by Wain (1978) as follows :-

'A. Knowledge: to simplify a number phrase which involves operations of addition, subtraction, multiplication and division, none in parentheses :-

(i) First add and subtract in the order in which each operation occurs and then multiply and divide.

(ii) First add, then multiply, then subtract, and then divide in the order in which each operation occurs.

(iii) First multiply and divide in the order in which each occurs and then add and subtract in the same order.

(iv) Perform all operations in the order of occurence from left to right.

(v) Choose whatever order you like to carry out the operations and you will always obtain the same answer.

B. Comprehension: which one of the following is a correct simplification of the expression $8 + 2 \times 3 - 8 \div 2$?

(i) 11

(ii) 10

(iii) 3

(iv) $- 3$

(v) 26

C. Application: the polynomial $p^2 - p - 6$ can be factored into $(p - 3)(p + 2)$. If natural numbers are substituted in place of p, which one of the following statements is true about the set of numbers obtained?

(i) Some numbers will be odd.

(ii) The number zero does not appear.

(iii) None of the numbers will be prime.

(iv) All of the numbers will be less than 100.

(v) None of the above statements is correct.

D. Analysis: Five points are drawn in the plane so that no three of them are on the same straight line. In how many ways can we join these points by straight lines such that each point is connected with exactly three other points?

(i) 0

(ii) 1

(iii) 3

(iv) 5

(v) More than 5

E. <u>Synthesis</u>: investigation of the following table of squares reveals an interesting pattern :-

n	1	9	2	8	3	7	4	6	5
n^2	1	81	4	64	9	49	16	36	25

This pattern can be explained by the fact that for any natural number n :-

(i) $(n - 1)^2 = n^2 - 2n + 1$

(ii) $n^2 - 1 = (n - 1)(n + 1)$

(iii) $100 - n^2 = (10 - n)(10 + n)$

(iv) $(10 - n)^2 - n^2$ is divisible by 10

(v) None of the above can serve as an explanation

As will be clear from a consideration of these examples the position of a question among these categories will, to some extent, depend on the students to whom they are directed. Thus, the first question is based on the assumption that the conventional order of operations in a computation has been explicitly taught; conversely, the last question assumes that the particular situation being looked at is new to the student and not a piece of book work! Even allowing for this, one may feel that there is some doubt about the exact categorization of these (or other) questions. Clearly there is a subjective judgment involved here, but in practice a large measure of agreement is usually found to occur'.

This kind of analysis of objectives makes the construction of tests a far less haphazard process; where previously tests were scrutinised only to see whether they covered the syllabus, these questions have been set to test the required levels of ability so that in each topic there are questions testing all five of Bloom's categories.

Therefore, because examinations play such an important role in the assessment of a pupil on which the prediction is going to be based, teachers should be encouraged to evaluate the kind of examination they set very carefully, particularly if it is a year-end examination. Questions should not be hastily compiled, but rather should carefully be thought out so that each of Bloom's five categories are, to some extent, tested.

With a profile based not only on achievement but on qualities such as skills, originality, perseverance and self-understanding a teacher or counsellor would be in a far stronger position to advise and predict what a Standard 7 pupil would be likely to achieve in the examination three years later.

3. RECOMMENDATION TO THOSE COUNSELLING MATHEMATICS PUPILS AT THE END OF STANDARD 7

Having discussed predictions and assessment in some detail, the following may be used as a broad guide for those counselling mathematics pupils at the end of Standard 7. In a number of cases, particularly where the pupil is achieving well, this may not be necessary, but where there is doubt whether or not the pupil should continue with mathematics the following recommendations may be of use to the counsellor :-

1. A mathematics profile be drawn up for each pupil. A form similar to the one in appendix 3 is probably the most appropriate and convenient for counselling. The weighted areas, all of which should receive a C or above, should be knowledge, understanding and perseverance.

2. The pupil's year-end mark is the next, and also the most important indicator. Any mark over 60% would indicate that the pupil will be able to cope with mathematics whatever the grade.

A mark between 50% and 60% would seem to indicate that the pupil should consider taking mathematics on the Standard rather than the Higher Grade. For those in this category who wish to take Higher Grade mathematics a careful study should be made of the geometry mark as well as the profile and a decision made on the strength of these results. (See Page 4).

3. Any pupil obtaining below 50% should be counselled very carefully. Reference to frequency tables, total I.Q. scores and non-verbal I.Q. scores should also be considered before counselling.

The check-list may be tabulated as follows (the reader is again reminded that this is only a guide) :-

	Mathematics HG	Mathematics SG
1. Profile: Components - knowledge, understanding, perseverance important (See Appendix 3)	A minimum of a 'B' in each of these categories	A minimum of a 'C' in each of these categories
2. Std. 7 year-end mark :		
60% +	Yes	Yes, but should try HG
50% - 60%	Yes, with reservations	Yes
40% - 50%	Only in exceptional circumstances	Yes, but only after very careful screening
33 1/3% - 40%	No	Only in exceptional circumstances
Below 33 1/3%	No	No, although each case must be studied carefully before rejection

In no instance can one afford to be dogmatic, it must always be remembered that every pupil is an individual and where there is the slightest doubt each case should be evaluated individually rather than falling back on broad generalizations.

Finally, as mathematics occupies a key position in the curriculum, pupils who have the ability should be encouraged to include it in their choice of subjects. The headmaster, teacher-psychologist and the mathematics teacher should, in consultation with the pupil and parent, make every effort to ensure that those pupils who are capable of continuing with mathematics after Standard 7 in fact do so.

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APPENDIX 1

SYMBOL-PERCENTAGE CONVERSION TABLE

Symbol	Percentage	Mean used for calculation purposes
A	80 +	90
B	70 - 79	75
C	60 - 69	65
D	50 - 59	55
E	40 - 49	45
F	33 1/3 - 39	37 1/2
FF	30 - 33 1/3	32
G	25 - 29	27 1/2
GG	20 - 24	22 1/2
H	Below 20	15

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APPENDIX 2

THE ASSESSMENT OF MATHEMATICAL ABILITIES

Osborn (1983) defines the four components as follows :-

Computational Operations (C)

The ability to manipulate numerical quantities and to perform numerical operations, e.g. addition, subtraction, multiplication, division, etc. rapidly and with accuracy.

Pattern Recognition (P)

The ability to discern pattern and order in geometrical shapes and in algebraic configurations. It is recognised there is a distinction between the visual discernment of, e.g. the number of rectangles in a many-paned window, and the almost entirely mental perception of pattern and order in, e.g. a numerical or algebraic series.

Logical Reasoning (L)

The ability to recognise that certain conditions lead to universally accepted conclusions, e.g. Aristotelian syllogism (i.e. if $A = B$ and $B = C$, then $A = C$) or 'if A, then B', and the ability to build further logical structures on accepted premises.

Symbolic Manipulation (S)

The ability to handle quantities expressed in symbolic form and to manipulate symbolic entities irrespective of the substance, if any, of symbolic representation.

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APPENDIX 3

PROFILE FORM

The form would be set out as produced below (Mathematics in Secondary Schools, P.G. Scopes, p.153) :-

> 'These assessments are based on the teachers' observations over a period of the pupil's work, attitude and ability in class. They give a more complete profile than is obtained from the usual assessment based on performance in terminal examinations, though they may be supplemented by various tests. It is intended that they should be used to find and develop a pupil's strengths rather than to emphasise weaknesses. The five-point scale is applied to the whole of a year group in which there will be approximately 5% in the A (excellent), 20% in the B (good), 50% in the C (average), 20% in the D (below average) and 5% in the E category. The abilities assessed are as follows :-
>
> 1. Knowledge
>
> The ability to memorise the facts connected with the subject, topic or activity.
>
> 2. Understanding
>
> Ability to apply the facts learnt. Powers of deduction. Ability to recognise problems and choose appropriate means to solve them.
>
> 3. Skills
>
> Acquisition of skills applicable to the particular activity or subject, e.g. ability to write grammatically or spell correctly, to calculate, use tools correctly, the techniques of painting or drawing as opposed to the creative or imaginative side.
>
> 4. Originality
>
> Powers of creativity and original thought. Initiative.

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5. Neatness

How the work is presented. Layout, order, arrangement, etc.

6. Oral

Ability to take part in discussion and express a point of view.

7. Co-operation

Ability to accept others, to pool knowledge and work co-operatively in groups. (This also includes attitude to authority and readiness to obey or take command if required.

8. Perseverance

Conscientiousness. Progress over a period. Persistence, etc.

9. Self-Understanding

Realistic self-understanding and self-acceptance. Self-disciplining when required by needs of others or an activity. Self-forgetting, curiosity and enjoyment.'

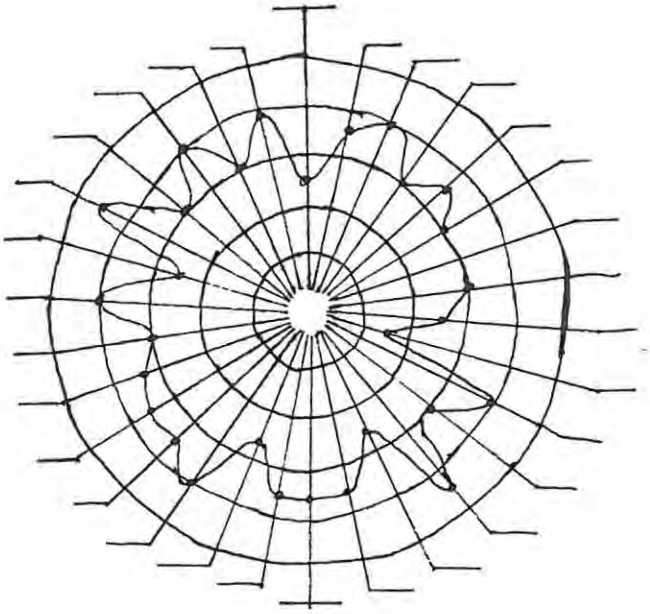
PROFILE FORM

Subject					
	A	B	C	D	E
Knowledge					
Understanding					
Skills					
Originality					
Neatness					
Oral					
Co-operation					
Perseverance					
Self-understanding					

APPENDIX 4

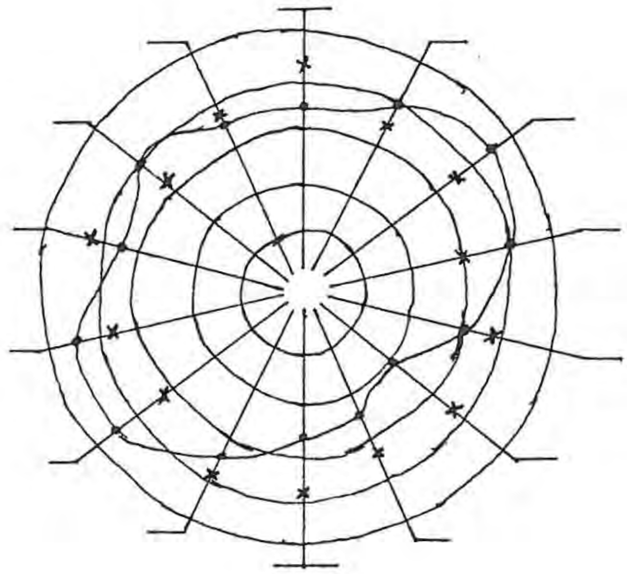
PUPIL ASSESSMENT PROFILES

Fig. 1: Group Assessment Profile



Centre 0%
Outer Circle 100%

Fig. 2: Pupil Assessment Profile



Centre 0%
Outer Circle 100%
x Group Average

Overson (1980) gives profiles in the form of Polargrams :-

> 'The assessment of children, particularly in the comprehensive school, should be a continuous process; monitoring their progress under normal working conditions as well as by formal examination. The results of a continuous assessment programme should be presented in a form suitable for immediate interpretation and be readily accessible. Two pieces of information are usually required: a) how the pupil performs within his group, and b) the position and performance of the group with respect to other

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groups in the same year following the same course. By the use of simple Polargrams, all the information relating to a) and b) above can be displayed for immediate analysis without reference to rows and columns of figures. Using the Polargram it is possible to produce group assessment profiles (GAP's) (see fig. 1) and pupil assessment profiles (PAP's) (fig. 2) which are independent of methods of grouping such as sets or mixed ability.

Mode A

The procedure for mode A operation is as follows: after marking each test, the teacher is able to construct a group profile (fig. 1). At the same time he inserts the individual pupils' marks in the relevant space on their PAP sheets - a little more time consuming than the marking columns but well worth the effort. Figure 2 shows a completed PAP. The average mark shown here is the group average so that the pupil's mark can be seen in some perspective. The average mark for the whole year group may be used if desired. An important feature of the PAP is that general trends in performance can be identified at an early stage and remedial action taken if necessary. It can be seen from fig. 2 that this pupil made a good start to the course; for some reason flagged behind in the spring term, then made a revival towards the end of the year. Some questions may be asked about the spring term work. Is there something common to all topics on this part of the syllabus which the child could not grasp? Did his performance fall short in other subjects during this period? (If other departments used PAP's, this information would be readily available, particularly if stored on magnetic tape rather than in departmental files!)

PAP's showing both coursework and examination performance (which do not necessarily correlate) may be used as a guide in setting groups and as a basis for discussion if set adjustments have to be made.

As the child moves through the school the previous year's PAP would join the current file; in this way the child's academic history would be available to new teachers and an accurate assessment of a child's progress could be made from year to year by observing any expansion or contraction of the profile. Such information, most valuable in mixed ability groupings, is often lost in discarded mark books. The problems associated with the transfer of a pupil to a new school might be relieved if a 'case history' of the pupil were available in PAP form. I would further suggest that a newly appointed teacher (or student teacher) would benefit greatly from a complete set of PAP's of his/her tutor group and subject groups.

Group assessment profiles are a valuable aid to curriculum management in that :-

i) they give a perspective view of all teaching groups;

ii) the spread of ability within each group is immediately apparent;

iii) the effects of curriculum modifications can be monitored;

iv) the effects of any change of method of teaching can be monitored;

v) they can be used for diagnostic purposes.'

APPENDIX 5

INTERPRETATION OF A CORRELATION COEFFICIENT

Rochford (1983) makes the following comments with regard to the interpretation of a correlation coefficient :-

'1. Assuming that a very low correlation coefficient is not statistically significant, e.g. r = 0,06.

In fact, if a correlation of 0,06 is obtained between two variables with a population of 1 000 or more, this is, indeed, statistically significant at the 5% level, i.e. a correlation as good as this could be obtained by chance only once in 20 times, if the expected correlation were zero.

The following table gives the minimum values for r required for statistical significance at the 5% level of probability for different sized groups :

N	Minimum value for r for statistical significance
5	0,88
10	0,63
25	0,40
100	0,20
1 000	0,06

2. Assuming that a statistically significant correlation is also educationally significant.

This is not necessarily so. For example, if, for an adult population of 1 000 people, the correlation between IQ and height were found to be 0,06, this would be statistically significant, but height would hardly be used as a basis on which to stream the 1 000 adults into graded classes for learning! A statistically significant result is not necessarily the best one to use for practical decision-making in education.

3. Assuming that the correlation coefficient you obtain (or which you read about in a research report) can be taken at face value, e.g. how stable is a reported correlation coefficient of r = 0,60?

   If r = 0,60 is found for only 10 cases the, if the experient were repeated with the same 10 cases, but at a slightly different time, the new value for r could well be as low as 0,41 or as high as 0,74! In fact, 19 times out of 20 it could be as low as -0,05 or as high as 0,89 (!) i.e. negative or excellent! Merely reporting "r = 0,60" without indicating the stability of this figure can be misleading and dishonest.

4. Assuming that the data used for calculating the product moment correlation coefficient was normally distributed and arranged on at least an equal interval scale.

   This might have been arranged in the planning stage of the research before the actual coefficient calculation was made. In practice, however, this rarely happens amongst research workers.

5. Failing to realize that a correlation coefficient of say, r = 0,60 can be either high or low, depending on the circumstances under which it was calculated.

   (a) r = 0,60 is high if it is the correlation between the IQ test results of pupils obtained in January correlated with the pupils' school marks in November.

   r = 0,60 is low if it is the correlation between two forms of an IQ test issued to a given class of pupils on the same day.

   (b) r = 0,65 obtained with a narrow range of talent in a class is fully as good as r = 0,90 obtained with a group with twice the spread of scores of the first class! A correlation coefficient can be artifically boosted by deliberately including extreme cases in the spread of talent in a group. Some unscrupulous "researchers" have been known to do this.

6. <u>Assuming that a coefficient obtained with one population group will remain the same with other groups.</u>

   Such an assumption is rarely justified, particularly in a country such as South Africa with its diversity of cultures, religions, economic levels, etc.

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