For
Deanne
Cathy
and
Nicky

thanks for the patience.

# AN INVESTIGATION INTO METHODS OF PREDICTING UNDERACHIEVEMENT OF ABOVE AVERAGE I.Q. PUPILS AT A BOYS' SCHOOL.

by

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## CHAPTER HEADINGS

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# CHAPTER 1.

## STATING OF PROBLEM, AIM AND METHOD OF RESEARCH, AND PROGRAMME TO BE FOLLOWED

### 1.1 INTRODUCTION

A justifiable preoccupation amongst many South African educators, politicians and researchers is the concern over the loss of manpower caused by people who apparently do not realise their full academic potential. This loss is felt at all three stages of formal education and much work has already been done analysing the factors associated with underperformance.

In South Africa, Project Talent survey of 1965 and subsequent years provided much material for educational research, much of which involved the predictability of scholastic success and the loss of manpower due to underachievement. Roos (1970) analysed the background profile of the intellectually superior pupil at standard six level. Schaffer (1972) established the influence of social status on the education of a group of Afrikaans-speaking high school boys. Lätti (1972) investigated the prediction of scholastic success with the aid of biographical data, while Ackermann (1973) did similar work on predicting success in matric with the aid of I.Q. and biographical data. Education for, and the academic achievement of, mentally highly gifted pupils was researched by Engelbrecht (1974 and 1976) and

Gouws (1977). Laubscher (1976) listed the factors associated with underachievement during the secondary school phase.
Le Roux (1977) analysed the factors associated with differential prediction of academic success, while Verhage (1977) examined the relationship between certain non-intellectual personality qualities and scholastic achievement. Schoeman (1978) investigated means of improving the prediction of scholastic achievement by developing and testing an amended prediction model.

Despite such valuable and informative research, we still find so many cases of underperformance, accompanied by the consequent loss of manpower and unfulfilled lives, in our educational system. It seems that educators need to address themselves to the problem of predicting potential underperformance in candidates and helping the candidates to eradicate the causes of underperformance in their lives, so that they can make useful and self-fulfilling contributions to society.

For obvious reasons researchers to date have tended to use a wide range of tests available to determining the factors related to underachieving. Such tests are usually not available to the average teacher in the classroom and underachievers are then discovered too late for satisfactory remedial action to be taken.

In addition, much research completed already is not relevant to the teacher in the classroom. Laubscher (1976, p. 63) concluded that notwithstanding the statistically significant differences which were found in respect of personality, anxiety, aptitude and interest, these differences are too small to be of any practical importance in dealing with the individual underachiever.

1.2 Aim of Investigation

1.2.1 The major purpose of this investigation is to find a tool from data readily available to senior school teachers, which they can use to predict underachievement amongst average and above average pupils at a semi-rural English speaking boys' school.

If any significant factors are found, it is expected that they will be of use only in the same homogeneous environment, i.e. -

(a) English speaking boys, of
(b) average and above average intelligence, who are
(c) attending senior school in a semi-rural town,

in the Republic of South Africa.

1.2.2 A secondary aim of the investigation is to examine the value of using an estimated I.Q., based on

Junior Aptitude scores, for predicting underachievement.

1.2.3 A third aim of the investigation is to establish and analyse three dimensional patterns derived from projecting the six aptitude groupings of the Junior Aptitude scores on the interaction between the pupils' verbal I.Q. scores and standard seven results, and relate these to underachievement.

1.2.4 A fourth aim is to see if pupils who join the school after standard seven are more likely to underachieve than those who have an uninterrupted stay at the school.

1.3 Method of Research

In this investigation the standard seven and standard ten examination results of three consecutive groups of matriculants at the school will be used, as well as the Junior Aptitude Test,[1.)] the Junior Scholastic Proficiency Battery[2.)] and New South African Group Test I.Q. scores, where available.

1.3.1 For the major aim the following models will be used to identify underachievers -

(a) the linear regression model, using verbal I.Q. as predictor and the standard seven and standard ten results as performance;

(b) the stanine model, using the verbal I.Q., the standard seven results' stanines and the standard

1.) Hereafter referred to as the J.A.T.

2.) Hereafter referred to as the J.S.P.B.

ten result stanines in various combinations as predictors and performance;

(c) the performance index model, based on the difference between the standardised standard ten results and the verbal I.Q. scores;

(d) the stepwise regression model, which predicts the standard ten result from data of the standard seven results, the J.A.T. and J.S.P.B. already written.

1.3.2 For the second aim the J.A.T. results will be used and an estimated I.Q. (E.I.Q.) calculated according to a standardised formula. The value of the E.I.Q. will then be established by means of a cross-correlation matrix, and by using the E.I.Q. in some of the projections, to test for underachievement.

1.3.3 For the third aim a three dimensional picture will be obtained by using the stanine standard seven results and verbal I.Q. scores on an x, y axis grid. The mean of the six aptitude groupings of the candidates in each rectangle of the x, y axis will be used to supply the Z axis dimension, given as a stanine average.

1.3.4 For the fourth aim a chi-squared test will be done on the standard 10 results of those who joined the school after standard seven as compared to those who stayed at the school from standard six to standard ten.

## 1.4 Method of Calculation

All statistical calculations will be performed by an I.B.M. 4341 computer using programmes written in S.A.S. (Statistical Analysis System).

## 1.5 Programme to be followed

Before the calculations are done, however, we shall first review the phenomenon in a broad historical perspective, in an atmosphere of more detailed definition. After that follows a description of the statistics and the methods used to arrive at the results. The results are then analysed and finally recommendations made for future research. A review of literature follows in the next chapter.

# CHAPTER 2.

# UNDERACHIEVEMENT, INTELLIGENCE AND THE PREDICTABILITY OF ACADEMIC SUCCESS

## 2.1 INTRODUCTION

In this survey of literature, we shall concentrate on three areas : The concept of underachievement, the predictability of scholastic success and the value of I.Q. testing. Because we are evaluating methods of predicting underachievement, we need to understand the concept of underachievement as used by researchers. Underachievement is closely related to the ability of researchers to predict academic success, so we need to understand the mechanisms of prediction, and both of those, in turn, hinge on I.Q. testing and its value. The literature available in all three areas is voluminous, and it is not our purpose to give a total picture but to sketch only the main ideas that have lead to the present climate of thinking.

## 2.2 Underachievement

A loose definition of underachievement is the failure of a pupil to perform scholastically at the level expected of him. This implies criteria for measuring scholastic performance and expectations, both of which fluctuate according to the design and purposes of scholar and layman. Certainly in the average White South African community the criteria of expectation is usually supplied by the parent, often to the anguish of pupil and teacher.

### 2.2.1 Underachievement - The concept

The concept of underachievement was articulated relatively recently in educational literature. Van Aarde (1967, p. 2) suggests that very little research was done before 1950 and that the pace accelerated dramatically after 1960. Wellington and Wellington (1965, p. 2) point out that, in grandfather's time, underachievers were simply allowed to drift out of school and take a job and nobody bothered about it much. However, the standardisation of intelligence tests after the pioneering work by Galton, Binet, Spearman and others, and the close association between intelligence test results and academic performance, led educators to investigate means of predicting academic success. Soon the disparity between expected and actual performance on the part of many pupils gave rise to the concept of underachievement.

In more recent times the accelerating rate of technological knowledge has placed a severe strain on the manpower resources of industrialised countries and has caused educators to be concerned about the potential loss of such manpower, especially from the ranks of the more intelligent who did not achieve as was expected from them. Thus Frankel (1960, p. 172) points out that young people whose scholastic performance lags far behind their intellectual ability represent a serious loss to society in terms of their potential contributions. In similar vein Laubscher (1976, p. 1) points out that when an underachiever fails (i.e. somebody who should not have failed), his failure costs money, a total loss of R2 716 per annum per person, calculated according to 1971 monetary values.

Engelbrecht (1975 , p. 147) expresses concern over the statistic that 36,7% of the successful standard ten boys of 1969 did not study further even though their I.Q. scores led to the assumption that all of them were intellectually capable of successfully completing a degree or diploma course.

What Roberts (1962, p. 183) said more than twenty years ago is still true, namely, that what the world needs is the contribution of every gifted child, not only in the realm of scientific and mathematical research, but far more in the realm of statesmanship.

However, not all researchers are happy with the use of the concept. One group questions the definition and application of the concept, and another questions the tools used to predict the phenomenon.

Coleman (1960)[1.)] has pointed out that scholastic achievement rates low on the priority scale of the adolescent. The adolescent subculture provides greater rewards elsewhere in, for example, physical attractiveness. Similarly Kowitz (1965)[2.)] argues that too much emphasis is placed on underachievement since the non-scholastic goals of the "underachiever" are usually ignored when such value judgments are made. On the campus involved

1.) See page 62

2.) See page 123

in our study, success at sport may, for example, be a powerful non-scholastic goal affecting pupils' performances.

Thorndike (1963)[1.)] argues that, in the past, intelligence scores were over-valued as predictors of performance and that many other factors, especially non-cognitive ones, are involved. Kornrich[2.)] (1965, p.78 ) quotes Carlson and Gulliver who claim that the use of the term "underachievement" merely exposes an inability of educators to predict achievement accurately.

Schwitzgebel (1965, p.84 ) challenges the concept of underachievement as a great American myth, even though the word refers to an empirically demonstrable problem. Because human behaviour is a result of complex interactions, our predictions at times may be quite inaccurate. This leads us to the logically impossible situation where we speak of "overachievement"; clearly nobody can achievebetterthan he is able. He suggests we should rather refer to "over predicted" than "underachieving" students.

Researchers such as Fine (1975), Hein (1970) and Houts et al (1977), challenge the concept of intelligence measurability and would be very reluctant to come to any conclusion of underachieving based on such

1.) See page 11.

2.) Primary source not available in S.A.

intelligence testing. Even Jensen (1980, p. 318), who has argued very vigorously for the validity of intelligence testing, comments that the designations of underachievers are quite arbitrary and really mean little more than the fact that I.Q. and achievement are far from perfectly correlated even if one corrects for measurement error. Because intelligence is not the only determinant of achievement, it is inevitable that there should be less than a perfect correlation, and hence the existence of "underachievers" and "overachievers".

It should be noted that Jensen is joining other researchers in suggesting that the causes of underachieving are multi-factorial, and not just a single factor, such as intelligence. As we shall see, the concept of underachievement has acquired varying definitions depending on the approach of the researcher and the method used to identify underachievers.

### 2.2.2. Underachievement - Definitions used by Researchers

At first inspection, the definitions used by researchers to describe underachievement appear vague and arbitrary. Kornrich (1965) has listed a variety of definitions used by researchers, pointing out their arbitrary and imprecise nature. At one end of the scale is the humorous description by Russel (as quoted by Kornrich (1965, p. 461)) of the underachiever as one

> "who sits on his potential"

while Newman (Kornrich 1965, p.462) is happy that the student's

> "own sense of underachievement"

is a valid criterion of the phenomenon.

Wellington and Wellington (1965, p. 8) tell us that since there is little agreement on the exact definition of an underachiever, they use the term when referring to a youngster who shows good or high potential on several measures of ability while his performance is average or poor, the discrepancy between achievement and ability being great enough to be obvious to any investigator.

Similarly, Laubscher (1976, p. 2) defines underachievement broadly as the condition that arises when a pupil's achievement in a task or standard is less than expected of him in terms of his mental ability.

Sumner and Warburton (1972, p. 16) selected their least industrious group from 28 schools by asking the headmaster to place pupils in the category "least industrious" using a rough guide list of items such as

> "Fails to use undoubted ability,
> homework return low, reluctant to
> conform to school standards, ... etc."

It needs hardly to be pointed out that the phrases "undoubted ability" and "reluctant to conform" must have a wide range of interpretation when used by individual teachers during the assessment of pupils.

Hence we are looking at three possible variables as defined and used: The measure of potential performance, the measure of actual performance and the measure of the difference between the two. Of necessity the variables have to be reduced to statistical measures.

2.2.3 Underachievement - Statistical methods used to define

Farquhar and Payne (1964) analysed the statistical methods used to identify underachievers under four main headings (quoted by Laubscher 1976, p.3)[1.)] -

1. The central cut-off method.
   In this method the average of the group in both potential and performance is used as a cut-off line.

2. The arbitrary cut-off method.
   Here candidates are matched in pairs according to potential, and those belonging to the top 25% of the class in performance are compared to those belonging to the bottom 25%, or any other percentage limit the investigator chooses to use.

1.) Author not able to acquire original source in South Africa.

3. The relative difference cut-off method.
   The I.Q. scores and performance scores are converted to T- scores and candidates are arranged in numerical order for each. Achievers and underachievers are then identified according to the difference in ranking of their respective T- scores. Van Aarde (1967) uses a similar technique by converting the examination total score to a standard score ($\bar{X}$ = 100, S = 15), enabling him to make a direct comparison with I.Q. scores. Those whose achievement scale score was 25 points or more lower than their intelligence score were considered to be underachievers, whereas normal achievers were those whose performance and intelligence scores were within five points of each other. His method was adopted by Brooks (1978, pp. 19-22).

4. The regression model cut-off method.
   A linear regression is constructed in which performance is projected from intelligence test scores. Achievement is then measured by the difference between predicted and actual scores, and an arbitrary decision is made as to where the cut-off line is. Jensen (1980, p. 318) comments on the arbitrariness of the cut-off point by saying that the achievement

of one standard deviation below the predicted scores has traditionally been termed the under-achievement point.

Wellington and Wellington (1965, p. 10) point out that different underachievers will be found depending on the method used. They found that achievement tests and intelligence tests cover about the same ground, they differ only in purpose, but when comparing intelligence scores and grades, a long list of underachievers was selected.

Because so many permutations of predictors and differences between predicted and actual performance are possible to use to identify the underachiever, we have chosen four models to be used in this study.[1.)]

2.2.4 Underachievement - Factors associated with

2.2.4.1 Personality Traits

In an attempt to anticipate underachievers, many researchers have done factorial analyses of non-intellectual traits associated with underachievement. It is not always clear from the results whether under-achievement caused the personality characteristics or vice versa. An interaction between the two is to be expected. On the one hand Wellington and Wellington (1965, p. 21) claim that when it becomes

1.) See Chapter 3.

necessary to try to assess the personality characteristics of underachievers, many studies have found that little or no difference exists between under- and overachievers. Yet they also claim that other studies showed overachievers had more confidence, greater motivation to study, more positive self-image, whereas underachievers were waiting to be pushed, often disguising their anxiety behind an air of boredom or disinterest.

Laubscher (1976) used the High School Personality Questionnaire (H.S.P.Q.) on a sample of 1969 Afrikaans speaking standard ten pupils (N = 313) of above-average I.Q. (⩾112). When he compared the over- with underachiever boys he found a 1% significance in factors G and I (conscientiousness and sensitivity). Underachievers scored high on enthusiasm, low on the other two. The boys also showed a 1% significant score in the realm of weak ego on the IPAT[1.)] anxiety questionnaire. Sumner and Warburton (1972, p. 29) found similar associations in their study.

> "In terms of Cattell's second order personality factors, the allergic pupils are
>
> (i) less stable,
>
> (ii) less introvert,
>
> (iii) less sensitive, and
>
> (iv) adopt fewer moral attitudes than the industrious."

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1.) See van der Westhuizen (1979,p 124)for a description of the test

Harper (1978, p. 114) reinforces the research findings of others that underachievers have a significantly low conception of themselves, suggesting strongly that there is a positive correlational relationship between self concept and academic achievement.

After listing eight personality and closely allied factors, Laubscher (1976, p. 12) concludes in his literature survey that it appears that the underachiever is less mature than the achiever, and that emotional maturity is very important for scholastic success.

Roberts (1962, p. 182) tested a particular hypotheses using Gough's scale of Socialisation and concluded that the findings reported substantiated the hypotheses that underachievement is closely related to the child's feelings about himself and his environment.

Roux (1977) found only a few tendencies among the H.S.P.Q. factors, with factor B (intelligence) and factor S (sensitivity) showing any significant relationship with over- and underachievement. Nor was he able to find any significant difference in motivation using the Pauli[1.)] test.

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1.) A standardised test for analysing motivation amongst pupils.

2.2.4.2 Background and other factors

Other studies have shown the tendencies which any perceptive and experienced teacher would expect to be associated with the underachiever. Reviewed briefly, the underachiever appears to be relatively younger (Roberts 1962, Roos 1973, Brooks 1978), male rather than female ( Roos 1973, Brooks 1978), have a working mother (Frankel 1964, Roos 1973), come from a lower socio-economic bracket (Engelbrecht 1972, Sumner and Warburton 1972, Scheffer 1972, Ackermann 1973), is more likely to be English speaking if living in South Africa (Ackermann 1973), and spends less time on homework and has unsatisfactory work patterns (Roberts 1962, Laubscher 1976, Brooks 1978).

Van Aarde (1967) found most of the above factors associated with underachievers at primary school level, in addition to the inability of underachievers to cope with their own frustrations. Underachievers had parents who were less academically orientated, both in training and attitude, but he found no significant difference in working patterns of mothers, nor did underachievers show less emotional stability, maturity and self-control than did the normal achievers. These findings were similar to those of Roberts (1962) in addition to her discovery that underachievers had poor school adjustment and different vocational aspirations.

2.2.5 Types of Underachievement

Laubscher (1976, p. 5) classifies underachievement under three main headings -

(a) standard underachievement occurs when a pupil scores an aggregate mark below expectations, in all subjects done;

(b) subject underachiever refers to a pupil that scores below expectations in a particular subject, but not others;

(c) stereotype underachieving indicates a consistent tendency for a pupil to underachieve in either a subject or in aggregate over consecutive periods of time.

In this study we shall concentrate on standard underachievement and make brief reference to stereotype underachieving when an analysis is made of those in standard seven who also underachieve in standard ten.

## 2.3 INTELLIGENCE

2.3.1 Intelligence - Definition and background of testing

Despite the fact that Binet and Simon's pioneering intelligence tests appeared in 1904 and that an incredible amount of research and academic debate has followed all over the world ever since, there is still controversy surrounding the definition of intelligence and the validity of intelligence tests. Jensen (1980, pp. 27-39) lists the findings of various court cases in America in which education authorities were sued for discriminating against children by using intelligence test results to place them in specified educational institutions. Heim (1970), Fine (1975) and Evans and Waites (1981) are but a few who have joined the ranks of those damning the decision-making processes based on I.Q. scores. Evans and Waites (1981, p. 179 ff) join Sir Peter Medower in calling intelligence testing an "unnatural science" with none of the bases accredited to the sciences.

The above is mentioned to serve as a word of warning to those who may be tempted to come to unwarranted decisions based on I.Q. scores. It is not the purpose of this study to join the academic fray, since we are looking at the I.Q. score as a predictor of scholastic success. However, so much thinking about underperformance is based on the potential of the pupil, variously called "intelligence", "I.Q.", "undoubted ability", "brightness", etc., that we must at least refer to the concept intelligence and sketch the background to the N.S.A.G.T. (the New South African Group Test) which is used in this study.

Jensen (1980, pp. 169-171) lists the various definitions used by man through the ages, ranging from Plato to Thomas Aquinas, to Webster's Dictionary, to Wechsler (1975), who sums up -

> "What we measure with (intelligence) tests is not what tests measure - not information, not spatial perception, not reasoning ability. These are only a means to an end. What intelligence tests measure, what we hope they measure, is something much more important : the capacity of an individual to understand the world about him, and his resourcefulness to cope with its challenges."

Van der Walt (1979, p. 182) sums up the four main streams of definitions and concludes -

> "Intelligensie word dus as die[1.] vermoë wat die individu besit om enige taak (in sy breedste betekenis) wat aan hom gestel word, te kan bemeester. Hoe hoër die kwaliteit van hierdie vermoë, hoe makliker word die bemeesteringsproses."

Gouws (1977, pp. 5-8) quotes a variety of definitions which concentrate on intelligence as a process of actualisation, a force for penetrating the surrounding world and an ability to think and perceive relationships. He uses the warning by Haber (p. 7) that the point at issue is not only whether one has a high intelligence, but also whether one uses it and what it is used for, and concludes that we must determine whether the child actualises his intelligence adequately and whether in this way he develops in an accountable manner.

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1.) Van der Walt prefers using the word "verstandsvermöe" to the word "vermoë".

The latter quotations seem clear encouragement for those trying to find potential underperformance as soon as possible!

In view of the above definitions of intelligence we can with safety skirt round the hazardous debate as to whether or not intelligence tests actually measure what we have defined as intelligence. We shall assume that the N.S.A.G.T. does, by simply observing that it is difficult to see a pupil achieving a high intelligence test score without being intelligent. This study will not directly concern itself with the candidates who are intelligent, but who achieve low test I.Q. scores, i.e. who have low intelligence C, (test intelligence) according to Vernon.[1.)]

2.3.2 Intelligence - History and nature of the N.S.A.G.T.

Fourie (1980) traces the background to the New South African Group Test (N.S.A.G.T.) which is used widely in South African schools and which was used in this study.

Since 1920 experiments were conducted to standardise group intelligence tests, but the early pioneers, such as Proff. H A Reyburn and R W Wilcocks, did not standardise the tests used. In 1924 Prof. J C Coetzee translated the American National Intelligence Test, but could not use it to satisfactorily classify

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1.) See Jensen 1980, pp. 183 ff. Vernon added the further distinction of Intelligence C to the model of D O Hebb, and defined it as the sample of intelligent behaviour that we can observe and measure at a given point of time.

pupils. After more work by Prof. Wilcocks, the stage was set for the South African Society of Psychologists to apply pressure at government level to develop a new test. The N.S.A.G.T. was standardised from 1951 to 1956, with additions in 1963 and 1965, all work directed by the Human Sciences Research Council.

Van der Westhuizen (1979, p. 74) defines that the aim of the N.S.A.G.T. is to obtain an impression of a pupil's general intellectual ability in the most economical and objective manner.[1.)]

It consists of six subtests, of which three measure what is essentially verbal ability and the other non-verbal ability.

The non-verbal tests are the following -

Test 1: Number Lines
Test 3: Figure Analogies
Test 5: Pattern Completion.

The verbal subtests are the following -

Test 2: Classification of Pairs of Words
Test 4: Verbal Reasoning
Test 6: Analogies of Words.

The N.S.A.G.T. has proved itself a reliable measuring instrument. Van der Westhuizen (1979, p. 79) quotes

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1.) A better definition would be to refer to the test as a measurement of intelligencec(page 22), in an economical and objective manner.

reliability coefficients of 0,86; 0,87 and 0,83 obtained on the total score.

Of relevance to this study is the general caveat that 4,6 I.Q. points allowance must be made for the standard error of measurement and that researchers must beware of using test results obtained more than two years previously.

## 2.4 The Predictability of Academic success

In the United States of America and the United Kingdom the predictability of academic success based on types of intelligence tests has been a socially sensitive issue. In times past, such predictive techniques have been used to place pupils in particular schools according to expected academic performance, often to the distress of the families concerned. Recently American courts had to give judgment in civil cases where dissatisfied parents sued school authorities regarding placings based on I.Q. test results (see Jensen (1980) and Evans and Waites (1981)). Critics of intelligence testing have used the supreme court rulings as a vindication for their views, whereas Jensen and others have called the expert evidence to question. In this survey we confine ourselves to the intellective and non-intellective factors associated with academic success and some of the statistical implications of the methods used.

## 2.4.1 The Intellectual Predictors

### 2.4.1.1 Intelligence scores as a predictor

Psychometrists have been using I.Q. test scores as a scholastic success predictor for many years.

de Cecco (1968), Cattell and Butcher (1968) all found significantly high correlations between I.Q. scores and academic achievement. Their findings have been confirmed in South Africa by Ackermann (1973), Roos (1973), Lätti (1972), Laubscher (1976), Schoeman (1978) and Fourie (1980). All agree that, whereas the I.Q. score is the best single predictor of scholastic success, it accounts for, at the most, 50% of the variation, a figure that drops consistently as the pupils move into tertiary education. At university level the correlation is only 0,138 (Ackermann 1973, p. 4).

Lavin (1965, pp. 55, 56) quotes seven different American studies which found correlations between intelligence and grades at high school level of between 0,44 and 0,80. He suggests the variation is caused by the different measures used, global or specific ability predictors being used to predict global or multidimensional grades or performances. Of interest is that the American results show higher correlations than the South African, yet they follow the same trend of producing lower correlations at tertiary level, a correlation of 0,60 at high school as opposed to 0,50 at college level.

Significant too is that many researchers find that the verbal components of tests, or the verbal I.Q. scores, are the best predictors of scholastic success. Frankel (1960, p. 173) found that when the Differential Aptitude test was applied to under- and overachievers, the achievers showed definite superiority in Verbal Reasoning.

Laubscher (1976, p. 22), after reviewing similar studies, came to the conclusion that, of the three N.S.A.G.T. scores available, the verbal intelligence score is undoubtedly the best predictor of academic achievement since it has the highest correlation with test scores in Arithmetic and Languages as well as with certain other subjects.

Lätti (1972, pp. 91, 92) found highly significant differences[1.)] between the sets of correlations obtained from correlating verbal I.Q. and non-verbal I.Q. scores with standard ten examination totals and individual subject totals of Afrikaans speaking boys.[2.)]

This is confirmed by Fourie (1980) in various correlation matrices between I.Q. scores, proficiency and aptitude scores and academic results.

To explain the unsatisfactory predictive value of intelligence scores, Lavin (1965, p. 48) has noted

1.) $\rho < 0{,}01$.

2.) The subjects were Afrikaans, English, German, Mathematics, Biology, Physical Science and History.

the argument of Goslin that nineteen different factors (such as general intelligence, specific capacities, achievement motivation) are reflected in a person's test score, and concludes that whatever the relative importance of these factors in determining ability scores may be, success in school requires, in part, certain cognitive skills. Moreover, these skills are measured, to a significant degree, by intelligence tests. For this reason, these tests are moderately successful in predicting academic performance.

Similar in nature to intelligence tests are a variety of batteries of proficiency and aptitude tests, such as the Differential Aptitude test used by Frankel (1960, p. 172), to which psychometrists have turned to predict academic performance.

2.4.1.2 THE JUNIOR APTITUDE TEST (J.A.T.)

According to Fourie (1980) the National Bureau for Educational and Social Research completed the application of Junior Aptitude tests, consisting of twelve items, in 1959. The test was finalised in 1969 and revised in 1975. The latter revision was standardised to be used as a guidance tool for pupils in standards five, six and seven, because of the introduction of differentiated education.

Van der Westhuizen (1979, pp. 97-99) points out that the J.A.T. must be used as a guidance tool in conjunction with -

(i) I.Q. scores (non-verbal, verbal and total);

(ii) results of the junior scholastic Proficiency Battery;

(iii) results of the school examination, as reflected in the school report.

The test consists of a battery of ten items. On the strength of past research on the Senior Aptitude test, the items can be grouped together to indicate a number of wider aptitude fields, which can be interpreted more readily and meaningfully than the results of individual tests.

The following six aptitudes can be indicated in this way (van der Westhuizen, 1979, p. 98) -

(i) Verbal Aptitude

Test 2 - Reasoning

Test 4 - Synonyms

Test 8 - Memory (Paragraph).

(ii) Numerical Aptitude

Test 3 - Number Ability

Test 5 - Comparison.

(iii) Visual-Spatial Reasoning

Test 1 - Classification

Test 6 - Spatial 20

Test 7 - Spatial 30.

(iv) Clerical Aptitude

Test 5 - Comparison.

(v) Memory

Test 8 - Memory (Paragraph)

Test 9 - Memory (Word and Symbols).

(vi) Mechanical Aptitude

Test 10 - Mechanical Insight.

The test scores of the J.A.T. results are also used to deduce an estimated I.Q. Van der Westhuizen (1979, p. 99) gives the correlation between the estimated I.Q. and the N.S.A.G.T. total as 0,80, but he argues that, because the estimated I.Q. does not have exactly the same qualities as the N.S.A.G.T. I.Q., it must be interpreted with great caution and used only when the N.S.A.G.T. I.Q. is not available.

The following formula can then be used -

$$\text{Estimated I.Q.} = \frac{6\,T_2 + 3\,T_4 + 2\,T_7 + 681{,}6 - 24\,A}{5}$$ [1.)]

where

1.) Van der Westhuizen (1979, p. 99)

$T_2$ = the raw score for test 2 (Reasoning)

$T_4$ = the raw score for test 4 (Synonyms)

$T_7$ = the raw score for test 7 (Spatial 3D)

681,6 = a constant which is added

A = the testee's age in years to two decimals.

The formula is valid only for ages between 11 and 16 years.

Both the aptitude groupings and estimated I.Q. were used as investigative statistics.

2.4.1.3 THE JUNIOR SCHOLASTIC PROFICIENCY BATTERY (J.S.P.B.)

The J.S.P.B. was compiled as an aid in placing pupils in standards five to seven in different study fields and proficiency groups. The battery consists of six sections, each with its own set of assumptions to predict performance in school subjects.

Van der Westhuizen (1979, p. 150) gives the rationale as follows -

(i) First and second language

Language proficiency can be determined by measuring a pupil's vocabulary, spelling ability and his use of punctuation and grammar.

(ii) Mathematics

A pupil's ability to manipulate numbers and to solve mathematical problems is a valid criterion of his mathematical proficiency.

(iii) Natural sciences

A pupil's knowledge and understanding of natural phenomena and the laws of nature are valid criteria of his proficiency in the natural sciences.

(iv) Geography

Proficiency in the geography of Southern Africa can be determined by the measurement of a pupil's knowledge and understanding of the geography of the Republic of South Africa and its neighbouring states.

(v) History

The measurement of a pupil's knowledge and understanding of the development and composition of the society in South Africa will determine his proficiency in the history of the Republic of South Africa.

The reliability coefficients obtained for the various tests are consistently above 0,80.[1.)]

2.4.1.4 The J.A.T. and J.S.P.B. as Predictors of Scholastic success

There is not complete agreement about the difference between an aptitude test, a proficiency test and an achievement test. By definition, an achievement test

1.) Van der Westhuizen (1979, p. 151). We ignore the Second Language (English) statistic of 0,785 for obvious reasons in this study.

should measure what the pupil has mastered in the immediate past and be confined to syllabus content only. The proficiency test should measure all the skills acquired by the pupil in the past and should not refer to syllabus material. The aptitude test should measure the potential of a pupil which can only be realised with future training.

Van der Westhuizen (1979, p. 149) concludes that there will inevitably be some overlapping between the various types of tests because human personality cannot be classified into convenient, watertight components.

Whatever the theoretical difference between an aptitude test and a proficiency test, both types of test are attractive to psychometrists and they should complement I.Q. tests as predictors of performance. This is because researchers are convinced that intelligence is a multifactorial ability, some factors not necessarily measured in a particular I.Q. test. Van der Walt (1970, p. 182) suggests that educators and psychologists have come to the conclusion that the expressing of mental ability as a single figure such as an I.Q. score, does not give an adequate picture of a person's aptitude for different school subjects, vocation or study directions.

Then too, researchers such as Laubscher (1976, p. 49) agree that present academic performance is a very good indicator of future academic performance. Since both the J.A.T. and J.S.P.B. test batteries contain elements of present performance, they should have predictive value. Frankel (1960, p. 174), Lätti (1972, p. 187 ff) and Schoeman (1978, pp. 86, ff) are among those who found significant relationships between present and future academic performance. Fourie (1980) found that both the J.A.T. and J.S.P.B. contributed significantly to explain performance when he did a stepwise regression analysis on the results of pupils per subject at the standard six, seven and eight levels. So, for example, he found (p. 173) that, to predict the performance of Afrikaans, the best predictive contributions came from non-verbal I.Q., J.A.T. item 4, J.S.P.B. items 2 and 3. To predict English (p. 180), the best predictors were verbal I.Q., total I.Q. and J.S.P.B. items 2, 4 and 6.

When the predictor pattern is looked at in greater detail, the picture becomes more complicated (p. 194). If the predictors in mathematics for standards six to eight are listed in tabular form, the following picture emerges -

| Mathematics Result | Predictors |
| --- | --- |
| Std Six | J.S.P.B. 2, N.V.I.Q., J.S.P.B. 5 |
| Std Seven | J.S.P.B. 2, N.V.I.Q., V.I.Q., J.A.T. 10 |
| Std Eight | N.V.I.Q., J.A.T. 4., J.S.P.B. 3, J.A.T. 1, J.S.P.B. 2 and J.A.T. 10. |

Fourie's explanation (p. 194) seems reasonable, that, as the child progresses, different and more demanding skills are required and, as a result, different aptitudes and proficiences are brought into play. It would however be interesting to see if the same results are obtained using subsequent population groups from the Free State schools.

Schoeman (1978) used the N.S.A.G.T. and the J.A.T. results of Free State matriculants as independent variables to predict the 1969 Senior Certificate results, thus providing himself with 17 out of 36 intellectual variables used. Nine of the eleven J.A.T. variables showed a highly significant correlation with academic performance, with reasoning the highest (r = 0,498), accounting for only 24,8% of the variation. However, after using discriminant analysis to reduce the 60-dimensional test space to one-dimensional and two-dimensional test spaces, he found that the J.A.T. items did not feature as chief components in his amended prediction models. He found significant chief component prediction in present academic performance as given by standardised tests in the form of Algemene Toetse in Taal en Rekenkunde, Spellingstoetse, Algemene Wetenskapstoets, Geskiedenistoets and the Aardrykskundetoets.

From the above it would appear that we can expect most help from the proficiency battery of tests, because they are a measure of present academic attainment, some help from aptitude tests, but we do not expect the two batteries to explain a very high percentage of variation.

### 2.4.2 The non-intellectual predictors

To complete the background to underachievement and academic predictability, mention should be made of the non-intellectual predictors of academic success. Lavin (1965, p. 6) argues that, since intellectual factors contribute statistically unsatisfactorily to academic performance, researchers should pay more attention to non-intellectual factors.

Cattell (1968, pp. 162 ff), while pleading for a consideration of environmental factors to help scholastic prediction, warns against undue importance being placed on correlations between factors which may not be causally related. According to Schoeman (1978, p. 8), research on personality traits has found that less than 20% of the variation of school achievement is accounted for by personality traits. Similarly, he claims that less than 25% of variation in school performance is accounted for by adaptability factors. His own study (Schoeman 1978, pp. 60-62) found that only factor B (intelligence) of the H.S.P.Q. made any significant contribution to the picture from a personality point of view, and fields 2, 3, 4. 7 and 9[1.)] contributed from the results of the adaptability questionnaire.

It does not necessarily follow that if non-intellective factors are poor predictors of under-achievers, the same factors will be poor predictors of academic achievement, even though underachieving prediction is a type of academic achievement prediction. It is to be expected that intellectual factors will predict academic achievement satisfactorily, except that when underachievement occurs, non-intellective factors start playing a significant role.

This area was investigated by Ackermann (1973, p. 55) and he found that, whereas I.Q. as a single variable is a better predictor than biographical data, the two together predict more satisfactorily than I.Q. alone. In this way, about 30% of the variance of academic achievement is accounted for. Although a smaller proportion (70%) of academic achievement is thus not accounted for, the 70% nevertheless represents a considerable area which is as yet unexplained.

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1.) Field 2: Feeling of own worth; Field 3: Feeling of personal freedom; Field 4: Feeling of acceptance and recognition; Field 7: Moral insight; and Field 9: School relationships.

He found the main contributors in sequential order were number of times failed, study problems, socio-economic status, place of residence (house, flat or hostel), time spent on homework, school problems, size of class (the bigger the better!), number of extra-mural activities, parental interest, home language, sex, and place of study.

It must be noted though that Ackermann records the findings of other researchers who do not necessarily concur.

Similarly Laubscher (1976, p. 52 ff) found the following factors associated with underachievement amongst boys, and concluded they have a bearing on academic success: type of school attended, number of schools attended, time spent on homework, school problems, and extra-mural activity at school. Personality factors are recorded elsewhere.

Lätti (1972, p. 149) found that the judgment of the teacher regarding the pupil's potential related highly to the pupil's subsequent performance. In fact it was next in usefulness to the standard six mark as a predictor of standard ten success. It is not clear from the study to what extent there is an interaction between the teacher's attitude and subsequent performance.

To summarise: From the literature it appears that there are non-intellectual factors associated with academic success and which can help predict the latter. A few may even have a causal relationship, but it is more likely that other, non-cognitive factors give rise to both since all the non-intellective factors contribute very little statistically to the total academic achievement picture. Some of the non-cognitive factors may be the social values generated by the peer group, the academic aspirations and academic background of parents or the fact that the basic needs of the pupil (such as security, social, self-esteem, etc.) are not met.

In the next chapter an outline of the method of investigation is given.

# CHAPTER 3

## METHOD OF INVESTIGATION, THE EDUCATIONAL BACKGROUND OF SUBJECTS AND STATISTICS USED IN THE STUDY.

## 3.1 INTRODUCTION TO INVESTIGATION

The aims of this investigation have already been defined.[1.)] In this chapter we outline the composition of the experimental group and define the statistics used in the study.

## 3.2 METHOD OF INVESTIGATION

### 3.2.1 Background of Pupils

The pupils used were taken from standard ten during three consecutive years 1981 - 1983, at an English-speaking boys' high school in a South African semi-rural community. The average enrolment at the school of standards six to ten is 330, of which 140 are boarders drawn from all four provinces in the Republic of South Africa, and from South West Africa, Zimbabwe, Botswana and Zambia..

### 3.2.2 Homogeneity of Group

Because the pupils came from such a wide range of geographic, socia-economic and scholastic backgrounds precautions were taken to make the investigated group as homogeneous as possible. Only those groups of pupils who had completed standards seven to ten in consecutive years at the same school were used for the major analysis. A common phenomenon in schools is the changed composition of the pupils in a standard from one year to the next. Table 3.1 tells us what happened to the group of standard seven pupils before some of them became the nucleus of the standard ten class four years later.

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1.) See page 3 ff.

## TABLE 3.1

FLOW OF PUPILS IN TEST GROUPS

### Group 1

| | Std 7 1978 | Std 10 1981 | |
|---|---|---|---|
| Went to Std 10 without failing | 48 | 48 | Arrived from Std 7 |
| Transferred from school | 15 | 15 | Joined school from elsewhere after Std 7 |
| Dropped out from school | 12 | 1 | Joined class because of failing |
| Failed along the way | 6 | | |
| Repeated standard | 1 | | |
| Total | 82 | 64 | Total |

### Group 2

| | Std 7 1979 | Std 10 1982 | |
|---|---|---|---|
| Went to Std 10 without failing | 44 | 44 | Arrived from Std 7 |
| Transferred from school | 14 | 13 | Joined school from elsewhere after Std 7 |
| Dropped out from school | 8 | 5 | Joined class because of failing |
| Failed along the way | 3 | 2 | Joined class because of repeating |
| Repeated standard | 1 | | |
| Total | 70 | 64 | Total |

Group 3

| | Std 7 1980 | Std 10 1983 | |
|---|---|---|---|
| Went to Std 10 without failing | 42 | 42 | Arrived from Std 7 |
| Transferred from school | 14 | 3 | Joined school from elsewhere after Std 7 |
| Dropped out from school | 3 | 2 | Joined class because of failing |
| Failed along the way | 6 | 1 | Joined class because of repeating |
| Total | 65 | 48 | Total |

Key :

Transferred from school -

refers to pupils whose parents left town and took pupil to another high school.

Dropped out from school -

refers to pupils who did not reach standard ten because they left school to work or become apprenticed.

Failed along the way -

refers to pupils who reached standard ten after repeating a standard.

Repeated standard -

refers to pupils who voluntarily repeated a standard and are therefore not in experimental group.

Joined school from elsewhere -

refers to pupils who joined standard ten group after standard seven.

Joined class because of failing -
refers to pupils who joined standard ten group after failing a standard after standard seven.

Joined class because of repeating -
refers to pupils who joined standard ten group after voluntarily repeating a standard after standard seven.

A noticeable feature of the flow of pupils is that only 60% of the original standard sevens reached standard ten without failing, a further 20% were transferred from the school, 16% dropped out and 6% failed.

Seen from the standard ten perspective, 76% form the reasonably homogeneous group, 18% joined the class after standard seven, and 6% joined the group because of failing or repeating.

It is of course possible that some underachievers are lost to the study because they did not reach standard ten. Some may have been transferred with their parents to another school, but the potentially most fruitful area for finding such underachievers would be amongst those who "dropped out", i.e. who could not, or would not, continue their education at an academically oriented institution.

Table 3.2 therefore indicates the I.Q. stanine grouping of those people who left the original standard seven groups, plus their reasons for leaving.

Relevant to the study is an analysis of the stanine I.Q. grouping of the pupils who do not qualify for the experimental group because of moving, since they may have moved because of being underachievers.

TABLE 3.2

I.Q. STANINE GROUPING ANALYSIS OF PUPILS WHO LEFT THE TEST GROUPS

| | Group 1 Stanines | | | Group 2 Stanines | | | Group 3 Stanines | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1-3 | 4-6 | 7-9 | 1-3 | 4-6 | 7-9 | 1-3 | 4-6 | 7-9 |
| Left school because of transfer | 1 | 12 | 2 | 1 | 9 | 4 | 1 | 10 | 3 |
| Dropped out from school | 1 | 11 | | 4 | 8 | | 2 | 1 | |
| Failed along way | | 6 | | | 3 | | 1 | 3 | 2* |
| Repeated standard | | 1 | | | | 1* | | | |

Key: As for table 3.1.

Engelbrecht (1975 (a), p. 147) has expressed concern at failures amongst the above average intelligence group, i.e. those who fall in the stanine 7-9 category (V.I.Q. $\geq$ 112), since they are virtually underachievers by definition. Table 3.2 indicates 3 candidates of interest (marked with asterisks). Two failed standard nine, and they should not have done so, and one repeated standard nine because he wanted a "better" Senior Certificate.

For the purposes of the major aim of this study we have taken the pupils from the standard seven groups who -

(1) are of average and above average intelligence,

(2) have either reached standard ten without failing or have failed a standard beyond standard six, or have dropped out from academic education altogether,

(3) are not ill.

After applying the above criteria to tables 3.1 and 3.2, we arrive at the experimental group indicated in table 3.3.

Table 3.3

COMPOSITION OF EXPERIMENTAL STANDARD SEVEN GROUPS

| Group | Average I.Q. | Above Average I.Q. | Total |
|---|---|---|---|
| 1 | 45 | 20 | 65 |
| 2 | 31 | 21 | 52 |
| 3 | 27 | 20 | 47 |
| Total | 103 | 61 | 164 |

It should be noted that the maximum number of pupils available are used for each statistical procedure. Thus all standards seven and ten results are used to standardise scores and derive stanines and linear regressions, but only the results of the homogeneous group for the stepwise regressions, etc.

## 3.3 STATISTICS USED

### 3.3.1 The J.A.T. and J.S.P.B. Test results

Since 1978 all pupils at the school have been doing the standardised Junior Aptitude Tests and Junior Scholastic Proficiency Battery Tests during the September of their standard seven year. These tests were introduced by the Cape Province Department of Education during 1977 and are administered by the Teacher psychologist at the school, guided by the Departmental School Psychologist.

Unfortunately the J.A.T. results were not available for the sevens of 1979 since only the J.S.P.B. was administered in that year. The researcher therefore used the J.A.T. stanines which had been administered to some of the pupils during their standard five year at their (same) primary school. For stepwise regression purposes raw scores had to be assigned to those stanine values and the table issued by the H.S.R.C. was used. Where a choice of scores was presented, the lowest was used and, where three scores were presented, the middle one was chosen.[1.)] This process involved 18 candidates, of whom 12 fall in the group V.I.Q. $\geq$ 112.

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1.) This was done to minimise any statistical tendency, so that if any significant relationships exist, the significance will not be forced by exaggerated figures.

In all other cases, the raw scores and stanines as given by the psychologist after the tests had been administered and marked, were used.

The J.A.T. results were also used in six factorial[1.)] groupings to interact with the V.I.Q. and performance regression and presented as a three dimensional picture.

3.3.2 The I.Q. scores

All pupils in Cape Provincial schools do the New South African Group Test during their standard three and standard five years. These results are recorded on the cumulative record cards, which contain all relevant educational, medical and personal records of the pupils' academic progress, in the form of non-verbal I.Q., verbal I.Q. and total I.Q.

If the results of two intelligence tests are not available on the cumulative cards when the pupils arrive (this is often the case with pupils from private schools or foreign countries), or if the school has any doubt about the accuracy of the results, pupils are re-tested and the results used. In this investigation most of the standard five I.Q. results were used but, in fewer than 10% of the cases, more recent test results had to be used.

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1.) See section 2.3.1.2.

We should therefore note that many projections, such as standard seven and standard ten results, will be based on I.Q. scores which had been determined two years or more previously. Van der Westhuizen (1979, p. 79) warns against using the results of intelligence tests obtained more than two years previously. However, we must accept that these are the results normally available to the standard six and seven teacher and that re-testing is not always practically possible. Therefore we have added an investigative dimension by calculating Estimated Intelligence I.Q. (E.I.Q.) based on the Junior Aptitide results.[1.)] Van der Westhuizen (1979, p. 99) refers to this figure as an "estimated I.Q."

### 3.3.3 The Standard Seven Results

All standard seven pupils in the Republic do the same compulsory five subjects: A first language (in this case English); a second language (Afrikaans); General Science; Mathematics; and Geography/History. Every year the pupils at the school write two cycles of tests in each subject, as well as a formal examination at the end of the year. The raw scores achieved by the pupils in each subject, as determined by the demands of each syllabus, were used in this investigation, as well as the total standard seven mark.

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1.) See section 2.4.1.2.

The total standard seven mark used was the percentage mark the pupil achieved at the end of year examination. This total mark consists of the marks obtained in the five compulsory subjects, as well as the marks obtained in two optional subjects. The optional subjects consist of one option from either Latin or Art, and one from either Accountancy or Metalwork. The percentage mark was calculated from an aggregate of 2 000 marks. Some of the pupils, about ten in each group, did Afrikaans as a first language as well as English as a first language. In those cases the pupils had a theoretical aggregate of 2 100 marks because a first language has a total of 400 marks vis-a-vis 300 marks for a second language. In this investigation we followed the usual practice of considering the maximum of such pupils to be 2 000 marks, since it is thought that an additional first language is to the advantage of the pupil.

3.3.4 The Stanines

The stanines of all examination marks in this study were calculated with the basic assumption that the marks are normally distributed (van der Walt 1970, p. 66). The stanine scale provides standard scores from 1 to 9 with a mean of 5 and a standard deviation of 2 (van der Walt 1970, p. 60).

Expressed as a formula we have

$$\text{stanine} = 2z + 5$$

where

$$z = \frac{X - \bar{X}}{S.D.}$$

where

$X$ = raw score achieved

$\bar{X}$ = average of marks

S.D. = standard deviation of marks.

Expressed as percentages in the normal distribution curve, the stanines appear as follows -

Table 3.4

PERCENTILE RANGE AND DESCRIPTION OF STANINE SCALE [1.)]

| Percentage of Testees | Stanine | Cumulative Percentages | Relevant I.Q. Range |
|---|---|---|---|
| Lowest 4% | 1 | 4 | 73 and below |
| Next 7% | 2 | 11 | 74- 80 |
| Next 12% | 3 | 23 | 81- 88 |
| Next 17% | 4 | 40 | 89- 69 |
| Middle 20% | 5 | 60 | 97-103 |
| Next 17% | 6 | 77 | 104-111 |
| Next 12% | 7 | 89 | 112-119 |
| Next 7% | 8 | 96 | 120-126 |
| Highest 4% | 9 | 100 | 127 and above |

1.) See van der Walt (1979, p.61)

### 3.3.5 The Standard Ten Totals

The standard ten totals used in this investigation were the raw scores achieved by the pupils during a formal examination written at the beginning of September each year as a preparation for the final senior certificate examination a few weeks later. The September marks were chosen in preference to the final November examination marks because the former are easily available and the latter are difficult to compute accurately since the results are supplied by the Education Department in symbol form. It should be noted that, because only the total standard ten mark is used, we shall be concerned in this investigation with what Laubscher (1976, p. 5) called standard achievement. This has the disadvantage of comparing pupils who do not do the same subjects with each other in the linear regression calculations.

The options available to these pupils for the Senior Certificate are as follows -

CHOICE OF SUBJECTS IN STANDARDS EIGHT, NINE AND TEN

| Choose ONE in EACH Section | JMB Grouping |
|---|---|
| 1. English First Language HG | A |
| 2. Afrikaans First Language HG | A |
| 3. Mathematics HG or SG | B |
| Metalwork SG | F |
| English Literature SG | F |
| 4. Physical Science HG or SG | C |
| History HG or SG | E |
| Art HG or SG | E |

| | |
|---|---|
| 5. Geography HG or SG | E, F |
| Biology HG or SG | C |
| Mathematics HG or SG | B |
| 6. Latin HG | D |
| Biology HG or SG | C |
| Accountancy HG or SG | F |
| Art HG or SG | F |

N.B. (1) Music may be offered as an alternative in any of the groups, except 1 and 2.

(2) Boys who wish to do Physical Science must also do Mathematics.

Only those candidates who chose subjects to qualify for a matriculation exemption course (aggregate maximum 2 100) were considered in this investigation.

An analysis of the subject options exercised by the pupils over the three years in question shows that 48% of the pupils investigated do the same five out of six subjects, i.e. English first language, Afrikaans first language HG or second language HG, Mathematics HG, Physical Science HG and Biology HG. A further 10% do the same subjects, but only one of Mathematics, Physical Science or Biology on the standard grade. Such a high percentage of homogeneity is to be expected, since we have limited ourselves to the group consisting of matriculation exemption candidates. Of the remaining 40% of the group, all have to do at least four of the five subjects quoted above to qualify for an exemption and, with the exception of Metalwork, the remaining choices possible are all with a heavy academic bias.

Although it is to be expected that standard error of measurement in each subject will therefore "cancel out" underachievement effect in a global mark, we believe that such a homogeneity of subject choices could still make an underachievement statistical exercise on the global mark valid.

3.3.6 Age of Pupil

The age of the pupil as used in the E.I.Q. and stepwise regression calculations was the age of the pupil during September of his standard 7 year when the J.A.T. and J.S.P.B. were written. In each case the age was used in decimal form. The ages had a mean of 14,95 with a range from 13,75 to 17,5 and a standard deviation of 0,59.

## 3.4 THE PREDICTOR MODELS OF UNDERACHIEVEMENT

### 3.4.1 The Linear Regression Model

The technique of linear regression is widely used both in the physical sciences and the social sciences. It is employed predominantly for two purposes, the investigation of a causal process and for the purpose of prediction. In this study we shall be concerned with the latter use.

For the exercise to be valid we must make the reasonable assumption that there is a linear relationship between the V.I.Q. score of the pupil and his academic test(s) score(s).

The mathematical bases of the equations have been established and can be found in numerous applied statistics sources.[1.)]

The method is very attractive educationally since the data can be pictured on a graph with axes, X (I.Q. score), and Y (performance points). If there exists a strong linear relationship between X and Y, the resultant scatter diagram or graph will be elliptical in shape, and the coefficient of linear regression equation $y = a + bx$ is called the least squares regression line of y on x. The higher the coefficient between x and y, the closer the plotted points will be to the straight line.

The following formulae are used -

$$y = a + bx$$

where

$$a = \bar{y} - b\bar{x}$$

$$b = \frac{S_{xy}}{S_{xx}}$$

and $$S_{xx} = \Sigma x^2 - \frac{(\Sigma x)^2}{n}$$

$$S_{yy} = \Sigma y^2 - \frac{(\Sigma y)^2}{n}$$

$$S_{xy} = \Sigma xy - \frac{\Sigma x . \Sigma y}{n}$$

n = number of cases.

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1.) See: Unisa publication Applied Statistics Sta 102, pp. 97-101, C F Crouse 1974.

To determine the underperformances, a line parallel to $y = a + bx$ is drawn, one standard deviation below. The standard deviation $s_y$, is calculated as follows[1.)] -

$$s_y = S_y \sqrt{1 - r^2}$$

where

$S_y$ = standard deviation of performance points

$r$ = correlation between X and y.

All pupils whose scores fall below the second line are defined as underachievers.

In this study the underachievers in each of the three groups were found by this method, using the verbal I.Q. score and the estimated I.Q. as predictors, and the standard seven and standard ten totals as predictands.

3.4.2 the Stanine model

The stanine model of indicating underachievement is probably the easiest for pupil, parent and teacher to understand and administer. It consists of a tabular 9 x 9 rectangular array of blocks, stanines 1 - 9 on the x axis indicating potential, and stanines 1 - 9 on the y axis indicating achievement. At a

1.) See Laubscher 1973, p. 3.

glance it can be seen if the pupil's achievement is the same as his measure of potential (i.e. the same stanine score or one above or below), or if he is "overachieving" (i.e. stanine of achievement is two or more above potential), or underachieving (stanine of achievement is two or more below potential stanine).

The statistical validity of the exercise is obvious from the definition of a stanine. Each stanine represents 2 standard deviation measures, and a difference of two stanines represents 4 standard deviation measures etc.

In this study, tabular arrays are set out using the stanines of verbal I.Q. and estimated I.Q. as predictors, and standard ten scores, standard seven totals and standard seven subjects, and Junior Proficiency stanines as measures of achievement in various combinations.[1.)]

3.4.3 The Performance Index Model

The Performance Index is a figure derived from subtracting a standardised test result score from the verbal I.Q. score. In this study the test scores of standards seven and ten were standardised to be the same as the V.I.Q., with a mean of 100 and standard deviation of 15. Once again an arbitrary decision must be made as to how big a difference will

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1.) Van der Walt 1979, pp. 112-113.

denote underachievement, one standard deviation difference being the most attractive figure.

### 3.4.4 The Stepwise Regression Model

Stepwise regression is used when many factors are suspected of contributing to the result of a dependant variable. The resultant linear expression is useful for predicting future results for the same population in the same experimental situation. When such a multiple correlation exists, the researcher is guided by the increase in percentage of variance explained as each new factor is added in the forward stepwise regression. The highly complex mathematical processes are usually left to computers and computer programmers and will not be attempted here.

## 3.5 SUMMARY

In this chapter the background of the pupils was outlined. The standardised test results and examination results which will be used were defined as well as the statistical tests to be used. We are therefore in a position to proceed to an analysis of the results in the next two chapters.

# CHAPTER 4.

## PRIMARY RESULTS ANALYSED AND DISCUSSED, SKEWED DISTRIBUTIONS, PREDICTOR MODEL RESULTS

### 4.1 THE PROBLEM OF SKEWED DISTRIBUTIONS

Laubscher (1976, p. 6) is one of many[1.)] researchers to raise objections against the use of examination totals as a measure of academic achievement. He therefore pleads for the use of standardised tests which would eliminate the problems of fluctuating standards in difficulty of test, consistency of mark schemes and skewed distributions.

This study uses both standardised and examination scores as measures of achievement. If examination scores are used, allowance must be made for the objections to their use - the variation in standard from one examination to the next in the same school, and the variation in standard between the school examination and that of the external or universal examination.

Most of these difficulties are exemplified by possible skewed distributions when compared to all the candidates in the Cape Department of Education.

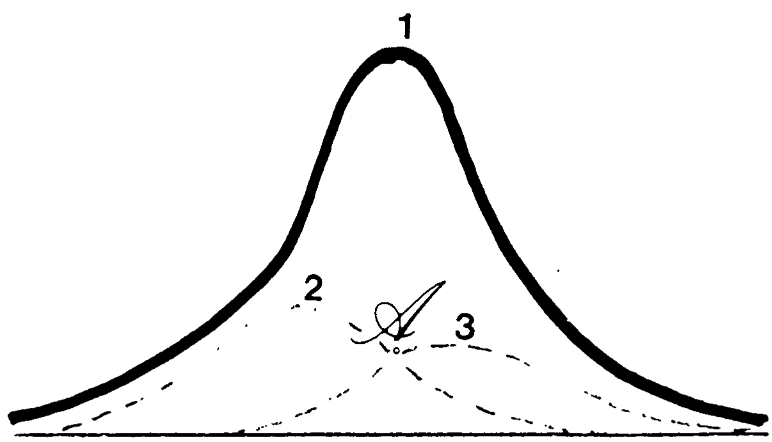
---

1.) Laubscher quotes eight other studies.

If the symbol distributions of the test groups are negatively skewed in terms of the universum, it follows that "average" candidates in the group could in fact be underachievers when viewed in terms of all candidates.

The problem is illustrated in figure 4.1, where three distributions are shown -

FIGURE 4.1




Normal Probability curve as viewed against the distribution of marks of two schools, x and y.

curve 1 is the normal distribution of all candidates;

curve 2 is the distribution of marks of candidates in school x; and

curve 3 is the distribution of candidates in school y.

In terms of the total populaton, candidate A has an average mark, yet if he achieved those marks at school x he would appear well above average, and below average at school y.

The danger of using school marks as a criterion for achievement lies in the difficulty the researcher has in placing a small sample distribution in relation to the whole population. In the stanine calculations a normal distribution has to be assumed, and in the linear regression candidates achieve or underachieve in relation to the rest of the group only.

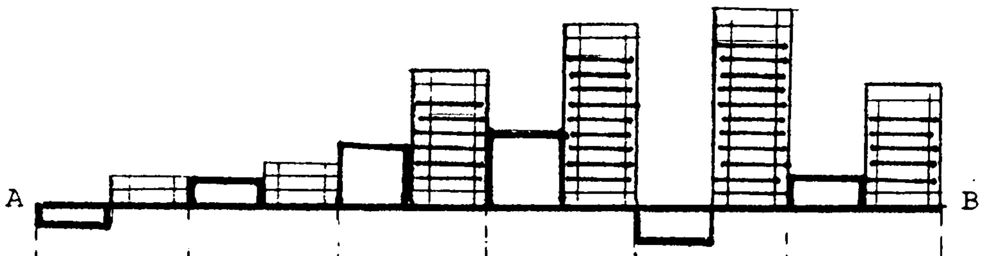
Is skewed distribution a problem in this case?

It appears not to be.

In table 4.1 we view the relationship between the average mark of the September examination in five subjects, and the end of the year average as well as the population average, to see if the possibility exists that pupils in the experimental group could be defined as underachievers when they are achievers in terms of the population.

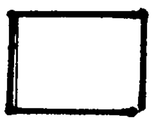
## Table 4.1

THE RELATIONSHIP BETWEEN THE AVERAGE MARK OF SEPTEMBER AND END OF YEAR COMPARED TO THE POPULATION AVERAGE, FOR GROUP 2.

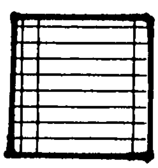



| | English | Afrik. | Biology | Ph.Sci. | Math-s. | Geog. |
|---|---|---|---|---|---|---|
| n= | 61 | 53 | 28 | 21 | 18 | 36 |
| N= | 6241 | 5379 | 6437 | 3442 | 3676 | 2695 |

Key : Line AB - September Average for the six Higher Grade subjects as indicated.



Histogram of December average increase over September for group 2 in the six subjects



Histogram of Cape Senior Certificate average increase over group 2 September average in the six subjects

n = Number of candidates in test group 2 taking subjects

N = Number of candidates who wrote the December examination

From table 4.1 which indicates the typical tendency of the senior certificate groups at the school over the past few years, we see that the marks of the experimental group are slightly lower than their marks in December, which in turn tend to be slightly lower than the marks of all the candidates.

Although the differences are not statistically significant, we can conclude that if underachievers are found in the experimental groups, they are likely to be underachievers in the total population. In fact, there may even be some underachievers in terms of the population who appear merely below average in the experimental groups.

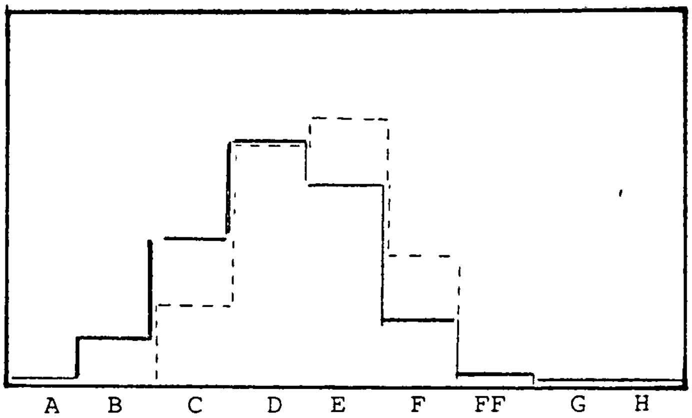
This tendency is confirmed when the histograms of the subject symbol distributions in the subjects which have a larger number of candidates in the experimental groups are compared to the symbol distribution of the population.

In table 4.2 we look at the symbol distribution of three subjects compared to the symbol distribution of the population to see if the same tendencies are confirmed.

Table 4.2

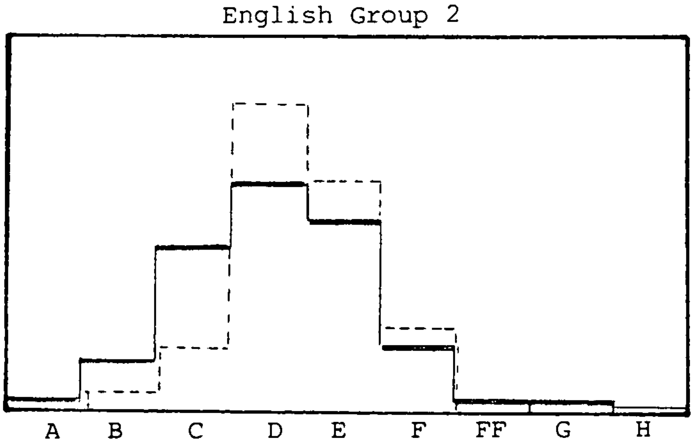
SYMBOL DISTRIBUTION, REDUCED TO PERCENTAGES, OF THE EXPERIMENTAL GROUP AS COMPARED TO THE POPULATION, IN THREE SUBJECTS;

English Group 1



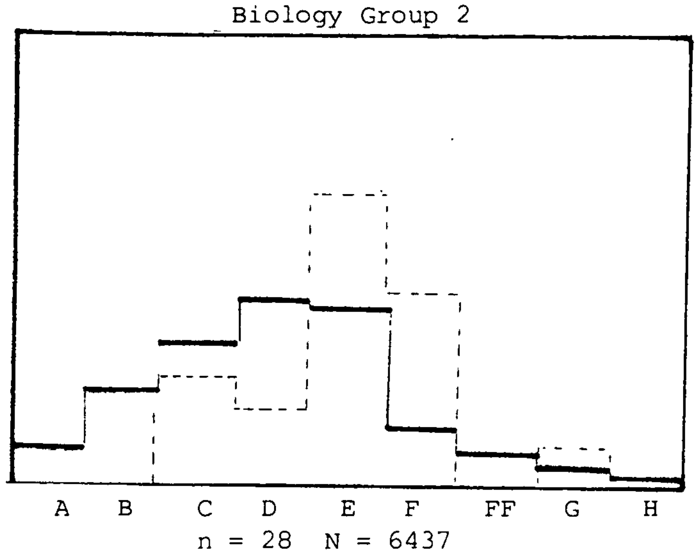

n = 62 N = 6056

English Group 2




n = 61 N = 6241

Biology Group 2




Key : ______ - Population symbol distribution

...... - Symbol distribution of experimental group

n = Number in experimental group

N = Number in population.

The three graphs of table 4.2 are given as typical of all subjects. Although the differences are not significant, there is a slight negative skew in each case for all subjects and, if we bear in mind that the test group marks are lower than those indicated in table 4.2 we cannot possibly find underachievers in the experimental group who are not also underachievers in the population. With this in mind, we can proceed with an analysis of the various models of prediction.

## 4.2 THE LINEAR REGRESSION MODEL RESULTS

The linear regression results are produced in graphic form on pages 65, 66, 67, 68, 69 and 70. In each case the standard seven graph is followed immediately by the standard ten graph of the same group.

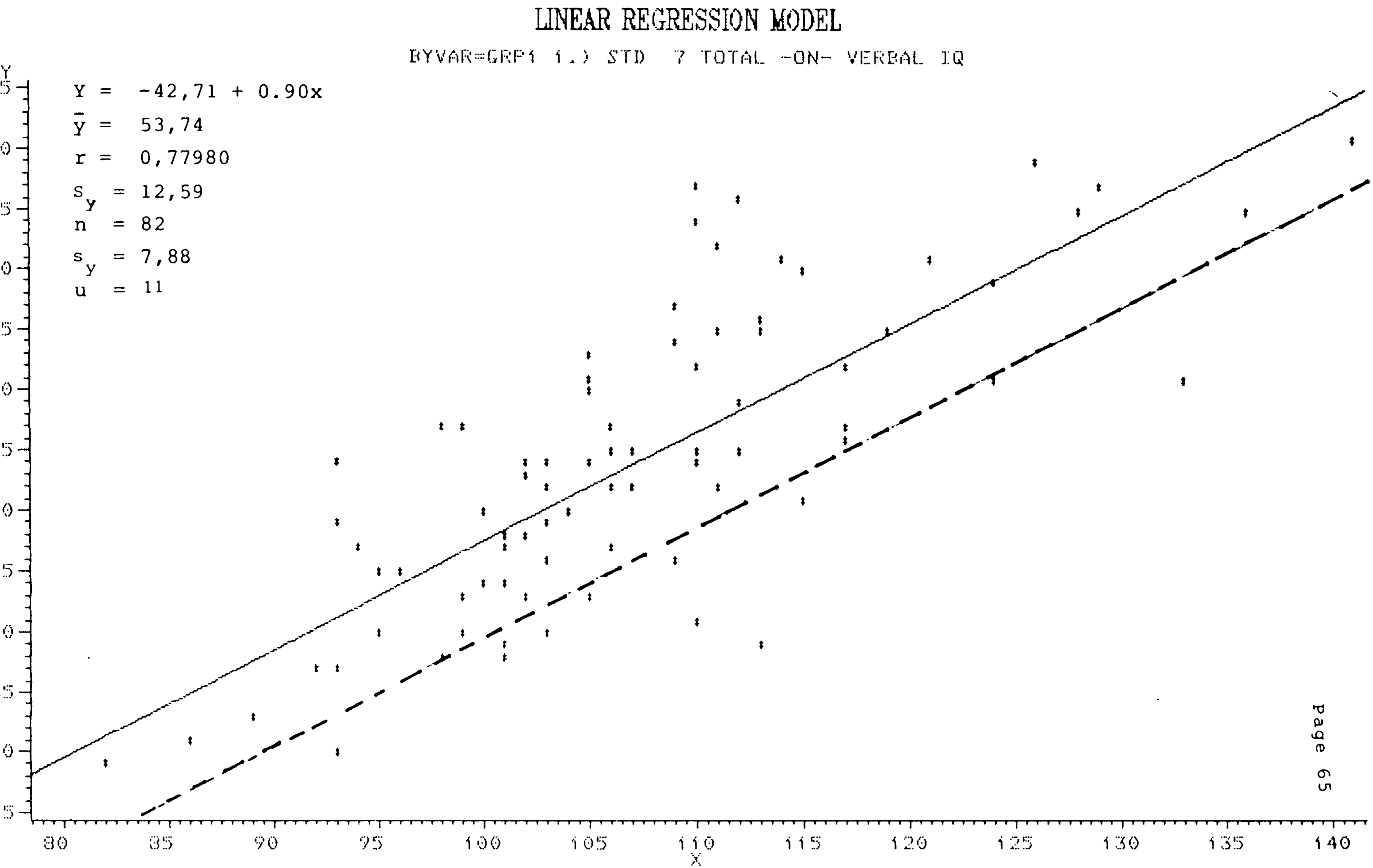
The results are indicated in table 4.3

For the purposes of the experiment, the following pupils were not included in the data -

1. Those who left the school to continue their education elsewhere.
2. Those who had a verbal I.Q. below 89, i.e. who fell in the V.I.Q. stanine 1-3 range. It was felt that they had such an unsatisfactory academic history by the time that they got to standard seven, that any conclusions based on their subsequent record would be difficult to justify.

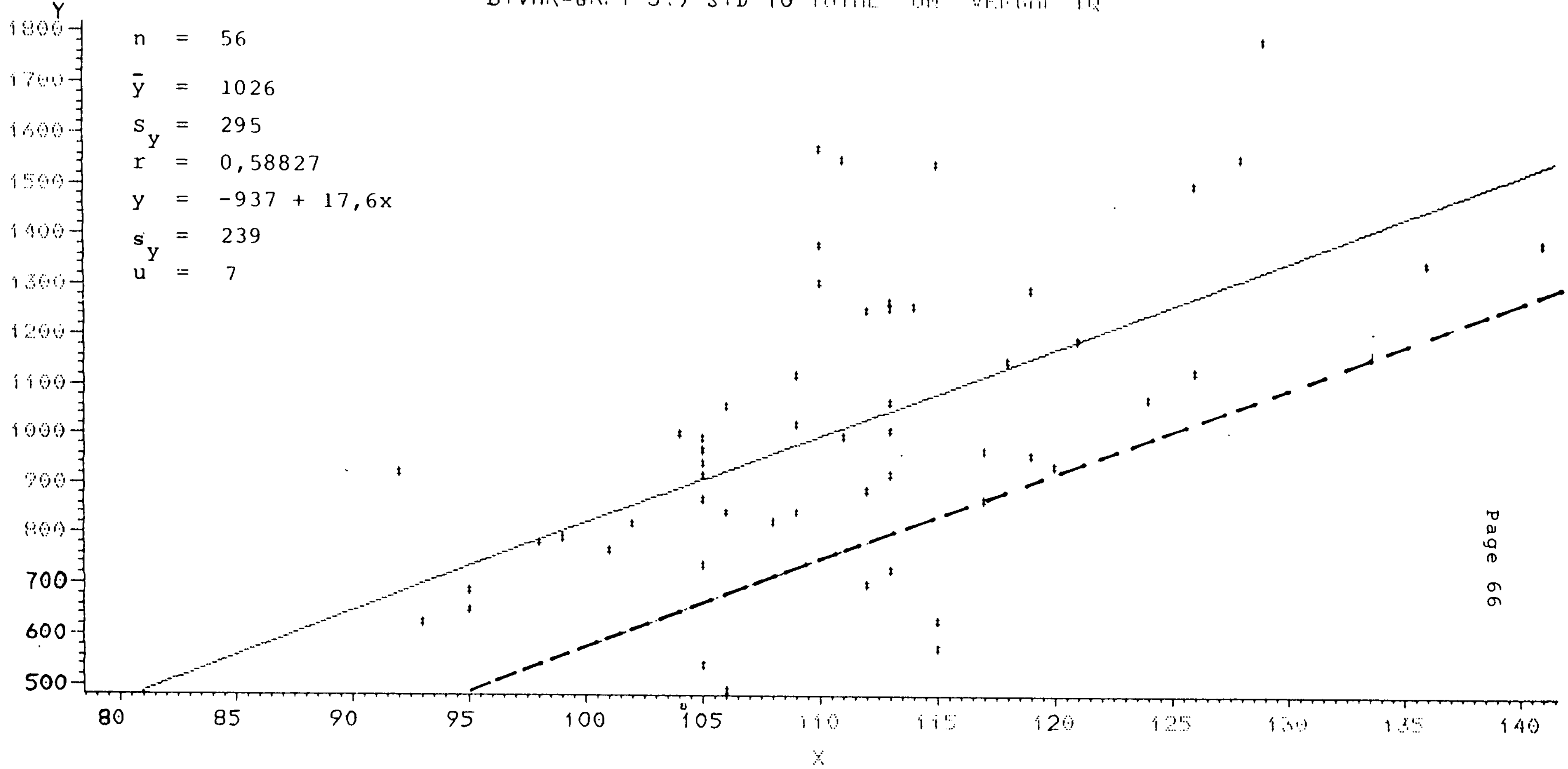
Key to linear regression graphs :

| | |
|---|---|
| $y = a + bx$ | : Linear formulae for the regression lines |
| $s_y$ | : standard deviation for y values |
| $s_y$ | : $s_y = s_y\sqrt{1 - r^2}$ |
| $r$ | : correlation between x and y values |
| $u$ | : number of underachievers identified. |


LINEAR REGRESSION MODEL
BYVAR=GRP1 1.) STD 7 TOTAL -ON- VERBAL IQ
Y = -42,71 + 0.90x
ȳ = 53,74
r = 0,77980
s_y = 12,59
n = 82
s_y = 7,88
u = 11
Y
95
80
75
70
65
60
55
50
45
40
35
30
25
80
85
90
95
100
105
110
115
120
125
130
135
140
X

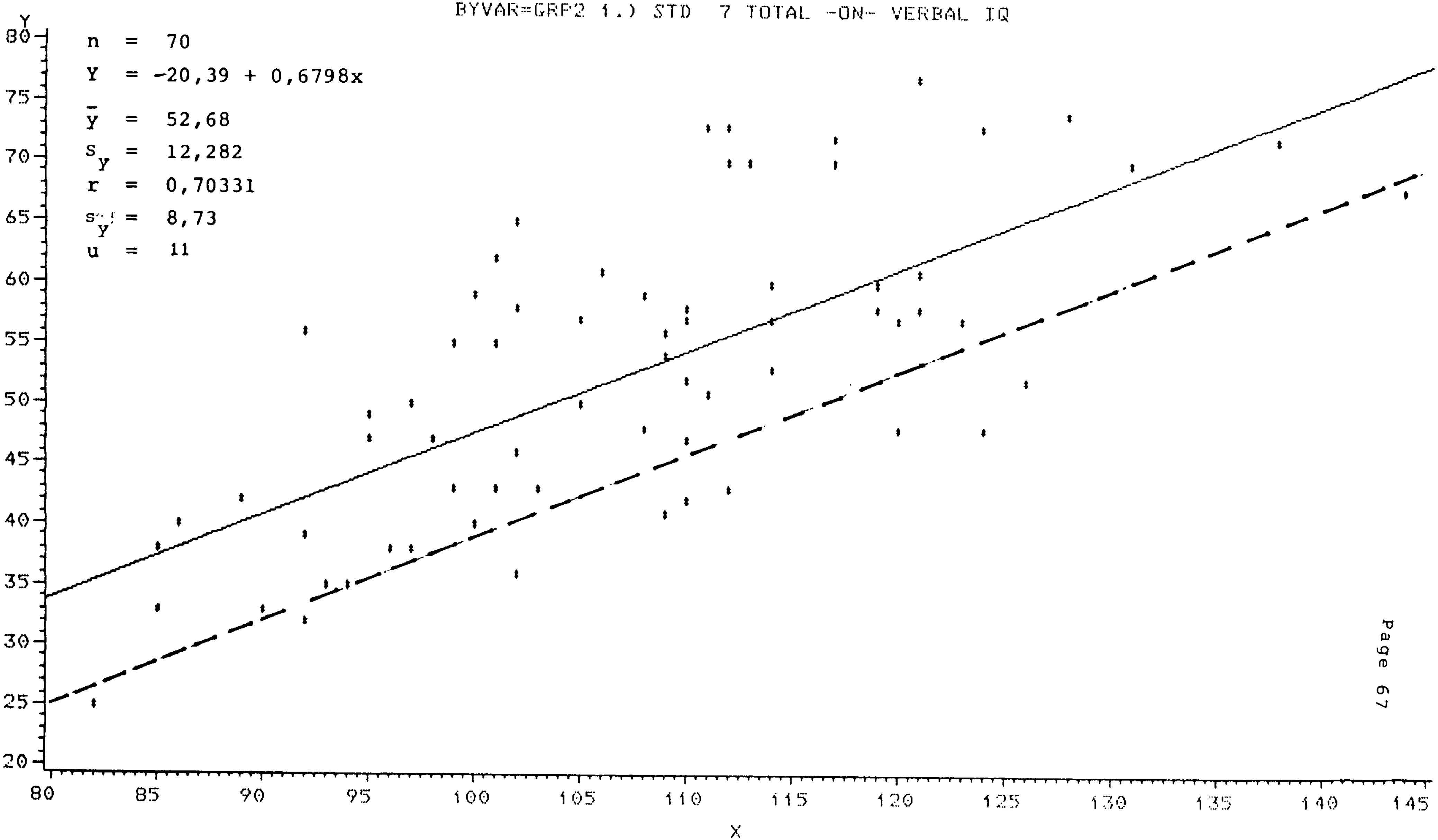
# LINEAR REGRESSION MODEL

BYVAR=GRP1 3.) STD 10 TOTAL UN VERBAL IQ



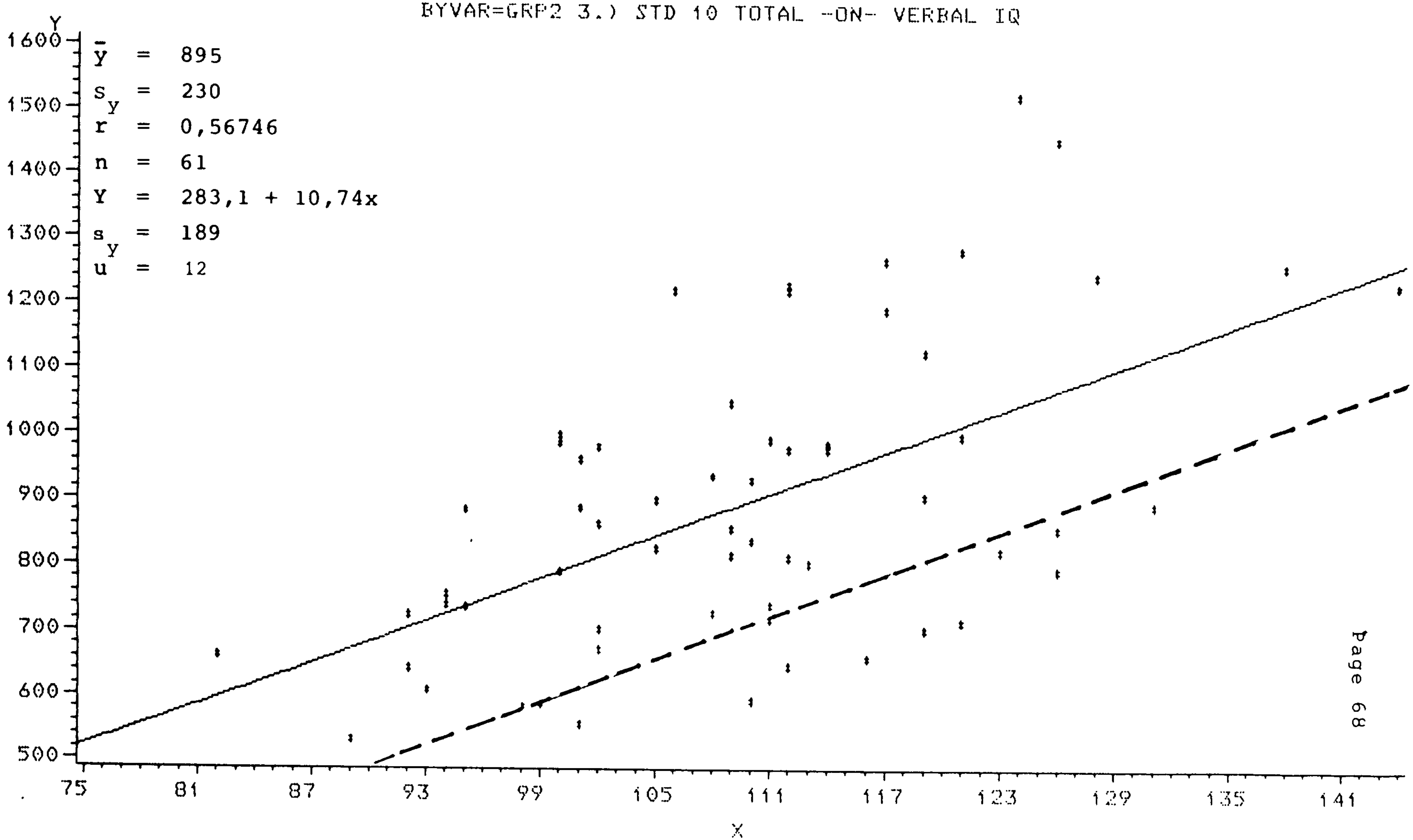
## LINEAR REGRESSION MODEL

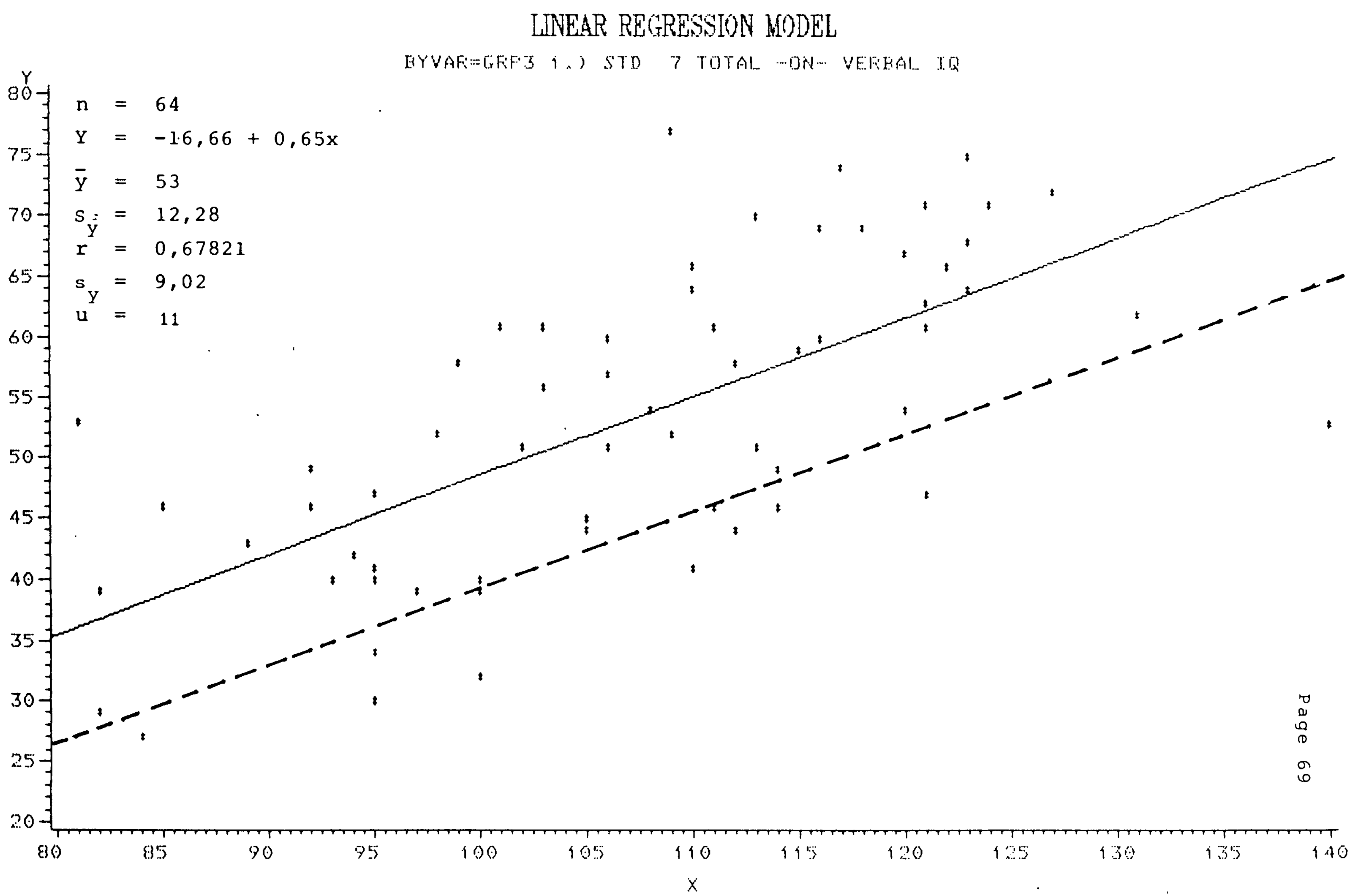
BYVAR=GRP2 1.) STD 7 TOTAL -ON- VERBAL IQ



# LINEAR REGRESSION MODEL

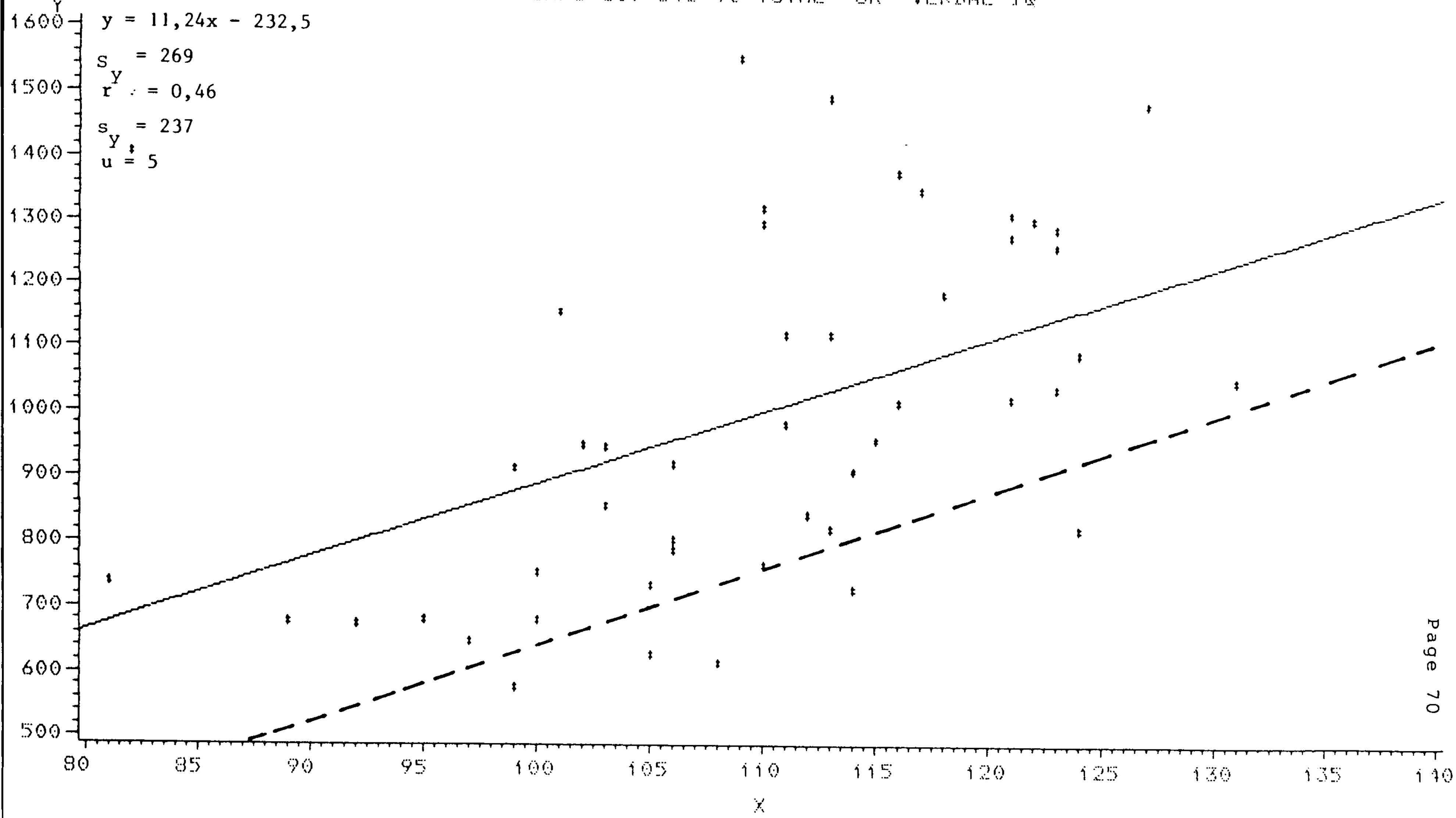
BYVAR=GRP2 3.) STD 10 TOTAL -ON- VERBAL IQ




LINEAR REGRESSION MODEL
BYVAR=GRP3 1.) STD 7 TOTAL -ON- VERBAL IQ
n = 64
Y = -16,66 + 0,65x
ȳ = 53
s = 12,28
r = 0,67821
s = 9,02
u = 11
Y
80
75
70
65
60
55
50
45
40
35
30
25
20
80
85
90
95
100
105
110
115
120
125
130
135
140
X

# LINEAR REGRESSION MODEL

BYVAR=GRP3 3.) STD 10 TOTAL -ON- VERBAL IQ



DISTRIBUTION OF UNDERACHIEVING PUPILS BY LINEAR REGRESSION METHOD;

TABLE 4.3

The linear regression results which have been illustrated graphically are given in tabular form below.

| | Underachievement Predicted in Std 7 | | Underachievement Not Predicted in Std 7 | | |
|---|---|---|---|---|---|
| | Average I.Q. | Above average I.Q. | Average I.Q. | Above average I.Q. | |
| Under-achievers | 7 | 5 | 22 | 8 | 42 |
| Achievers | 3 | 3 | 72 | 44 | 122 |
| | 10 | 8 | 94 | 52 | 164 |

Key :

Underachievement predicted - pupils who were shown to be underachievers in their group by the linear regression test in standard 7.

Underachievement not predicted - those not shown to be underachievers

Average I.Q. - those in the V.I.Q. stanine range of 4-6

Above average I.Q. - those in the V.I.Q. stanine range of 7 - 9

Underachievers - those who either failed after standard six, or dropped out of academic work because they were doing poorly, or who were identified as underachievers in standard ten on the linear regression method.

Achievers - those who reached the final standard ten examination without being identified as underachievers.

Unfortunately table 4.3 had to be abandoned, and the Null hypothesis associated with it, when a $X^2$ test was applied since one of the frequency theoretical cells had fewer than 5 candidates. The Null hypothesis was therefore formulated as follows, based on table 4.4

Null hypothesis 4.1: There is no difference between the academic performance of those who are predicted as underachievers and those who are not predicted as underachievers, using the linear regression method.

TABLE 4.4

In table 4.4, the results of table 4.3 are given with collapsed cells.

DISTRIBUTION OF UNDERACHIEVING PUPILS DEFINED BY LINEAR REGRESSION METHOD.

| | Underachievement Predicted in Std 7 | Not predicted in Std 7 | Totals |
|---|---|---|---|
| Under- chievers | 12 | 30 | 42 |
| chievers | 6 | 116 | 122 |
| otals | 18 | 146 | 164 |

$X^2 = 15,6$ d.f. = 1 $p < 0,005$.

Key : As for table 4.3

The Null hypothesis is therefore rejected, and we conclude that the linear regression model has high predictive value.

The rejection of the Null hypothesis is valid only if it is assumed that a pupil with a verbal I.Q. above 88 is underachieving if he fails a standard above standard six or cannot cope with academic work above standard six. In this connection it is interesting to note the composition of the 42 underachievers as indicated in table 4.5

TABLE 4.5

DISTRIBUTION OF UNDERACHIEVERS

| | Underachievers Predicted | Underachievers Not predicted |
|---|---|---|
| Failed | 4 | 3 |
| Dropped out | 7 | 10 |
| Linear regression in 10 | 3 | 15 |
| Total | 14 | 28 |

It is not surprising that, of the 15 candidates who are identified as underachievers in standard ten by the linear regression method, 10 are in the above average I.Q. group. This suggests that their superior mental ability was able to cover up weakness, such as poor study methods, which were revealed only later.

An evaluation of this method of identifying under-achievers was done when it was compared to the other methods of identification later.[1.)]

## 4.3. THE STANINE PREDICTIONS

### 4.3.1. V.I.Q. Stanine against Examination totals Stanine:

For the first stanine model investigation, the V.I.Q. stanine was used as a predictor, and placed against the total standard seven examination mark as measure of achievement. The stanines for the performance totals were calculated for each group, but are placed together in table 4.6.

<u>Table 4.6</u>

DISTRIBUTION OF CANDIDATES PLACED ACCORDING TO VERBAL I.Q. AND PERFORMANCE IN STANDARDS SEVEN AND TEN.

<u>Standard Seven</u>

| Performance Stanine | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 9 | | | | | | 2 | 1 | 3 | 2 |
| 8 | | | | | | 3 | 11 | 4 | 6 |
| 7 | | | | | 2 | 5 | 3 | 6 | 1 |
| 6 | | | | 1 | 7 | 16 | 10 | 6 | 2 |
| 5 | | | 1 | 1 | 10 | 15 | 5 | 2 | 1 |
| 4 | | | 1 | 8 | 8 | 8 | 3 | 3 | |
| 3 | | | 3 | 9 | 21 | 7 | 3 | | |
| 2 | | | 1 | 8 | 2 | | | | |
| 1 | | | 5 | 2 | | | | | |

I.Q. Stanine

1.) See section 4.6.

Standard Ten

| Performance Stanine | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9 | | | | | | 4 | 2 | 2 | 2 |
| 8 | | | 1 | | | 1 | 6 | 3 | 4 |
| 7 | | | | | | 4 | 7 | 4 | 2 |
| 6 | | | | | 4 | 4 | 6 | 5 | 1 |
| 5 | | | | 1 | 5 | 13 | 9 | 3 | 1 |
| 4 | | | 1 | 5 | 11 | 11 | 6 | 3 | |
| 3 | | | 1 | 6 | 8 | 6 | 6 | 2 | |
| 2 | | | | 3 | 3 | 2 | 2 | 1 | |
| 1 | | | | 1 | | 1 | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

I.Q. Stanine

According to the stanine prediction model, all candidates below the solid step line, i.e. those who have a difference of two stanines or more between potential and performance, are underachieving.

It should be noted that many of those who underachieve in standard seven of table 4.6, either dropped out of school, or failed, or left the school to continue their education elsewhere. Some of those who appear as underachievers in standard ten joined the class after standard seven.

To test if the predictions of the standard seven results are meaningful, the same factors were taken into account as for the regression model: Those with stanine I.Q. less than four were ignored, as were pupils who failed through illness. Those who dropped out of academic tuition, or who failed a standard after six were considered underachievers, as were those who underachieved in standard ten according to the stanine model. Those who joined the class after seven were similarly ignored.

With the above in mind, it is then possible to formulate the Null hypothesis.

Null hypothesis 4.2. There is no difference in the future performance of those who are predicted to be underachievers in standard seven as compared to the future performance of those who are not predicted to be underachievers in standard seven, using the stanine model: V.I.Q. Stanine - Performance stanine $\geqslant 2$.

TABLE 4.7

DISTRIBUTION OF UNDERACHIEVERS USING STANINE MODEL

| | Predicted Underachiever | | Not predicted underachiever | | Total |
|---|---|---|---|---|---|
| I.Q. | Average | Above | Average | Above | |
| Underachievers | 22 | 18 | 29 | 15 | 83 |
| Achievers | 7 | 2 | 44 | 27 | 81 |
| | 29 | 20 | 73 | 42 | 164 |

d.f = 3 $\chi^2 = 28{,}02$ $p < 0{,}005$

Key: Predicted underachiever refers to pupil whose verbal I.Q. stanine was two or more above his standard seven examination total stanine.

Underachievers are those pupils who are either identified as underachievers in standard 10, using the same method of predicting as for standard seven, or who failed a standard after six, or who dropped out of academic education altogether.

Average refers to those pupils whose verbal I.Q. stanine falls in the 4-6 category.

Above refers to those pupils whose verbal I.Q. stanine falls in the 7-9 category.

Since we started with a two-tailed hypothesis, and chi-squared is a two-tailed test, no adjustment was made to the result, and the Null hypothesis was rejected at the 1% level of confidence.

We conclude that the stanine model using verbal I.Q. and examination totals has provided us with a highly significant result indicating that those who are predicted to become underachievers at standard seven level are very likely to have difficulties in completing their academic career to standard ten.

An evaluative comparison of this method will be done later.[1.)]

1. See pages 99 and 101

### 4.3.1.1 Stanine Model using V.I.Q. Stanine set against Standard Seven subject Stanines

For the second stanine model the V.I.Q. stanine is used as a predictor, and the stanines of the standard seven subjects are used as a measure of achievement. If a pupil has two or more of his subjects showing a stanine of two or more below his verbal I.Q. stanine, he is considered to be an underachiever for the purposes of the test. Underachievers are defined as those who have a two or more difference between their verbal I.Q. stanine and their standard ten stanine, or who failed or dropped out as defined previously.

The Null hypothesis can then be formulated as follows -

Null hypothesis 4.3: There is no difference in the subsequent performance of those who have been predicted as underachievers and those who have not been predicted as underachievers, using the V.I.Q. stanine and two standard seven subject stanine differences as a method of defining underachievement.

The results are tabulated in table 4.8.

TABLE 4.8

DISTRIBUTION OF PUPILS USING V.I.Q. AND STANDARD SEVEN SUBJECT STANINES AS DEFINITION OF UNDER ACHIEVEMENT.

| | Underachievement predicted | | Underachievement not predicted | | |
|---|---|---|---|---|---|
| | Average | Above | Average | Above | |
| Under-achieved | 31 | 27 | 21 | 6 | 85 |
| Achieved | 11 | 9 | 40 | 19 | 79 |
| | 42 | 36 | 61 | 25 | 164 |

d.f. = 3 $\chi^2 = 30,00$ $p<0,01$

Key : as for Table 4.7

What is noticeable about this method of prediction is that more underachievers are predicted than previously, 77 as opposed to 53 in table 4.7 and the chi-squared value is as high.

The basic difficulty of the above two tests is however that they rely on school examination results, in which candidates at best can be assessed only in relation to a small group. It is therefore important to look at tests which are standardised in both predictor and achievement measures, and evaluate this stanine model in terms of them.

4.3.1.2 Stanine model using V.I.Q. set against the Proficiency Test average.

As we have seen previously, [1.)] the Junior Scholastic proficiency Battery of tests was designed as an objective standardised test to measure the level of proficiency or attainment reached by the pupil at that stage. Pupils are defined as underachievers if the difference between the V.I.Q. stanine and the proficiency average is two or more.

Null hypothesis 4.4: There is no difference in the subsequent performance of those who have been predicted as underachievers and those who have not been predicted as underachievers, using a difference of two or more between V.I.Q. stanine and J.S.P.B. stanine average as a method of defining underachievement.

Underachievement subsequent to standard seven is defined as previously : Those who drop out, or fail, or are considered underachievers at standard ten level.

The results are tabulated in table 4.9

1.) See section 2.4.1.3

Table 4.9

DISTRIBUTION OF PREDICTED AND NON-PREDICTED UNDERACHIEVERS USING AS PREDICTOR -

V.I.Q. STANINE --J.S.P.B. AVE. STANINE $\geq$ 2.

| | Underachievement predicted | | Underachievement not predicted | | |
|---|---|---|---|---|---|
| | Average | Above | Average | Above | |
| Under-achieved | 1 | 5 | 50 | 23 | 79 |
| Achieved | 0 | 2 | 52 | 31 | 85 |
| | 1 | 7 | 102 | 54 | 164 |

d.f = 3 $\chi^2 = 3,54$ $p > 0,10$

Key: As for table 4.7.

The chi-squared result is not reliable since two squares give theoretical frequencies below 5. The Null hypothesis must therefore be accepted, and this particular test for predicting underachievement must be rejected.

A noticeable feature of the results is the small number of underachievers predicted (only 8). This figure is obviously too small and will continue to be inadequate even if the definition of underachievement is changed to the most generous in favour of the candidate. This result appears to contradict the findings of Laubscher (1976, p. 22), who used the V.I.Q. stanine set against the Senior Proficiency Battery stanine average as a measure of underachievement, and will therefore be discussed later when all the models are evaluated.[1.)]

### 4.3.1.3 Other Stanine Models

It is possible to use the stanine model in other combinations of measures of potential and achievement, but many of these are virtually impossible to interpret. One such is using the J.A.T. and J.S.P.B. stanine average, set against V.I.Q. stanine. The results had no statistical significance, but even if they did, interpretation would be a severe problem, since aptitude tests themselves are a measure of potential.

## 4.4 THE PERFORMANCE INDEX PREDICTIONS, USING STANDARDISED SCORES

To calculate the performance index, the technique of van Aarde (1968, p. 6) and Brooks (1978, p. 20) is used. The standards seven and ten examination scores are standardised with a mean of 100 and deviation of 15, so as to match the standardised N.S.A.G.T. scores. The performance index is then calculated as the difference between the standardised examination total and the V.I.Q. score. When the difference is greater than 25, the pupil is defined as an underachiever.

Neither van Aarde nor Brooks justify their choice of 25 as being the critical figure. In the present study it could be justified as approximately the sum

1.) See Section 4.6

of one standard deviation of marks (15, as per definition), and 7, which is the difference between the two averages. In this connection an examination of the means and deviations of the V.I.Q.'s and examination totals is of interest, since the examination totals were standardised within each group.

Table 4.10

AVERAGES AND STANDARD DEVIATION OF V.I.Q.
AND EXAMINATION TOTALS FOR EACH GROUP,
AND FOR ALL CANDIDATES TREATED AS ONE POPULATION.

| | Group 1 | Group 2 | Group 3 | Total |
|---|---|---|---|---|
| V.I.Q. Average | 107 (98) | 107 (90) | 106 (70) | 107 (258) |
| V.I.Q. Std. Dev. | 10,5 | 12,4 | 13,00 | 11,8 |
| Std 7 Exam Average % | 53,74 (82) | 52,68 (70) | 53,22 (66) | 53,24 (218) |
| Std 7 Std. Dev. % | 12,6 | 12,3 | 12,28 | 12,35 |
| Std 10 Exam Average Mark | 1026 (56) | 895 (61) | 1079 | 995 (169) |
| Std 10 Std. Deviation " | 295 | 230 | 271 | 275 |

(total in brackets) = (n)

Table 4.10 shows that there are no significant differences amongst any of the variables under consideration. It also shows that since the V.I.Q. mean in each case is about 107, there is a built in bias towards under-achievement of 7 points the moment the examination totals are standardised with a mean of 100. At first glance then, 25 seems a reasonable difference to define underachievement.

This technique also seems attractive since it makes comparisons amongst the groups, and between the groups and total population, easier, especially at standard ten level.

The total column indicates the results obtained after treating the candidates of the three groups as one population. From this it would seem to be a legitimate exercise to treat the groups as a homogeneous population.

It therefore becomes possible to formulate the Null hypothesis 4.5 -

There is no difference in the future performance of those candidates identified as underachievers and those not so identified, using the criterion of underachievement P.I. : S.E.S. - V.I.Q. $\leq$ -25, where S.E.S. is a standardised examination score, mean 100, standard deviation 15.

The results are indicated in table 4.11

Table 4.11(a)

DISTRIBUTION OF CANDIDATES USING A PERFORMANCE INDEX OF 25 POINTS DIFFERENCE BETWEEN V.I.Q. SCORE AND STANDARDISED EXAMINATION TOTAL AS A CRITERION OF UNDERACHIEVEMENT.

| | Underachievement Predicted | | Underachievement Not Predicted | | |
|---|---|---|---|---|---|
| | Average | Above | Average | Above | |
| Under - achieved | 2 | 5 | 26 | 9 | 42 |
| Achieved | 1 | 0 | 74 | 47 | 122 |
| | 3 | 5 | 100 | 56 | 164 |

Unfortunately two cells have a theoretical frequency less than 5, so the chi-squared test is not reliable. The same information is therefore presented with collapsed cells in table 4.11(b)

Table 4.11(b)

| | Underachievement Predicted | Underachievement Not Predicted | |
|---|---|---|---|
| Under-achieved | 7 | 35 | 42 |
| Achieved | 1 | 121 | 122 |
| | 8 | 156 | 164 |

d.f = 1 $\chi^2$ = 13,79

Although the chi-squared result appears highly significant, it has to be rejected since one of the cells has a theoretical frequency less than 5.

The results of this model also leads us to seriously question the use of this model as it stands because of the very few (8) underachievers predicted. Many pupils known to the investigator who should be defined underachievers according to almost any of the criteria previously suggested, [1.)] are simply not identified as underachievers using this method. Yet this is the moethod of identification used by at least two researchers, van Aarde (1968) and Brooks (1978), albeit under different circumstances. Van Aarde used it with Afrikaans speaking pupils in primary schools, and Brooks with Afrikaans speaking boys in senior schools. Both were able to cull enough candidates from large population groups, using this method. Does this suggest that English speaking pupils are even more notorious underachievers than previously suggested, or should the test be refined slightly?

From an inspection of the results of the performance index calculations, it seems that the cut-off lines should be adapted slightly. We note that the correlations between the V.I.Q. and examination totals in each group are as follows -

1.) See section 2.2.2.

Table 4.12

CORRELATION MATRIX OF V.I.Q. AND STANDARDS SEVEN AND TEN EXAMINATION TOTALS, PER GROUP

| | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| Standard 7 exam | 0,779 | 0,703 | 0,678 |
| p | ,0001 | ,0001 | ,0001 |
| n | 82 | 70 | 64 |
| Standard 10 Exam | 0,588 | 0,567 | 0,451 |
| p | ,0001 | ,0001 | ,0009 |
| n | 56 | 67 | 51 |

Key: p = prob > |R| under HO : RHO = 0

n = number of observations.

Although the differences between the correlations within each group are not statistically significant, the standard seven correlation suggests that a slightly smaller critical figure must be used, than for the standard ten figure. If it is true that the general tendency of the pupils at the school is to perform below the population average, as we have seen from an analysis of skewed distributions, then the 7 points difference between V.I.Q. mean and standardised examination score mean should be included in the performance index critical figure, since it probably reflects the performance tendency of the pupils in relation to the population.

The experimental performance index figures of 10 for standard seven and 15 for standard ten are therefore chosen, and reflected in table 4.13.

Table 4.13

DISTRIBUTION OF CANDIDATES USING AS CRITERIA FOR UNDERACHIEVEMENT, STD 7: P.I. = S.E.S. - V.I.Q. - 10 AS PREDICTOR AND STD 10: P.I. = S.E.S. - V.I.Q. - 15 AS UNDERACHIEVEMENT LEVEL.

| | Underachievement predicted | | Underachievement not predicted | | |
|---|---|---|---|---|---|
| | Average | Above | Average | Above | |
| Under-achieved | 24 | 23 | 20 | 9 | 76 |
| Achieved | 10 | 1 | 48 | 29 | 88 |
| | 34 | 24 | 68 | 38 | 164 |

d.f = 3 $\chi^2 = 47,35$ $p < 0,05$

A new Null hypothesis can therefore be formulated -

Null hypothesis 5.6: There is no difference in the subsequent performance of those who are predicted as underachievers, and those not so predicted, using a criterion of prediction as a 10 point or more difference between V.I.Q. and a standardised examination score at standard seven level (mean = 100, standard deviation = 15), and a similar 15 point difference as a measure of underachievement at standard ten level.

Since both the hypothesis and the chi-squared test are two-tailed, no adjustment is required to the result, and the Null hypothesis can be rejected at the 1% level of confidence.

The performance index model can therefore be accepted as a very useful method of predicting underachievement, but care must be taken to determine the critical cut-off points at reasonable levels. Such decision making can best occur only after a few experimental runs and the results evaluated by the staff who know the behaviour of the pupils, given the assumption that underachievement will be accompanied by a definable behaviour and work pattern.

## 4.5 THE STEPWISE REGRESSION PREDICTIONS

The stepwise regression model is a very sophisticated statistical method of predicting performance after analysing all the factors associated with previous performance done under similar conditions. The underlying assumptions are that, in this case, standard ten pupils will annually produce the same sort of marks commensurate with their abilities. It is hoped that there is a causal relationship between abilities measured by standardised tests and the final examination mark which is measured. As more factors are added to the correlational calculations, so the percentage of variance, which explains the apparent relationship, improves until the stage is reached where the adding of more factors does not increase to any significant degree the percentage variance explained.

This method has been widely used by researchers who were unhappy about looking at only one factor, such as verbal I.Q., to explain examination performance.[1.)] Where large populations are involved, it is possible to select à smaller control group to verify the accuracy of the stepwise prediction. At the school in question such a large population can be built up only during the course of a few years, and the accuracy of a stepwise model based on the present figures must be treated with great caution. It should be used only as an aid to the other models of prediction.

An additional difficulty is that, by definition, the stepwise model is a predictor of performance, not underachieving. In fact, the more "underachievers" there are in the sample, the more inaccurate the stepwise model in predicting the performance of "normal" pupils. Such inaccuracy will be indicated by the percentage of variance explained by the model.

With the above two areas of caution in mind, the investigator chose to use the standardised scores of

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1.) See the work of Schoeman 1978, Laubscher 1976, Lätti 1972, Fourie 1980.

all the variables to eliminate as far as possible the problem of relative annual fluctuation in marks.

Four variations were investigated.

4.5.1 Stepwise regression variation 1: Prediction of standardised ten total.

The independent variables chosen to predict the standardised ten total were the standardised standard seven subjects and exam total, and the J.A.T. and J.S.P.B. scores, as well as the age of the pupils.

After analysis of the steps involved in producing the best 8 variable model (R square = 0,764), the best 4 variable model was chosen, since it had an R square value of 0,745 and used three scores from standardised tests and the standard seven total in its formula.

The best 4 variable model was found to be

TET = - 19,211 + 0,229 T.I.Q. + 0,927 STOT + 0,283 APT. 3
- 0,385 APT 6

R-Square = 0,75

where

TET = standardised ten total, mean = 100, s = 15

T.I.Q. = total I.Q. score

STOT = standardised seven total, mean = 100, s = 15.

APT 3 = aptitude 3 score

APT. 6 = aptitude 6 score.

The subsequent steps produced a very slight increase in the R-square value, and introduced the more suspect variables such as Std seven science total, std seven mathematics total, etc.

4.5.2 Stepwise regression variation 2: Prediction of Performance Index = V.I.Q. - Ten Tot.

The same independent variables as previously were used to predict the performance index as used previously,[1.)] since the index is a measure of underachievement, the lower the score along the negative scale, the larger the degree of underachievement. The best 8 variable model had an R square value of 0,63, but the decision was made to use the best 5 variable model, for the same reasons as given in the first variation of this model.

The best 5 variable model was found to be

PI = TET - V.I.Q. = - 0,627 - 0,851 V.I.Q. + 1,049 STOT - 0,253 SVGOH + 0,546 APT. 3 - 0,348 APT. 6

R-square = 0,61

where

PI = Performance Index

TET = Standardised Std Ten total, mean 100, s D. = 15

V.I.Q.= verbal I.Q. score

STOT = Standardised Standard Seven total

SVGOH = Standardised Std Seven Geography and History score

1.) See section 4.4.

APT. 3 = J.A.T. Aptitude 3 (Number Ability)

APT. 6 = J.A.T. Aptitude 6 (Spatial 2-D).

It is interesting to note that 0,85 of the V.I.Q. must be subtracted in this model, which is not surprising since it exists as a negative value on the left hand side of the formula. The same two aptitudes (3 and 6) feature in this model as in the first but, surprisingly, it seems to be a disadvantage to have ability in 2-D spatial perception, and in standard seven Geography/History.

Also of interest is that neither aptitude 3 or 6 are used in the Estimated I.Q. calculation.[1.)]

4.5.3 Stepwise regression variation 3: Prediction of Standardised Ten Total for pupils with V.I.Q.$\geq$112.

This model was tested to see if above average intelligence pupils have different factors in operation when performance and underachievement are predicted. Since only 30 candidates were used in this model because of missing values, the results must once again be treated with caution.

The best 8 variable model produced an R square value of 0,58, but the best 6 variable model was chosen.

1.) See section 2.4.1.2.

$$\text{TET} : \text{V.I.Q.} \geq 112 = 90{,}97 - 8{,}53\ \text{AGE} + 1{,}18\ \text{APT. 5} - 0{,}79\ \text{APT. 6} - 1{,}12\ \text{APT. 7} + 1{,}65\ \text{PROF 1} + 1{,}47\ \text{PROF 2}$$

$R^2$ R-Square = 0,55

TET = Standardised Std Ten total, mean 100, S.D. = 15

AGE = Age in decimal of pupils when in Std Seven

APT. 5 = J.A.T. Aptitude 5 (Comparison)

APT. 6 = J.A.T. Aptitude 6 (Spatial 2-D)

APT. 7 = J.A.T. Aptitude 7 (Spatial 3-D)

PROF 1 = J.S.P.B. Proficiency 1 (English)

PROF 2 = J.S.P.B. Proficiency 2 (Mathematics).

It is to be expected that the above average intelligence pupils will be younger than the others in standard seven.[1.)] Once again aptitude 6 makes a negative appearance, almost as if a previously acquired skill is no longer of use in standard ten, whereas the more complicated function of 3-D spatial (Aptitude 7) is. The earlier acquired proficiencies of First Language and Mathematics explain the variance at only 7,4% and 2% respectively.

4.5.4 Stepwise regression variation 4: Prediction of Performance Index of pupils with V.I.Q. $\geq$ 112 where P.I. = St.TET - V.I.Q.

This variation is the same as variation 2, except only the pupils with V.I.Q. $\geq$ 112 were used. The

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1.) Ackerman (1973 p 8) suggests an earlier start at schooling as a reason best 8 variable model produced an R square = 0,501, and the best 5 variable model was chosen.

PI: TET - V.I.Q. = 136.7 - 11.30 AGE - 0,98 V.I.Q.

+ 1,19 APT; 5 + 1,61 PROF 1 + 1,47 PROF 2

R-Square = 0,42

where

TET = Standardised Ten total

AGE = Decimalised Age of pupil in September Std Seven

V.I.Q. = Verbal I.Q. score

APT. 5 = J.A.T. Aptitude 5 (Comparison)

PROF 1 = J.S.P.B. Proficiency (First Language)

PROF 2 = J.S.P.B. Proficiency 2 (Mathematics).

This time virtually the total V.I.Q. has to be subtracted, and the age factor is the same as for variation 3. The sudden appearance of Aptitude 5 makes one suspect the value of using this model for meaningful decision making.

## 4.6 EVALUATION OF PREDICTION MODELS

In evaluating the four major models of predicting underachievement, we must remind ourselves of the objective of this investigation: To find a tool from data readily available to senior school teachers, which they can use to predict under-achievement amongst average and above-average pupils at a semi-rural English speaking boys' school. To find the most effective tool, we must therefore bear in mind the following factors -

1. accessibility of data;
2. ease of statistical manipulations;
3. validity of statistical manipulation.

### 4.6.1 Accessibility of data

As we have seen previously[1.)] from the analysis of statistics used, the data required for these evaluations are readily available to teachers working in South African provincial schools. The N.S.A.G.T. results are collected in the primary standards three and five, and recorded in pupils' cumulative records which are at the disposal of teachers. The J.A.T. and J.S.P.B. results are similarly collected in September of the standard seven year and recorded in the cumulative records. There is

1.) See section 3.3.1

therefore no way of distinguishing amongst the predictor models regarding this criterion since all models use the same information in various combinations.

### 4.6.2 Ease of statistical manipulation

As far as the individual investigator is concerned, this area must depend on the availability of a micro-computer or electronic calculator. After that the investigator will have to decide which statistical process is more easily understood before the decision is made as to which one to use, assuming all methods have equal statistical validity. Of the four types of model - linear regression, stanine, performance index and stepwise regression - the linear regression is the easiest since the graphic display is easy to record, and the linear regression equation easy to calculate on most pocket calculators. Most calculators are programmed for the operation and, if not, the ingredients of the formula, such as $\Sigma x^2$ etc are usually easy to find.

Both the stanine model and performance index model have at their core the standardisation of marks, so it is doubtful if either will be faster to work out than the other. Many calculators can be programmed for such an operation as standardisation.

The stepwise regression model is the least attractive under this criterion, since it can be done only if a micro-computer and a stepwise programme are available. Most investigators and many schools do not have the financial resources available for such an operation.

4.6.3 Validity of statistical manipulation

All definitions of underachievement have to be reduced to a statistical operation before they can be used for predictive purposes. As Wellington and Wellington (1965) have already pointed out,[1.)] different definitions identify different under-achievers. This is also done in this study.

In the case of each definition, the critical question is: Where must the line defining underachievement be drawn so that the maximum number of future under-achievers can be identified? Each model can have a variable line. The linear regression decision line can be drawn anywhere, the stanine model is usually at two stanines, but could be at 1,75 or 3,75 stanines etc. The performance index model can similarly also be drawn anywhere, 10,15 or 115 points difference. Obviously, the further the line is away from normal, the more likely that the few so identified will be stereotype underachievers, the closer the line to normal, the more likely some of

1.) See page 15

the many identified will not be future underachievers, merely standard underachievers.

Before comparisons could be made between the models, refinements were made within each model and only one type chosen, as follows -

a) Linear regression: Only one model was used, with the critical distance $S_y = s_y\sqrt{1-r^2}$ left for comparative purposes.

b) Stanine: The model V.I.Q. stanine placed against standard seven examination total stanine was chosen after a chi-squared test revealed that there was no difference between the predictive values of the three tests. The figures used are shown in table 4.14.

Table 4.14

NUMBER OF UNDERACHIEVERS CORRECTLY IDENTIFIED USING THE VARIOUS STANINE TESTS.

| | Test 1 | Test 2 | Test 3 | Totals |
|---|---|---|---|---|
| Underachievement redicted in Std 7 | 49 | 78 | 8 | 133 |
| Underachievers ɔund | 40 | 58 | 6 | 101 |
| | 89 | 136 | 14 | 234 |

Key: Test 1 = V.I.Q. stanine - standard seven examination stanine $\geqslant 2$.

Test 2 = V.I.Q. stanine - standard seven subject stanine $\geq 2$ in two or more subjects.

Test 3 = V.I.Q. stanine - J.S.P.B. stanine Ave $\geq 2$.

With 2 degrees of freedom, a $\chi^2$ value of 0, was obtained, given a value of $0{,}975 > p > 0{,}95$, hence the Null hypothesis is accepted that there is no difference between the predictive abilities of the three stanine tests.

For the purposes of further comparison with the other models, test 1 was chosen. Test 2 was rejected on the grounds that the calculating of all the standard seven subject stanines would be too tedious an exercise, even though the test identified more underachievers that way. Test 3 was rejected because it predicted far too few candidates, and had to be rejected because its predictive validity was questionable.

c) Performance index: Of the two models tested, the second, whereby underachievement is defined at a 10 points difference between V.I.Q. and standardised examination score at standard seven level, and 15 points difference similarly at standard ten level, was used since it identified a larger number of underachievers.

To see if the tests differ significantly in their predictive value, the following Null hypothesis is formulated -

Null hypothesis 4.7

There is no difference between the predictive abilities of the linear regression, the stanine and performance index models of predicting underachievement.

The results are tabulated in table 4.15.

Table 4.15

NUMBER OF UNDERACHIEVERS CORRECTLY IDENTIFIED USING THREE PREDICTIVE MODELS.

| | Test 1 | Test 2 | Test 3 |
|---|---|---|---|
| Underachievers predicted in standard seven | 18 | 49 | 58 |
| Underachievers found | 12 | 40 | 47 |

Where -

Test 1 = Linear regression model

Test 2 = Stanine model : V.I.Q. - Seven Total $\geq 2$

Test 3 = Performance index model

df = 2 $\chi^2 = 1{,}16$ $p>0{,}50$

The Null hypothesis is therefore accepted.

Since there is no significant difference between the tests as far as predictive value is concerned, we can now determine which sections of the population are identified by each test. Table 4.15 shows us that tests 2 and 3 "found" about 43 underachievers each, yet test 2 predicted 49 and test 3 predicted 58

An analysis of the spread of candidates so identified is shown in table 4.16.

Table 4.16

DISTRIBUTION OF ALL 60 CANDIDATES PREDICTED BY THE THREE PREDICTIVE TESTS AND COMBINATIONS OF TESTS.

| 1 only | 2 only | 3 only | 1,2 only | 1,3 only | 2,3 only | all three |
|---|---|---|---|---|---|---|
| 0 | 1 | 9 | 0 | 0 | 28 | 22 |

Where -

Test 1 = linear regression, critical value $s_y = S_y\sqrt{1-r^2}$

Test 2 = stanine model: V.I.Q. - Seven total $\geq 2$

Test 3 = performance index model: V.I.Q. - standard seven total $\geq 10$.

From table 4.16 we see that test 1, the linear regression model, identifies underachievers who are identified by every other test. This suggests that the critical line can be moved closer to the regression line to identify more candidates who are highly likely to be correctly identified as underachievers. It also means that, in terms of the other models, the linear regression is the most reliable, since candidates predicted by it are sure to be predicted by at least one of the other models.

The large number of candidates identified only by test 3, the performance index model, suggests that the limit of 10 points difference between verbal I.Q. and standardised score is too small. An inspection of cases defined as "test 3 only" shows a range of marks 10-15, average 11,76 and standard deviation 1,69. This suggests that 15 will be a more acceptable critical figure at standard seven level.

Since test 2, the stanine model, cannot be altered by sliding the critical distance except by whole numbers, it seems possible to slide the critical distances in the other two tests until the optimum conditions are met whereby the highest number of underachievers are correctly identified by all three tests.

To do this, the candidates were arranged in ascending order of underachievement according to the linear regression test, using the standard deviation measure of the actual score subtracted from the predicted score according to the regression line, as the unit of measurement. Next to that the stanine difference, V.I.Q. - seven total, was indicated for each candidate and, next to that, the performance index score, V.I.Q. - standardised seven total. To complete the picture, the subsequent academic performance of the candidate was indicated. The results are recorded in table 4.17.

Table 4.17

TABULAR ARRAY IN ASCENDING ORDER, ACCORDING TO LINEAR REGRESSION PERFORMANCE, OF PUPILS WITH COMPARATIVE STANINE AND PERFORMANCE INDEX TOTALS, AS WELL AS THEIR SUBSEQUENT PERFORMANCE.[1.)]

| | Identifying Test Results | | | Subsequent Performance | |
|---|---|---|---|---|---|
| Student No | Std Diff | S-9 Diff | P.I. | Under | Achieve |
| 54 | -2,57 | -4 | -31 | x | |
| 6 | -1,98 | -3 | -25 | x | |
| 127 | -1,82 | -4 | -30 | x | |
| 213 | -1,68 | -4 | -29 | x | |
| 216 | -1,68 | -3 | -23 | x | |
| 252 | -1,55 | -3 | -25 | 1,2,3 | |
| 152 | -1,52 | -3 | -27 | 1,2,3 | |
| 112 | -1,48 | -3 | -22 | x | |
| 114 | -1,48 | -4 | -24 | 2,3 | |
| 104 | -1,42 | -3 | -23 | x | |
| 40 | -1,33 | -2 | -20 | x | |
| 50 | -1,30 | -2 | -19 | 1,2,3 | |
| 194 | -1,29 | -3 | -23 | 2,3 | |
| 44 | -1,28 | -2 | -18 | 1,2,3 | |
| 190 | -1,24 | -2 | -18 | x | |
| 77 | -1,23 | -2 | -18 | | x |
| 23 | -1,20 | -2 | -19 | x | |
| 150 | -1,16 | -2 | -17 | x | |
| 35 | -1,15 | -3 | -18 | 2 | |
| 126 | -1,09 | -2 | -25 | 3 | |
| 203 | -1,05 | -2 | -17 | x | |
| 29 | -0,98 | -2 | -17 | x | |
| 165 | -0,97 | -2 | -16 | | x |
| 193 | -0,96 | -3 | -19 | 1,2,3 | |
| 218 | -0,96 | -2 | -16 | 2,3 | |
| 155 | -0,90 | -2 | -15 | 3 | |
| 125 | -0,89 | -2 | -14 | x | |

1.) Key to Table 4.17 on page 109

| | Identifying Test Results | | | Subsequent Performance | |
|---|---|---|---|---|---|
| Student No | Std Diff | S-9 Diff | P.I. | Under | Achieve |
| 15 | -0,88 | -2 | -14 | 2,3 | |
| 206 | -0,86 | -3 | -16 | 2,3 | |
| 139 | -0,86 | -2 | -15 | x | |
| 148 | -0,85 | -2 | -17 | x | |
| 214 | -0,84 | -3 | -19 | x | |
| 76 | -0,84 | -2 | -15 | x | |
| 34 | -0,81 | -2 | -15 | x | |
| 48 | -0,81 | -2 | -15 | x | |
| 107 | -0,79 | -1 | -14 | x | |
| 226 | -0,76 | -2 | -15 | 2,3 | |
| 31 | -0,76 | -2 | -14 | 2,3 | |
| 224 | -0,75 | -3 | -21 | 2,3 | |
| 27 | -0,75 | -1 | -13 | 1,2,3 | |
| 128 | -0,71 | -2 | -18 | 1,2,3 | |
| 210 | -0,67 | -2 | -16 | 2,3 | |
| 49 | -0,64 | -1 | -11 | 2,3 | |
| 69 | -0,57 | -2 | -13 | x | |
| 191 | -0,48 | -1 | -10 | | x |
| 133 | -0,47 | -2 | -14 | | x |
| 163 | -0,47 | -1 | -13 | 2,3 | |
| 2 | -0,45 | -2 | -12 | x | |
| 157 | -0,45 | -2 | -11 | x | |
| 63 | -0,45 | -0 | -9 | 2,3 | |
| 137 | -0,44 | -2 | -15 | 1,2,3 | |
| 9 | -0,43 | -2 | -11 | 1,2,3 | |
| 19 | -0,42 | -2 | -12 | x | |
| 33 | -0,39 | -1 | -11 | 2 | |
| 164 | -0,36 | -1 | -9 | x | |
| 147 | -0,34 | -1 | -10 | 2 | |
| 21 | -0,33 | -1 | -10 | x | |
| 156 | -0,29 | -1 | -13 | 1,2,3 | |
| 55 | -0,18 | -1 | -9 | 2 | |
| 14 | -0,17 | -1 | -9 | x | |
| 215 | -0,17 | -1 | -9 | 2,3 | |
| 111 | -0,16 | -1 | -14 | | x |
| 72 | -0.16 | -1 | -9 | | x |

| Student No | Identifying Test Results | | | Subsequent Performance | |
|---|---|---|---|---|---|
| | Std Diff | S-9 Diff | P.I. | Under | Achieve |
| 247 | -0,15 | -2 | -12 | 2,3 | |
| 57 | -0,15 | -2 | -8 | | x |
| 70 | -0,12 | -1 | -8 | | x |
| 99 | -0,11 | -1 | -8 | 2 | |
| 32 | -0,11 | -1 | -7 | x | |
| 114 | -0,10 | -2 | -11 | 2 | |
| 121 | -0,08 | -1 | -10 | 2,3 | |
| 25 | -0,03 | -1 | -6 | 2,3 | |
| 135 | 0,01 | -1 | -9 | | x |
| 208 | 0,02 | -1 | -7 | 1,2,3 | |
| 158 | 0,03 | -1 | -7 | | x |
| 250 | 0,04 | -1 | -10 | | x |
| 26 | 0,04 | 0 | -6 | | x |
| 243 | 0,06 | -1 | -8 | | x |
| 253 | 0,07 | -1 | -9 | | x |
| 45 | 0,08 | -1 | -6 | 2,3 | |
| 118 | 0,09 | -1 | -5 | 2,3 | |
| 209 | 0,10 | -1 | -8 | 2 | |
| 205 | 0,12 | 0 | -5 | | x |
| 73 | 0,13 | 0 | -6 | x | |
| 22 | 0,14 | -1 | -6 | x | |
| 106 | 0,15 | -1 | -10 | 1,2,3 | |
| 246 | 0,17 | -1 | -8 | 2,3 | |
| 204 | 0,17 | -1 | -2 | | x |
| 65 | 0,24 | -1 | -5 | | x |
| 78 | 0,25 | 0 | -5 | | x |
| 18 | 0,26 | -1 | -5 | 1,2,3 | |
| 3 | 0,27 | -1 | -3 | | x |
| 134 | 0,30 | 0 | -5 | | x |
| 140 | 0,30 | 0 | -5 | | x |
| 13 | 0,31 | -1 | -4 | x | |
| 108 | 0,32 | 0 | -2 | | x |
| 237 | 0,33 | -1 | -7 | | x |
| 100 | 0,33 | -1 | -5 | | x |
| 39 | 0,41 | 0 | -1 | | x |
| 75 | 0,47 | 0 | -3 | | x |
| 227 | 0,48 | -1 | -3 | | x |

| Student No | Identifying Test Results | | | Subsequent Performance | |
|---|---|---|---|---|---|
| | Std Diff | S-9 Diff | P.I. | Under | Achieve |
| 241 | 0,49 | 3 | -2 | | x |
| 17 | 0,51 | 0 | -2 | | x |
| 103 | 0,55 | 0 | 0 | | x |
| 204 | 0,52 | 0 | -2 | | x |
| 245 | 0,57 | 0 | -2 | | x |
| 52 | 0,57 | 0 | 0 | 2 | |
| 74 | 0,59 | 0 | -2 | | x |
| 251 | 0,59 | 0 | 0 | | x |
| 232 | 0,61 | 0 | 3 | | x |
| 54 | 0,62 | 0 | -2 | | x |
| 219 | 0,63 | -1 | -5 | | x |
| 117 | 0,68 | 0 | 0 | 2,3 | |
| 62 | 0,69 | 0 | 0 | | x |
| 159 | 0,69 | 0 | 0 | | x |
| 82 | 0,72 | 0 | 0 | 2 | |
| 161 | 0,77 | 0 | 2 | 1,2,3 | |
| 200 | 0,81 | 0 | 2 | | x |
| 153 | 0,85 | -1 | -2 | | x |
| 5 | 0,85 | 0 | 2 | 2 | |
| 166 | 0,93 | 0 | 4 | 1,2,3 | |
| 220 | 0,94 | 1 | 1 | | x |
| 221 | 0,95 | 0 | 0 | | x |
| 66 | 0,96 | 1 | 2 | | x |
| 199 | 0,97 | 1 | 3 | | x |
| 16 | 0,98 | 0 | 1 | 2 | |
| 46 | 1,01 | 0 | 2 | 2 | |
| 10 | 1,01 | 1 | 4 | | x |
| 141 | 1,04 | 0 | 1 | | x |
| 105 | 1,04 | 1 | 4 | | x |
| 8 | 1,05 | 1 | 3 | 2,3 | |
| 116 | 1,07 | 0 | 4 | | x |
| 235 | 1,09 | 1 | 3 | | x |

| | Identifying Test Results | | | Subsequent Performance | |
|---|---|---|---|---|---|
| Student No | Std Diff | S-9 Diff | P.I. | Under | Achieve |
| 231 | 1,10 | 1 | 7 | | x |
| 41 | 1,13 | 0 | 4 | | x |
| 67 | 1,13 | 1 | 4 | | x |
| 238 | 1,14 | 1 | 6 | | x |
| 239 | 1,19 | 1 | 5 | | x |
| 228 | 1,24 | 1 | 3 | | x |
| 149 | 1,24 | 1 | 4 | | x |
| 202 | 1,28 | 1 | 8 | | x |
| 30 | 1,31 | 1 | 5 | 2 | |
| 145 | 1,31 | 0 | 8 | | x |
| 53 | 1,37 | 1 | 7 | | x |
| 20 | 1,39 | 0 | 6 | | x |
| 201 | 1,41 | 1 | 7 | | x |
| 42 | 1,43 | 1 | 6 | 2 | |
| 11 | 1,44 | 1 | 7 | | x |
| 120 | 1,47 | 1 | 7 | | x |
| 230 | 1,50 | 1 | 8 | | x |
| 162 | 1,57 | 2 | 10 | | x |
| 136 | 1,59 | 2 | 12 | | x |
| 60 | 1,62 | 1 | 7 | | x |
| 101 | 1,63 | 1 | 9 | | x |
| 109 | 1,73 | 1 | 9 | | x |
| 81 | 1,84 | 2 | 11 | | x |
| 167 | 1,84 | 2 | 13 | | x |
| 195 | 1,84 | 2 | 19 | | x |
| 115 | 1,98 | 1 | 13 | | x |
| 110 | 2,06 | 2 | 14 | | x |
| 24 | 2,21 | 2 | 14 | | x |
| 12 | 2,23 | 2 | 14 | | x |
| 242 | 2,40 | 3 | 19 | | x |
| 68 | 2,59 | 3 | 18 | | x |

Key to Table 4.17

Student No: Number assigned to student for identification.

Std Diff: Underachievement index on the linear regression scale expressed in standard deviations. Calculated by subtracting actual score from predicted score and dividing by the performance standard deviation for the group.

S-9 Diff: Stanine model; V.I.Q. - Seven Total.

P.I.: Performance index; V.I.Q. - Seven Total.

Under: Pupils who either failed, dropped out or were identified by tests to be underachieving in standard ten.

1: Linear regression identification in standard ten.

2: Stanine model identification in standard ten.

3: P.I. identification: Standardised Ten Total - V.I.Q.

Achieve: Pupils who did not underachieve.

From table 4.17 a very clear picture emerges, and it becomes possible to make the decision about the critical level less arbitrarily. As the linear regression difference becomes less, so does the stanine difference and performance index, and the percentage of subsequent underachievement starts decreasing. At -1.24 Std Diff the % underachievement is still 100%, at -0,98 the % is 95 %, at -0,48 the percentage is still as high as 95 %.

It should be borne in mind however that we have not established in this study that the three methods of identifying underachievement in standard ten are valid measures in terms of the pupils' performance subsequent to standard ten. In fact, the frequent appearance of test 2 in the "under" column, even at the +0,17 Std Diff level points out two warnings -

1. The stanine model casts a very wide net in its definition of underachievement.

2. The examination performance of pupils over four years fluctuates considerably. The pupils who perform at the +0,17 level in seven may well be on their way down when measured in seven, whereas others at the -0,16 level may be on their way up.

We should also remember that we are assuming that a pupil with V.I.Q. $\geq$ 89 is underachieving if he drops out or fails. This is so only if we define underachieving as being equivalent to lack of success at academic work, not equivalent to failure in life. A few pupils known to the investigator, two not predicted as underachievers, left school and did very well at a trade, but their results were included as unpredicted underachievers for consistency.

However, we obviously have a useful tool to guide pupils and teachers in terms of the concept "success at academic work", and a decision can be made as to where the critical line should be drawn. An inspection of the figures shows that at the -0,75 Std Diff level, a total of 40 observations, only 2 stanine values are not less than -1, and only 5 P.I. values are not less than -14, all 5 values being either -14 or -13.

### 4.6.4 Conclusion and Recommendation

We therefore conclude that of the models tested for standard 7, the linear regression model commends itself with the critical level at -0,75 standard deviations from the regression line because -

1. at that level it has an extremely high accuracy of prediction;

2. it is by far the easiest to compute and present graphically;

3. it is the easiest for all interested parties to understand.

4.6.5 Rule of Thumb Method

We saw earlier [1.)] that some investigators use an arbitrary cut-off method by defining the bottom 25% of the class as being underachieving. This seems a dangerous method since no account is taken of the probable distribution of the group according to ability in relation to the rest of the population.

To derive a more satisfactory rule of thumb method which requires almost no calculation when applied, the results were arranged per group in ascending order according to the criterion standard seven total as percentage - V.I.Q. In addition the cumulative percentage of cases was indicated in the group. The first 30% in ascending order indicated in table 4.18. It should be remembered that decision-making for performance is always done in the group, not over the passage of years.

1.) See page 13

Table 4.18

RULE OF THUMB TABLE IN ASCENDING ORDER

Group 1

| Cum Perc | Stot-VIQ | P.I. | S-9 Diff | Std Diff | Student |
|---|---|---|---|---|---|
| 1.2 | -74 | -31 | -4 | -2.57 | 54 |
| 2.4 | -72 | -24 | -3 | -2.07 | 36 |
| 3.7 | -69 | -25 | -3 | -1.98 | 6 |
| 4.9 | -64 | -18 | -2 | -1.28 | 44 |
| 6.1 | -63 | -21 | -3 | -1.41 | 80 |
| 7.3 | -63 | -20 | -2 | -1.33 | 40 |
| 8.5 | -63 | -19 | -2 | -1.30 | 50 |
| 9.8 | -63 | -18 | -2 | -1.23 | 77 |
| 11.0 | -63 | -15 | -2 | -1.04 | 71 |
| 12.2 | -62 | -19 | -2 | -1.20 | 23 |
| 13.4 | -62 | -18 | -3 | -1.15 | 35 |
| 14.6 | -61 | -14 | -2 | -0.88 | 15 |
| 15.9 | -61 | -11 | -1 | -0.64 | 49 |
| 17.1 | -60 | -17 | -2 | -0.98 | 29 |
| 18.3 | -60 | -13 | -1 | -0.75 | 27 |
| 19.5 | -60 | - 9 | 0 | -0.45 | 63 |
| 20.7 | -59 | -15 | -2 | -0.84 | 56 |
| 22.0 | -59 | -15 | -2 | -0.84 | 76 |
| 23.2 | -59 | -15 | -2 | -0.81 | 34 |
| 24.4 | -59 | -15 | -2 | -0.81 | 48 |
| 25.6 | -59 | -14 | -2 | -0.76 | 31 |
| 26.8 | -59 | -13 | -1 | -0.70 | 58 |
| 28.0 | -57 | -13 | -2 | -0.57 | 7 |
| 29.3 | -57 | -13 | -2 | -0.57 | 69 |
| 30.5 | -57 | -12 | -1 | -0.54 | 1 |

Group 2

| Cum Perc | Stot-VIQ | P.I. | S-9 Diff | Std Diff | Student |
|---|---|---|---|---|---|
| 1.4 | -76 | -30 | -1 | -1.82 | 127 |
| 2.9 | -76 | -25 | -2 | -1.09 | 126 |
| 4.3 | -74 | -27 | -3 | -1.52 | 152 |
| 5.7 | -72 | -26 | -4 | -1.51 | 168 |
| 7.1 | -69 | -24 | -4 | -1.46 | 144 |
| 8.6 | -68 | -23 | -3 | -1.46 | 102 |
| 10.0 | -68 | -23 | -3 | -1.42 | 104 |
| 11.4 | -68 | -23 | -3 | -1.42 | 130 |
| 12.9 | -66 | -22 | -3 | -1.48 | 112 |
| 14.3 | -66 | -18 | -2 | -0.71 | 128 |
| 15.7 | -66 | -14 | -1 | -0.16 | 111 |
| 17.1 | -63 | -17 | -2 | -0.85 | 148 |
| 18.6 | -63 | -15 | -2 | -0.48 | 160 |
| 20.0 | -63 | -15 | -2 | -0.44 | 137 |
| 21.4 | -61 | -14 | -2 | -o.47 | 133 |
| 22.9 | -61 | -13 | -1 | -0.29 | 156 |
| 24.3 | -61 | -10 | -1 | -o.15 | 106 |
| 25.7 | -60 | -17 | -2 | -1.16 | 150 |
| 27.1 | -60 | -15 | -2 | -0.87 | 151 |
| 28.6 | -60 | -15 | -2 | -0.76 | 169 |
| 30.0 | -60 | -14 | -2 | -0.58 | 154 |

Group 3

| Cum Perc | Stot-VIQ | P.I. | S9 Diff | Std Diff | Student |
|---|---|---|---|---|---|
| 1.6 | -87 | -40 | -4 | -2.38 | 197 |
| 3.1 | -74 | -29 | -4 | -1.68 | 213 |
| 4.7 | -69 | -25 | -3 | -1.55 | 252 |
| 6.3 | -69 | -21 | -3 | -0.75 | 224 |
| 7.8 | -68 | -26 | -3 | -1.82 | 217 |
| 9.4 | -68 | -23 | -4 | -1.36 | 196 |
| 10.9 | -68 | -23 | -3 | -1.29 | 194 |
| 12.5 | -66 | -19 | -3 | -0.84 | 214 |
| 14.1 | -65 | -23 | -3 | -1.68 | 216 |
| 15.6 | -65 | -20 | -2 | -1.07 | 249 |
| 17.2 | -65 | -19 | -3 | -0.96 | 193 |
| 18.8 | -62 | -16 | -2 | -0.67 | 210 |
| 20.3 | -61 | -18 | -2 | -1.24 | 190 |
| 21.9 | -61 | -17 | -2 | -1.05 | 203 |
| 23.4 | -61 | -16 | -3 | -0.86 | 206 |
| 25.0 | -60 | -16 | -2 | -0.95 | 218 |
| 26.6 | -60 | -15 | -2 | -0.76 | 226 |
| 28.1 | -60 | -12 | -2 | -0.15 | 247 |
| 29.7 | -59 | -10 | -1 | 0.04 | 250 |
| 31.3 | -58 | -14 | -2 | -0.84 | 223 |

Key: As for table 4.17.

Stot-VIQ: Standard seven % for all subjects - V.I.Q.

Although extremely rough and ready, this result is rather startling in that the cut-off point of the bottom 30% of the class occurs at $\pm$ - 60 in each case, despite the fact that we are dealing with different population groups and unstandardised exam totals. If the cut-off point is taken at 25%, it occurs at exactly -60 in each case, and only 6 out of 52 candidates are incorrectly defined as under-achievers according to the other 3 tests.

This method must of course be used only as an emergency measure, since other underachievers escape this net.

## 4.7 SUMMARY

In this chapter an evaluation was done of each of the three major models of predicting underachievement, after refinements were done to the models where required. The models were then evaluated by comparing them to each other, and after it was established as to which candidates were predicted by the different tests, the optimum conditions were established whereby the three tests would correctly predict subsequent underachievement. It was found that the linear regression model at 0,75 std deviations of measurement provided a significantly accurate critical cut-off point, and therefore commended itself for use. The stepwise regression model was recorded but not considered valid for predicting underachievement. A rule-of-thumb method was developed from the data which had value in predicting underachievement.

It is therefore possible to examine underachievement in relation to the use of an estimated I.Q., the use of aptitude profiles and the changing of schools, in the next chapter.

# CHAPTER 5.

## SECONDARY RESULTS ANALYSED AND DISCUSSED

## 5.1 INTRODUCTION

In this chapter the results connected with the secondary aims of the investigation are analysed. These are the use of an estimated I.Q. to predict underachievement, the relationship between aptitude fields and underachievement, and the way changing of schools by pupils affects underachievement.

## 5.2 THE USE OF THE ESTIMATED I.Q.

It often happens that a teacher has to assess the potential of a pupil, but no I.Q. scores are available. Van der Westhuizen (1979, p. 99) has suggested than an estimated I.Q. can be used "with great caution", applying a formula using as ingredients J.A.T. results.[1] He quotes a correlation of o,80 between the estimated I.Q. and the N.S.A.G.T. total I.Q. The correlation matrix of the estimated I.Q. and other variables is given in table 5.1

Table 5.1

CROSS CORRELATION MATRIX OF ESTIMATED I.Q. AND OTHER VARIABLES INDICATED PER GROUP.

Group 1

n = 39

| | E.I.Q. | N.I.Q. | V.I.Q. | T.I.Q. | STOT | TET |
|---|---|---|---|---|---|---|
| E.I.Q. | 1 | | | | | |
| N.I.Q. | 614 | 1 | | | | |
| V.I.Q. | 777 | 651 | 1 | | | |
| T.I.Q. | 796 | 891 | 891 | 1 | | |
| STOT | 752 | 693 | 693 | 815 | 1 | |
| TET | 569 | 489 | 589 | 614 | 827 | 1 |

1.) See page 29

Group 2.

n=19

| | | | | | | |
|---|---|---|---|---|---|---|
| E.I.Q. | 1 | | | | | |
| N.I.Q. | 621 | 1 | | | | |
| V.I.Q. | 665 | 668 | 1 | | | |
| T.I.Q. | 705 | 890 | 920 | 1 | | |
| STOT | 392* | 628 | 703 | 723 | 1 | |
| TET | 338* | 434 | 567 | 561 | 774 | 1 |
| | E.I.Q. | N.I.Q. | V.I.Q. | T.I.Q. | STOT | TET |

Group 3.

n=44

| | | | | | | |
|---|---|---|---|---|---|---|
| E.I.Q. | 1 | | | | | |
| N.I.Q. | 588 | 1 | | | | |
| V.I.Q. | 794 | 745 | 1 | | | |
| T.I.Q. | 734 | 900 | 938 | 1 | | |
| STOT | 701 | 517 | 678 | 650 | 1 | |
| TET | 682 | 387 | 451 | 462 | 909 | 1 |
| | E.I.Q. | N.I.Q. | V.I.Q. | T.I.Q. | STOT | TET |

Key: E.I.Q. = Estimated I.Q.

N.I.Q. = Non verbal I.Q.

V.I.Q. = Verbal I.Q.

T.I.Q. = Total I.Q.

STOT = Seven total

TET = Ten total

In each group n = total used for E.I.Q. calculations. All results are indicated with the decimal ignored, and are significant at the 1% level of confidence, except those marked with an asterisk.

From the results we can see that the E.I.Q. and V.I.Q. correlations all compare favourably with van der Westhuizen's figure of 0,80, despite the small population samples. (Range o,665 - 0,794)

It should therefore be possible to put the E.I.Q. to the same use as the V.I.Q. for predicting under-achievement.

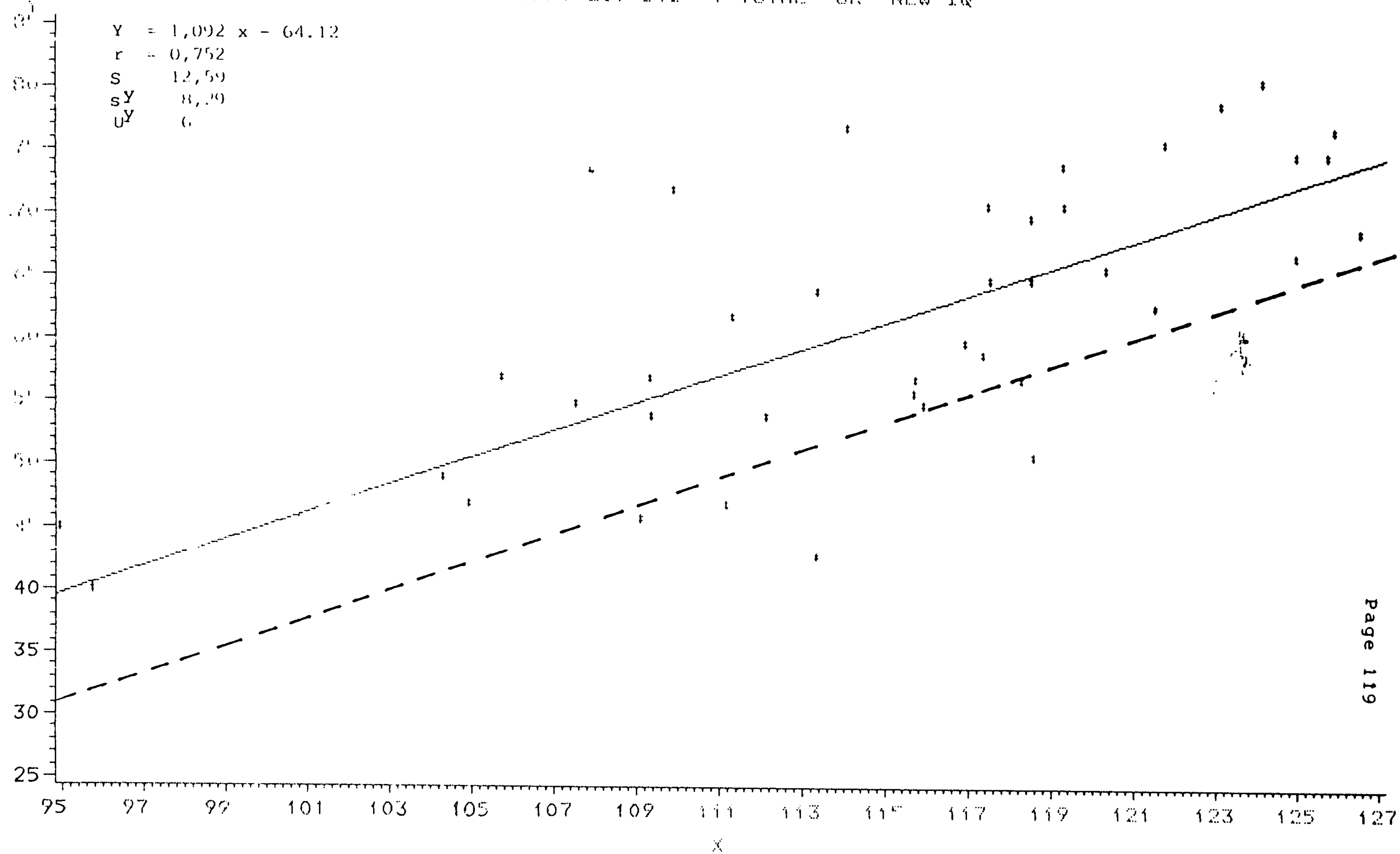
5.2.1 The E.I.Q. in a Linear Regression Model

Since the E.I.Q. can be calculated only when the J.A.T. results are available, an estimated I.Q. could not be calculated for all students. Group 2 had only 19 candidates, so the linear regression graph was abandoned in their case, but the graphs for groups 1 and 3 are reproduced on the next two pages.

In each group 6 underachievers were identified, and the results are recorded in table 5.2.

# LINEAR REGRESSION MODEL

BYVAR:GRP( 2.) STD 7 TOTAL -ON- NEW IQ



# LINEAR REGRESSION MODEL

BYVAR=GRP3 2.) STD

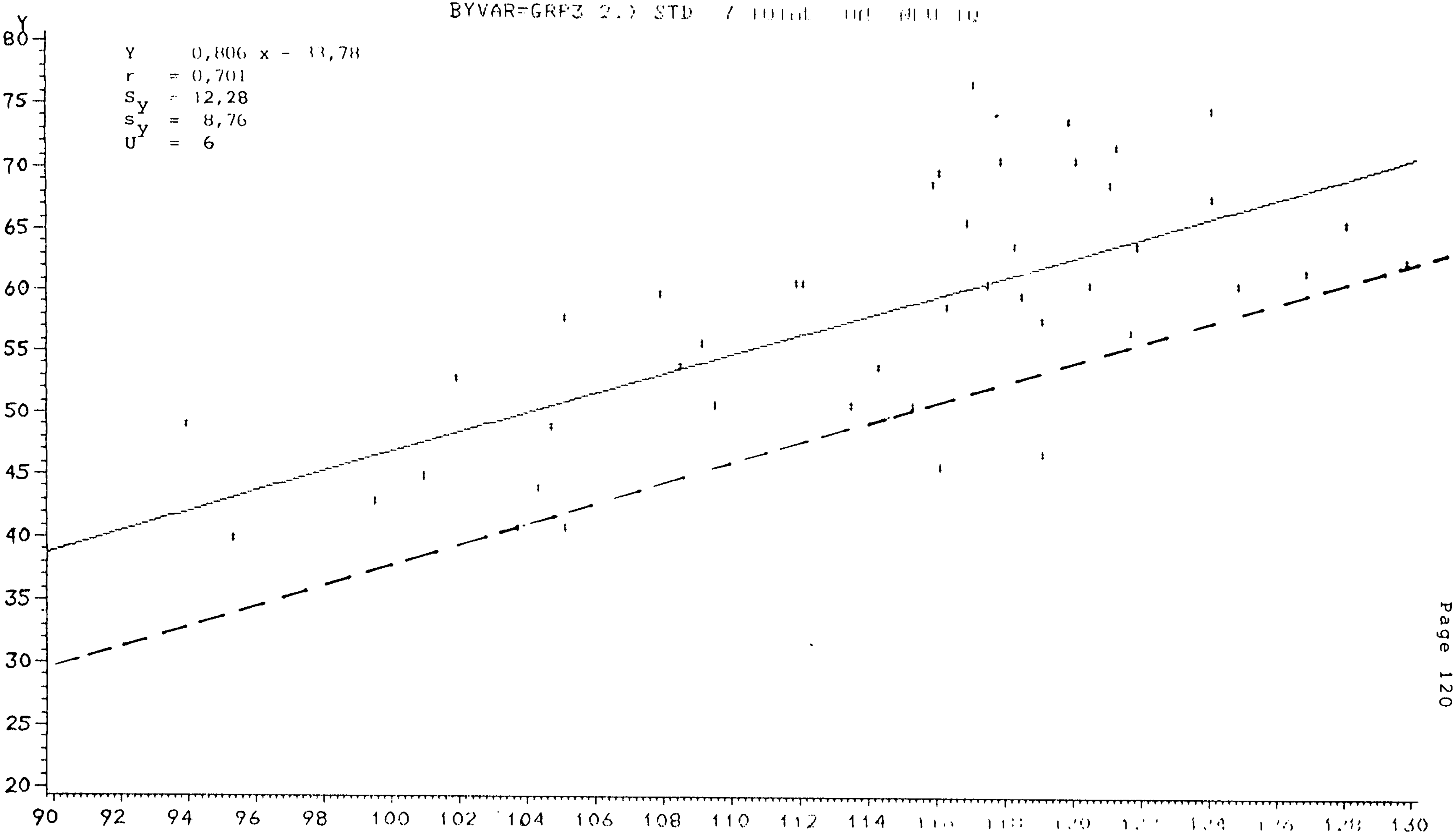


Table 5.2

UNDERACHIEVERS IDENTIFIED USING THE LINEAR REGRESSION METHOD AND AN ESTIMATED I.Q. AS PREDICTOR WITH STANDARD SEVEN EXAMINATION TOTALS

| | Urderachievers predicted | Underachievers not predicted | |
|---|---|---|---|
| Underachievers | 5 | 6 | 11 |
| Achievers | 7 | 65 | 72 |
| | 12 | 71 | 83 |

d.f. = 1 $\chi^2 = 7,146$ $p<0,01$

Key: Underachievers Predicted: Using E.I.Q. against standard seven examination total in a linear regression model.

Underachievers: Those who fail a standard after six, or who drop out, or who are identified as underachievers on the linear regression model in standard ten using V.I.Q. and ten total.

Although the result appears significant, a Null hypothesis was not formulated or rejected since one of the frequency theoretical cells had fewer than 2 cases. However, it does appear that if large enough numbers of candidates are available, the E.I.Q. can be used in a linear regression model to identify underachievers.

However, this is seldom likely to be the case, since most pupils have I.Q. scores assigned to them. It is more likely that the teacher will come across the odd case with no I.Q. assignation, and the E.I.Q. can then be used as a make-shift verbal I.Q. for the pupil's performance to be compared with the rest of the group.

If this is done, "new" underachievers will be defined only in those cases where the estimated I.Q. is more than the verbal I.Q. to the extent that the resultant performance/potential reference point falls below the defined critical line. Similarly, some candidates "already" defined as underachievers will be redefined as achievers if the estimated I.Q. is less than the verbal I.Q.

The significantly high correlation between the two I.Q.'s, as well as between the estimated I.Q. and seven and ten totals suggests that there will not be a major shift in identification of achievers and underachievers. Such a major shift should occur only if there are one or two stanine differences between verbal and estimated I.Q. An inspection of the results shows that, of the 102 cases where the estimated I.Q. is available, a few such differences occur. The results are tabulated in table 5.3.

Table 5.3

NUMBER OF CANDIDATES WHOSE ESTIMATED I.Q. STANINE CATEGORY DIFFER FROM THEIR VERBAL I.Q. CATEGORY

| E.I.Q. stanine count: | 3 or more lower | 2 lower | 1 lower | Same | 1 above | 2 above | 3 or more above |
|---|---|---|---|---|---|---|---|
| | 2 | 1 | 23 | 42 | 24 | 10 | 0 |

The above table suggests that the 13 candidates who have an estimated I.Q. which differs by two or more from the V.I.Q. should be retested. Not much need be said about the rest, since a shift in stanine category could represent a very small shift along the I.Q. scale. Table 5.4 shows how small the difference is in mean and standard deviation in the comparison of verbal I.Q. and estimated I.Q. in each case.

Table 5.4

MEANS AND STANDARD DEVIATIONS OF VERBAL AND ESTIMATED I.Q. IN EACH GROUP

| | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| V.I.Q. mean | 111 | 116 | 111 |
| S.D. | 10,8 | 12,4 | 10,5 |
| E.I.Q. mean | 115 | 108 | 114 |
| S.D. | 7,6 | 11,5 | 8,7 |
| n = | 39 | 19 | 44 |

None of the above means are found to differ significantly using the test of t whereby

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left(\frac{\Sigma x_1^2 + \Sigma x_2^2}{N_1 + N_2 - 3}\right)\left(1 - r^2_{xy}\right)\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}} \quad 1.)$$

Table 5.3 does however hint at a weakness in the use of the E.I.Q. in the areas of disparity. The 10 candidates who have an E.I.Q. of 2 stanines above their V.I.Q. stanine, are in the 3 - 6 V.I.Q. stanine range, whereas the 3 candidates in the 2 or more stanine below V.I.Q. bracket have V.I.Q. scores of 105, 131 and 124. The suggestion that the estimated I.Q. is weak at defining superior and very superior verbal intelligence is reinforced by the statistic that the 102 estimated I.Q.'s have a mean of 113, a standard deviation of 9, and a range from 71 to 129. The V.I.Q. range of the same pupils is from 89 to 144, with a mean of 112 and standard deviation of 9,3. We should bear in mind that the E.I.Q. is merely an estimate of total I.Q., and not verbal I.Q.

### 5.2.2 Conclusion

Since we have already suggested that the linear regression method is the safest predictor of underachievement, it will not be necessary to analyse the use of the E.I.Q. in the other two methods, although it can obviously be done.

From the above results it can be seen that a teacher is unlikely to be making a serious mistake if he uses the E.I.Q.

1.) Edwards (1956, p 200)

if the V.I.Q. is not available, and he discovers underachievement as a result. Whereas he should be cautious about his conclusions, he should be even more cautious about conclusions reached about pupils who could have a V.I.Q. > 127.

## 5.3 THE USE OF STANINE APTITUDE PROFILES IN DETERMINING UNDERACHIEVEMENT

### 5.3.1 Introduction

Van der Westhuizen (1979, p. 98) defines six wider aptitude fields which can be interpreted more meaningfully than the results of the individual tests, if the average stanine for the pupil in each group is calculated. He warns that the results are not yet empirically based, but argues that the results are the logical deductions of research undertaken using the Senior Aptitude tests.

We have already seen that individual aptitude results contribute to predictions of standard ten results when stepwise regression analyses are done. Van der Westhuizen (1979, pp. 203-206) provides much further evidence of significantly high correlations between individual aptitudes and individual subjects at high school. He quotes, for example (p. 201), that all ten J.A.T. results correlate at the 1% level in predicting achievement in the first language of English speaking boys in standard six, but tests 1, 6 and 7 do not contribute at all in predicting the same subject for standard six.

Whereas we are aware of possible relationships between the aptitudes and achievement, the purpose of this investigation is to see if a meaningful pattern can be found between underachievement and the six aptitudes.

5.3.2 Method Used

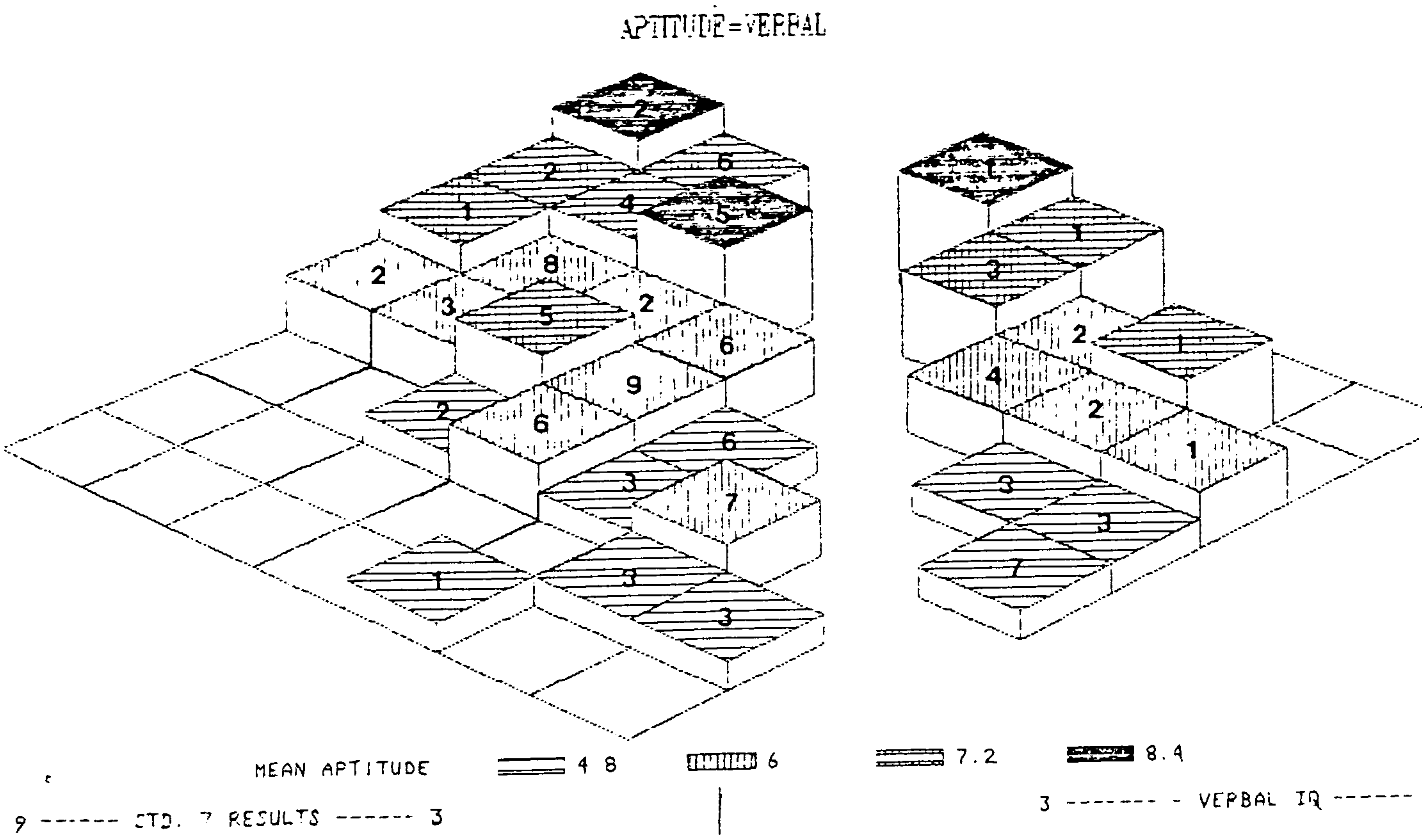
The method used was to allocate the 112 standard seven pupils for which the J.A.T. results are available and to allocate the pupils to their rectangle on a stanine grid with verbal I.Q. on the X axis, and standard seven results on the Y axis. The average stanine for the group for each aptitude was then calculated and brought to the nearest average to one of four levels. The levels cover the mean range at $\pm$ 1,2 stanine intervals.

The resultant mean was then used as a three-dimensional histogram on the Z axis. The resultant three-dimensional pattern was then split at the underachievement line, i.e. at the line where the V.I.Q. stanine - standard seven result stanine was equal to or greater than 2.

5.3.3 Results

The results are indicated graphically on the following pages, with the discussion for each aptitude below the graph. The number of candidates used is indicated in each stanine square.

# STANINE PROFILES - ALL STUDENTS




1. APTITUDE - VERBAL

This aptitude is a combination of test 2 (Reasoning), test 4 (Synonyms) and test 8 (Memory-paragraph). Since verbal ability gives the highest correlation to academic achievement,[1.)] and V.I.Q. is used throughout, even in this model, as a predictor of academic achievement one expects the weaker candidates (those in the 4/3, 5/3, 4/4, 5/4 squares) to be lower scorers, and the strong candidates to be high scorers.

This is obviously the case here, since we can see that as we progress along the X and Y axis, we also progress up the Z axis. The 7 candidates in the verbal 5/result 4 rectangle appear the odd ones out, but not significantly so since their mean score is only 1,2 better than their surrounding squares.

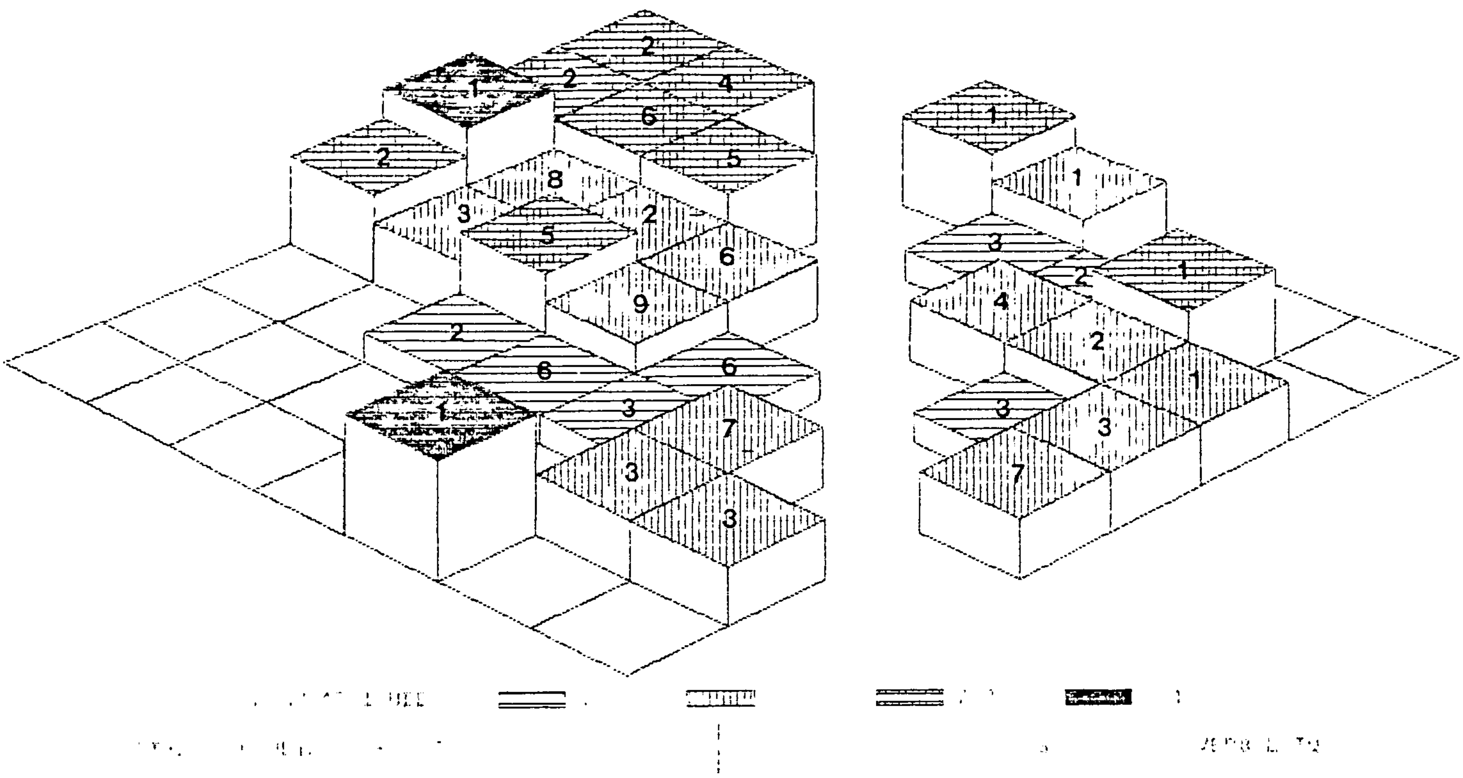
1.) Laubscher (1976) p 6

What is significant is that the same performance pattern is repeated for the underachievers, those in the right hand side set of blocks. The two sets of blocks fit together without any discontinuity worth mentioning.

From this we can only conclude that underachievers do not lack in verbal ability, to the extent that it causes under-achievement.

# STANINE PROFILES - ALL STUDENTS

APTITUDE=NUMERIC



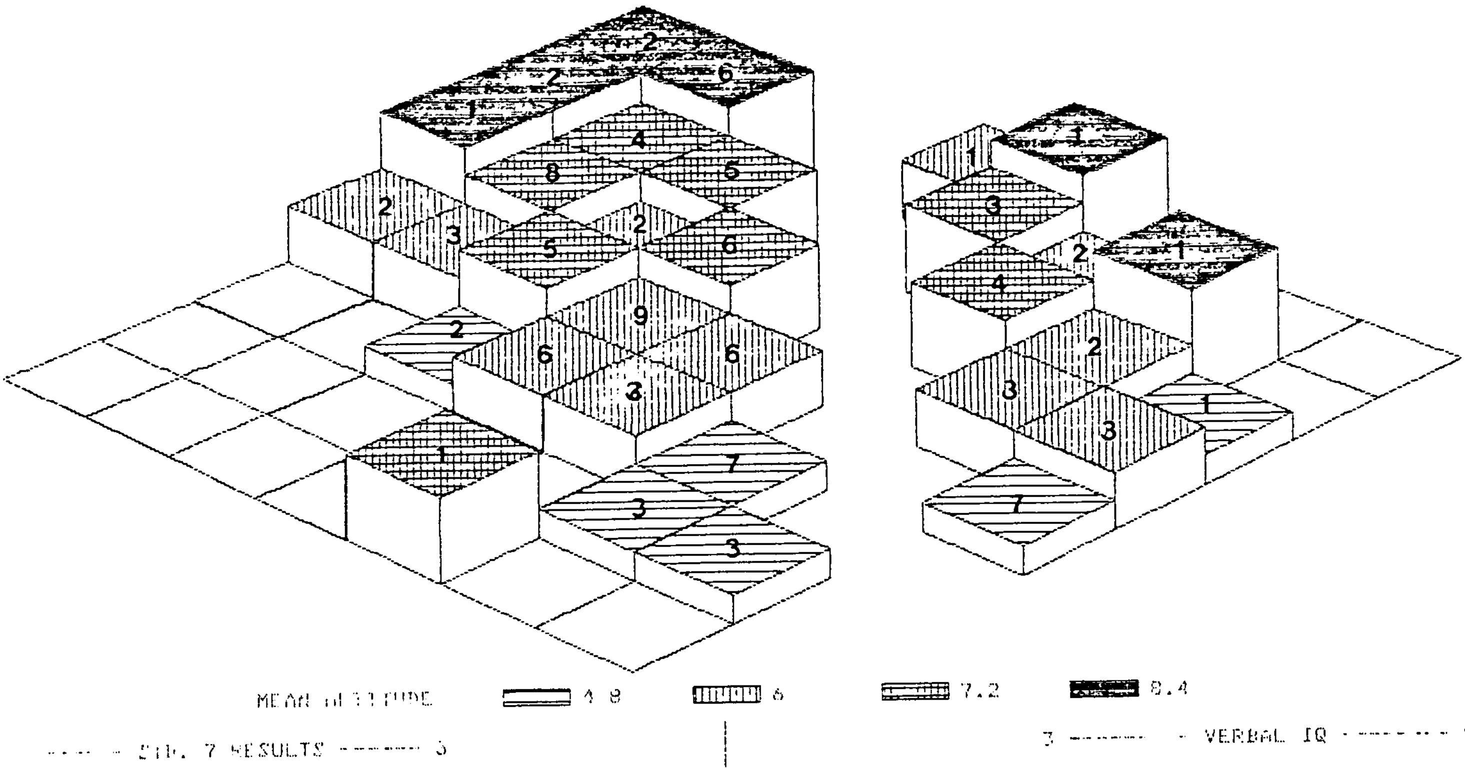
2. NUMERICAL APTITUDE

This aptitude is a combination of tests 3 (Number Ability) and 5 (Comparison). Although a general tendency emerges for Z to increase while X and Y increase, the pattern is less certain. Only two pupils score at mean 8,4, whereas the plateau of mean 6 appears in two distinct areas. The one area is on either side of the underachievement line amongst the average and below average performers, and the other in the 6-8 stanine category. By and large the 8-9 categories contain the pupils with better numerical ability, with their average at 7,2 or 8,4.

Once again the group of underachievers seem to be no different in this category to the achievers.
The underachievers seem to have the same ability in numeric aptitude, and we cannot from this conclude that lack of this ability is related to underachievement.

# STANINE PROFILES - ALL STUDENTS

APTITUDE=VISUAL/SPATIAL



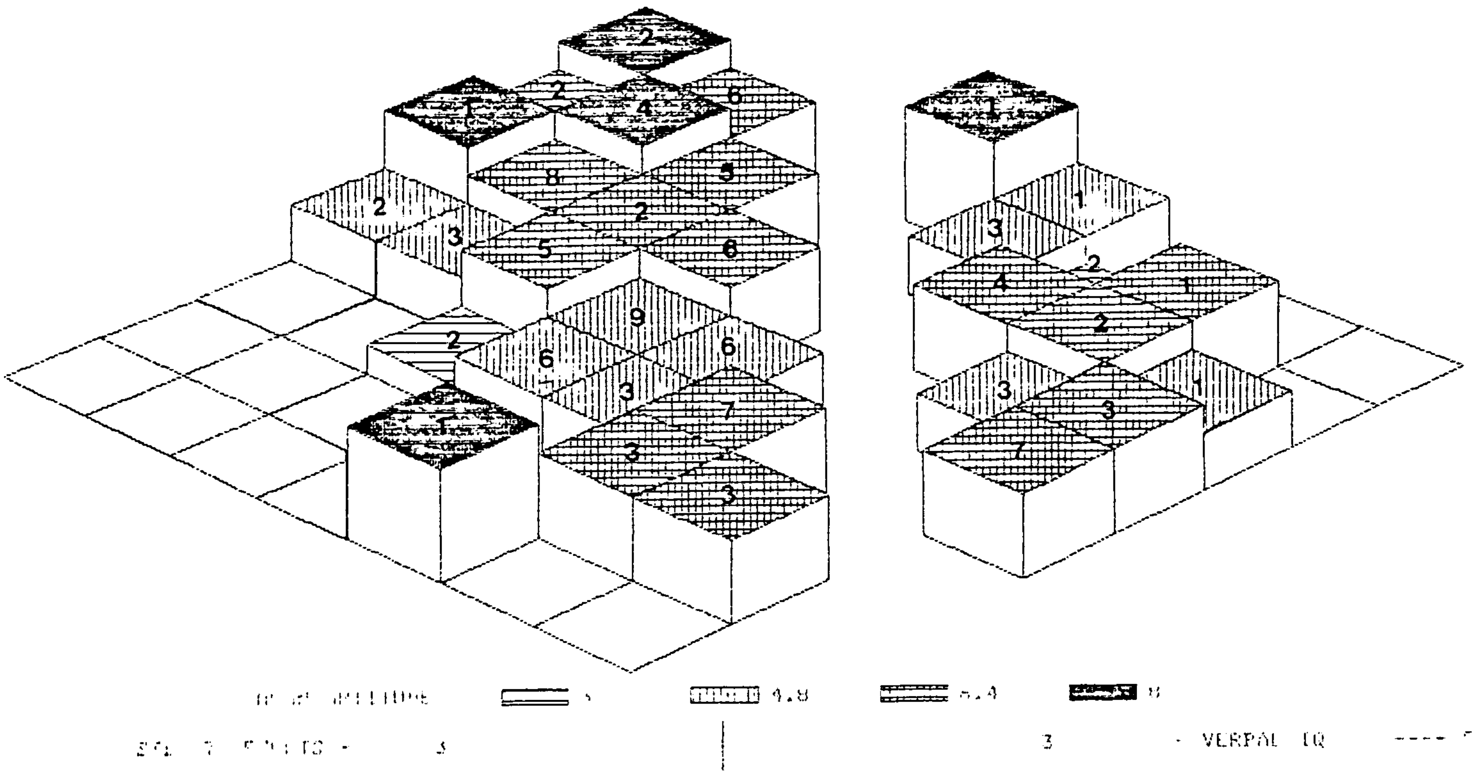

3. APTITUDE - VISUAL SPATIAL REASONING

This aptitude is a combination of tests 1 (Classification), 6 (Spatial 2D) and 7 (Spatial 3D). As can be expected, this aptitude is visibly directly related to both verbal I.Q. and academic performance. In almost all cases, three blocks on a diagonal line represents a significant 2,4 stanine difference in the means.

Once again there is no evidence that underachievers are such because they lack this ability, since their graphic pattern fits in smoothly with that of the achievers.

STANINE PROFILES - ALL STUDENTS

APTITUDE=CLERICAL



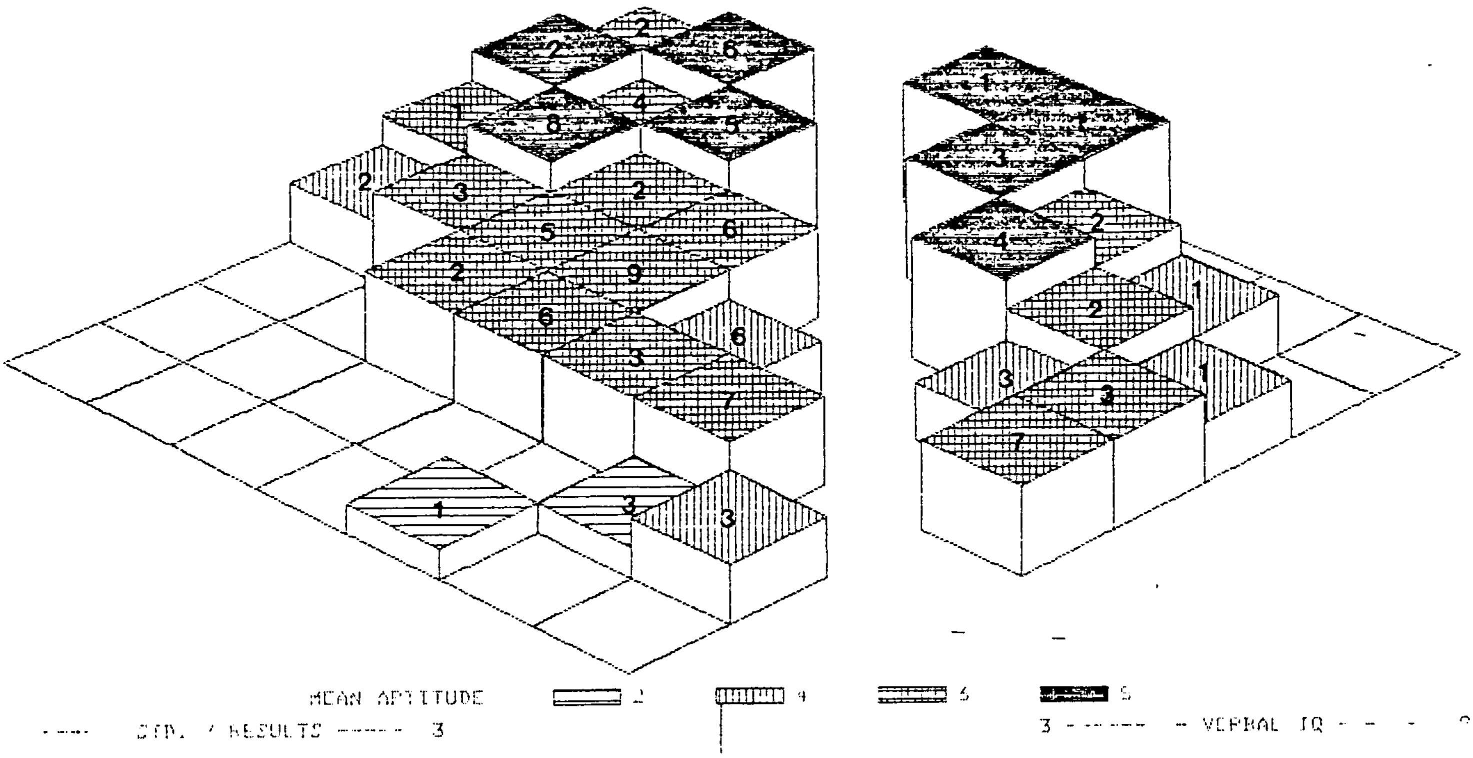

4. CLERICAL APTITUDE

This aptitude is so defined from test 5 (Comparison). If this aptitude defines what is normally meant by clerical aptitude, then no relationship is expected between it and the other two variables, verbal I.Q. and standard seven academic performance. This lack of relationship seems to be the case here. High-scoring (6,4 mean) candidates are scatterd all over, amongst achievers and underachievers alike. In the middle of the profile they are divided by 27 lesser performers (mean 4,8).

The underachievers have this ability just as haphazardly scattered amongst their ranks. Although it seems that this aptitude helps academic performance slightly at standard seven level, it does not seem to produce underachievement. It should be noted that in this graphic profile the mean differences are 1,6 stanines, which makes them close to significantly high.

STANINE PROFILES - ALL STUDENTS

APTITUDE=MECHANICAL



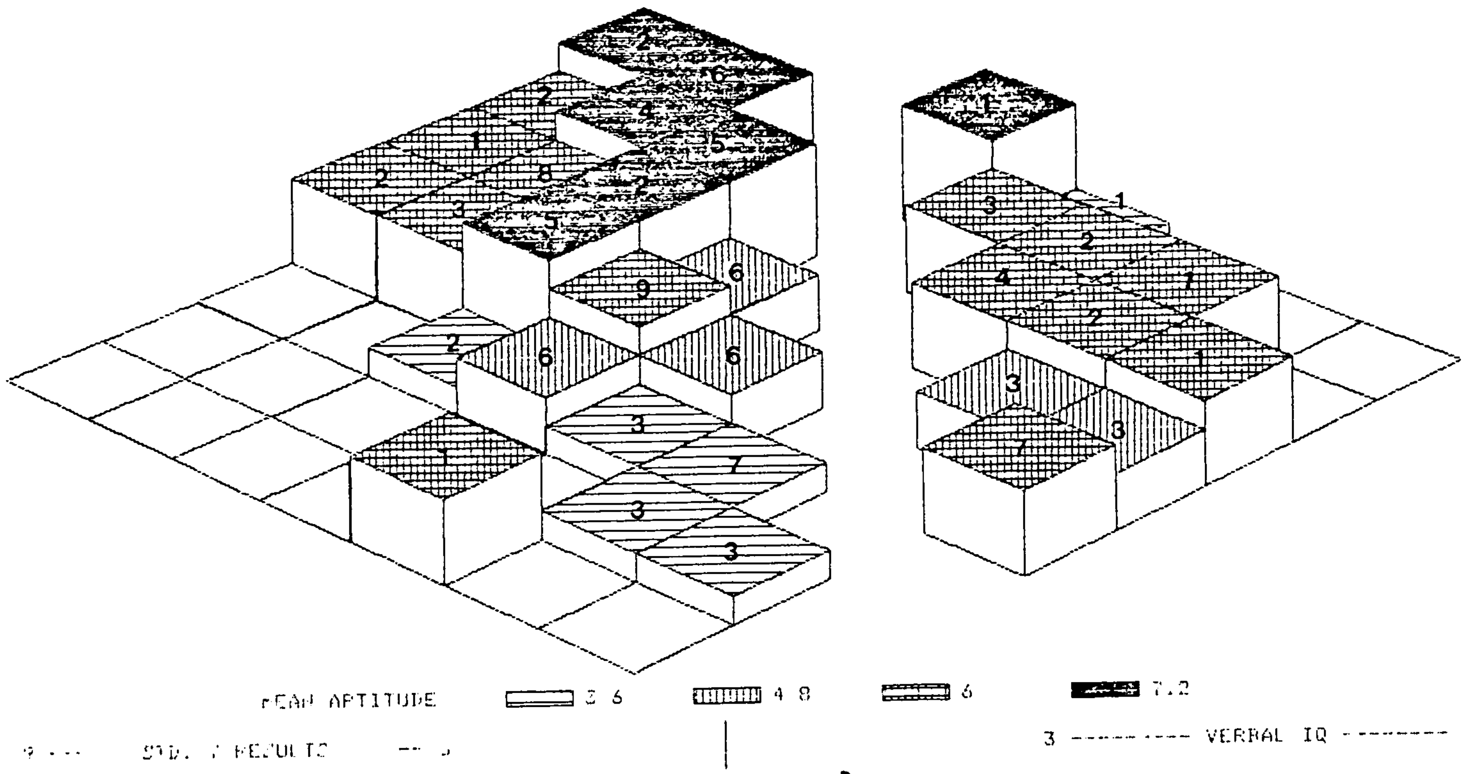

6. MECHANICAL APTITUDE

This aptitude is tested by test 10 (Mechanical Insight), which is used as a guidance indicator for both potential engineering and artisan students. We therefore expect some relationship between it and the V.I.Q./Performance axes, but not noticeably so.

This seems to be the case here. Although 22 of the better pupils score at the mean 8 level, 10 of them do not. Also noticeable is that 31 pupils score at mean 8, and 64 at mean 6. Of the latter 14 are underachievers, and 9 underachievers score at mean 8. This means that 95 of the pupils score at the high stanine levels of 6 and 8, but no clear pattern emerges to suggest that lack of this aptitude relates to underachievement.

STANINE PROFILES - ALL STUDENTS

APTITUDE=MEMORY




5. APTITUDE: MEMORY

This aptitude is a combination of tests 8 (Memory-paragraph) and 9 (Memory-words and symbols). It need hardly be said that there is an alarming tendency in South African schools to test memory rather than insight, and we therefore expect a strong relationship between this ability and academic achievement. Such a relationship is obviously visible, although 16 of the top performers (mean 6) are less well endowed in this ability than 12 others (mean 7,2).

The presence of 20 students also with mean 6 amongst the underachievers emphasises that lack of this ability does not contribute to underachievement.

### 5.3.4 Conclusion

Five of the aptitudes defined seem to have a relationship with the interaction between V.I.Q. and standard seven academic performance. In the cases of verbal and visual spatial reasoning the relationship seemed most marked, in the others less so. Clerical ability seemed to have a tenuous relationship, at best.

Not a single profile showed that the possession of the aptitude, or otherwise, in any way affected the under-achievement or achievement of the pupil. At best the aptitudes merely relate to subsequent achievement.

The most valid conclusion to come to after an investigation of these profiles is to join the chorus of investigators who argue that intelligence is a multifactorial ability which requires a number of different types of test to indicate its presence. In these profiles we seem to be measuring intelligence exerting its influence on a verbal I.Q. score, a standard seven exam score, and a test score which ostensibly measures a specific aptitude.

## 5.4 UNDERACHIEVEMENT AND THE CHANGING OF SCHOOLS

### 5.4.1 INTRODUCTION

It is to be expected that the moving around of a pupil from school to school will affect the quality of his work and increase his chance of becoming an underachiever. Laubscher (1976, p. 35) found a 5% significant relationship between underachievement and the number of schools visited in the case of boys, thereby reinforcing the findings of Ackermann (1973, p 66). We have already noted that a large percentage (19%) of pupils in the original experimental group of standard seven either drop out or are transferred from school before reaching standard ten. Similarly 18% of the standard tens of the experimental group are pupils who joined the class after standard seven.

### 5.4.2 Purpose of Investigation

We therefore wish to find out if a significant number of underachievers can be found amongst the pupils who changed school after standard six. In this case the pupils are defined by the group who were in standard seven but left subsequently, and the group who arrived in standard ten having joined the school after standard seven.

### 5.4.3 Method of Investigation

The 202 pupils who make up the standard seven experimental group, and 151 pupils in standard ten were classified according to which of the three definitions of underachievement defined them as such. If two of the methods defined them as underachievers, they were deemed such. Chi-squared tests were then carried out on each group to test for significance.

### 5.4.4 Results

An analysis of the pupils defined as underachievers by the three tests at standard seven is recorded elsewhere.[1.)] For comparison a similar statistic is recorded in table 5.5.

Table 5.5

ANALYSIS OF PUPILS DEFINED AS UNDERACHIEVERS BY THE THREE MODELS OF UNDERACHIEVEMENT, AT STANDARD TEN LEVEL

| Test Defining: | 1 only | 2 only | 3 only | 1 and 2 | 1 and 3 | 2 and 3 | 1, 2 and 3 |
|---|---|---|---|---|---|---|---|
| No of Pupils | 0 | 20 | 1 | 0 | 0 | 34 | 24 |

Key: Test 1 = Linear regression model, critical value $s_y = s_y \sqrt{1-r^2}$ where $s_y$ = Std. Dev. of performance values, and r = correlation between V.I.Q. and performance values.

Test 2 = Stanine model, critical level: Stanine performance - V.I.Q. $\leq -2$.

Test 3 = Performance index with critical level: Standardised ten total - V.I.Q. $\leq -15$.

1.) See table 4.16.

Once again we note the same pattern as for the standard seven models, with the linear regression definitions included in both the others, and most definitions elicited by the stanine model.

The two groups were investigated with specific Null hypotheses.

Null hypothesis 5.1

There is no difference in the number of underachievers in standard seven who left school after seven, compared to the number who continued to stay at the same school.

The results are recorded in table 5.6.

Table 5.6

DISTRIBUTION OF UNDERACHIEVING PUPILS AMONGST THOSE WHO LEAVE AFTER STANDARD SEVEN AND THOSE WHO STAY

| | Underachievers | Achievers |
|---|---|---|
| Leavers | 20 | 29 |
| Stayers | 49 | 114 |

d.f. = 1 $\chi^2 = 5,36$ $p < 0,025$

After correction for continuity a $\chi^2$ value of 5,36 was obtained, which is significant at the 5% level, and the Null hypothesis was therefore rejected. Since both hypothesis and the $\chi^2$ test were two-tailed, no further adjustment was made.

Null hypothesis 5.2

There is no difference in the number of underachievers found amongst pupils who have not changed schools after standard seven as compared to those who have.

The results are recorded in table 5.7.

Table 5.7

DISTRIBUTION OF PUPILS FOUND TO BE UNDERACHIEVERS IN STANDARD TEN FROM AMONGST THOSE WHO JOINED SCHOOL AFTER STANDARD SEVEN

| | Underachievers | Achievers |
|---|---|---|
| Joined after 7 | 12 | 17 |
| Stayed | 38 | 84 |

d.f. = 1 $\chi^2 = 0{,}688$ ; $0{,}5 > p > 0{,}10$

After correction for continuity the $\chi^2$ value was found to be too low for the Null hypothesis to be rejected.

## 5.3.5 Conclusion

This result only partially confirms the findings of Laubscher and Ackermann. The most obvious explanation for the difference between the standard seven and standard ten result is that moving school is less likely to affect the older pupil. It seems likely that many of the standard seven movers had moved before, or had been pre-occupied by the knowledge they were going to move. We note that Laubscher's significant result was obtained by investigating pupils who moved once, twice, etc up to five times or more. In our standard ten experimental group the majority of pupils changed school only once. In addition Laubscher's criterion of underachievement[1.)] was abandoned as being too strict, since it defined only 8 candidates at the standard seven level.

For the standard ten group Laubscher's method could not be used either since it makes little sense to use a standard seven result to predict post matric performance.

We can therefore conclude with confidence that changing school is more likely to produce underachievement in the pupil at standard six and seven level than in standards nine and ten. We should remember however that underachievement could also cause a change of school to occur!

1.) Stanine model: V.I.Q. - Proficiency test average $\geq 2$

# CHAPTER 6

## 6.0 FINDINGS CONCLUSIONS AND RECOMMENDATIONS

6.1 This investigation tried to find a tool from data readily available to senior school teachers whereby underachievement could be identified and predicted. The validity of using an estimated I.Q. to predict underachievement was also examined, as well as the relationship between underachievement and specific aptitudes. Underachievement was also investigated in relation to pupils changing schools.

Statistical data was obtained from the examination results and psychological test results of three consecutive groups of English speaking standard seven boys who had an unbroken progression to standard ten, (n = 164).

6.2 Four models of predicting underachievement were used and, after suitable refinements, were evaluated by comparing with each other.

6.3 It was found that the linear regression method of defining and predicting underachievement was the most sensitive, accurate and easiest to calculate and manipulate.[1.)] The estimated I.Q. was found to be an adequate substitute for use instead of the verbal I.Q. to predict underachievement.[2.)]

1.) See pages 104 - 111

2.) See pages 116 - 124

Three dimensional histograms were established relating defined aptitudes to both achievement and ability, but no relationship between the aptitudes and underachievement was discernable.[1.)]

It was found that underachievement was related to the changing of schools prior to standard eight, but no significant under-achieving was found amongst pupils who changed school after standard seven.[2.)]

6.4 We therefore conclude that a valid and reliable tool for predicting underachieving has been found, and when required an estimated I.Q. can be used as a substitute for statistical purposes.

6.5 Two areas of future research present themselves from this study. The use of the three-dimensional histogram to analyse the relationship between performance and other independent variables seems a useful technique. It is also paramount that more work be done on devising remedial programmes for pupils who are defined as underachievers at such an early stage, so that they may have a better chance of leading productive and self-fulfilled lives.

1.) See pages 126 - 134

2.) See pages 135 - 139

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## SUMMARY

Educators have long been concerned at the fact that there are pupils at all three levels of education who appear to have mental abilities far in excess of their actual academic performance. Such people are called underachievers, but the exact definition of underachievement tends to fluctuate according to the purposes of the investigator or the statistical method used. Various personality and social factors have been found to be associated with underachievement, such as poor self image, poor study methods and home conditions, but the relationships have not been found to be necessarily causal.

Doubt has been expressed about the accuracy of predicting academic success since underachievers may be victims of over prediction. However, the highly significant correlations of 0,50 at secondary level between verbal I.Q. scores and academic results have made researchers conclude that the former provides researchers with a valid tool to measure academic potential, even though only 50% of the variation has been explained. All indications are that pupils who underachieve at secondary level are doomed to leading unfulfilled lives because of their unrealised potential.

This investigation therefore tried to establish a valid method to be used by teachers to predict underachievement at secondary level amongst boys of above intelligence at a semi-urban South African English speaking school. A total of 164 subjects were chosen, representing three consecutive groups of standard seven pupils to reach standard ten without failing. Four models of predicting underachievement were investigated : the linear regression, the stanine difference, the performance index and the step-wise regression. Variables used were the test results from Junior Aptitude tests, Junior Scholastic Proficiency Battery tests,

five standard seven subject examinations, the total standard seven and ten examination results, as well as the verbal I.Q. totals of the pupils.

The verbal I.Q. total was used as a predictor of academic potential in the linear regression, stanine difference and performance index models at standard seven level and the subsequent performance of the pupils was used to refine the critical level of each predictive model. The results of the three models were compared, and statistical definitions found for each which described the area they had in common. The linear regression model was found to be the most satisfactory to use, with a critical cut-off line at 0,75 standard deviations below the regression line. The stepwise regression results were analysed but discarded as impractical.

The secondary aims of the study were the use of an estimated I.Q. to predict underachievement, the relationship between aptitudes and underachievement, and underachievement and the changing of schools. The estimated I.Q. was found to be an adequate substitute instead of verbal I.Q. to predict underachievement. No discernable relationship was found in the three dimensional histograms relating defined aptitudes to both achievement and ability. Underachievement was found amongst pupils who change schools before the end of standard seven at the 5% level of confidence, but not amongst those who change seven.

We therefore conclude that a reliable tool has been found to predict underachievement at standard seven level, and an estimated I.Q. can be used as a substitute predictor for statistical purposes. Using both, a teacher is able to identify potential underachievers and with the help of wise counselling help pupils lead more academically rewarding lives.