

**DISADVANTAGED STUDENTS'  
ACADEMIC PERFORMANCE:  
ANALYSING THE  
ZONE OF PROXIMAL DEVELOPMENT**

**A thesis submitted for the degree of  
Doctor of Philosophy (Ph.D.),  
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**by**

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**Determination to be wise  
is the first step towards becoming wise**

**Proverbs 4 verse 7**

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## ABSTRACT

The aim of the study is to investigate the practical application of Vygotsky's construct of the Zone of Proximal Development to the selection of disadvantaged students in higher education. There is a need in post-apartheid South Africa, with its legacy of inequality in educational experiences, to find accurate and fair predictors of academic performance that would act as alternatives to matriculation marks and static tests. The study relates the students' response to mediation to their academic performance and analyses the role that non-cognitive factors such as motivation, approaches to learning and learning strategies play in cognitive performance.

The investigation was done in the form of different studies using over 400 first year students at the Peninsula Technikon as subjects. The first study focused on the effectiveness of the mediated lessons that form part of the two dynamic tests using a Solomon Four Group and a Two Group design. The second study made a comparison between the predictive validity of past academic achievement, conventional static tests, several non-cognitive variables as well as the two dynamic tests. In the third study the students' response to a period of mediation was analysed. The fourth study focused on comparing different groups of students according to the following classification: schooling, gender, language, type of course and assessment and level of course to see whether any of the variables would have a moderator effect. Finally a differentiation was made between the profiles of more successful as opposed to less successful students.

The weight of evidence of the study indicates that it is possible to find alternatives to matriculation marks and static tests in selecting disadvantaged students by making use of the concept of the Zone of Proximal Development. The results further showed that disadvantaged students are not a homogeneous group. Although the matriculation marks seemed to be the best single predictor of academic performance for the total group of students, alternative predictors were identified when looking at different subgroups. Modifiability (students' response to mediation) had a moderator effect on the predictive power of various variables. For the less modifiable group of students, the matriculation marks and, to a certain extent, static tests were good predictors, while for the more modifiable group of students a dynamic test proved to be a significant predictor of academic performance. The implications of the findings for the selection and academic development of disadvantaged students are discussed.

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# INTRODUCTION, CONTEXT AND AIMS

## 1. INTRODUCTION

The aim of this study is to investigate the practical application of Vygotsky's (1978) concept of the zone of proximal development (ZPD) to the problem of selecting disadvantaged students for courses at an institution for higher learning. More specifically the study will be looking at how students' response to mediation can be linked to their academic performance and the role that various cognitive and non-cognitive factors play in predicting the academic success of disadvantaged students. The concept of the zone of proximal development and modifiability has important implications for academic prediction. A measure of learning potential or the students' ability to benefit and learn from a period of mediation, might be a more valid and fair predictor of academic performance for disadvantaged students than traditional or static measurements. Dynamic assessment procedures enable disadvantaged students to demonstrate their learning potential by showing how they respond to the provision of a mediated learning experience.

In South Africa, where the student population is drawn from a diversity of backgrounds, one cannot assume that all individuals have reached their ability plateaus. Disadvantaged groups, in particular, are likely to contain members who are still on the steep part of the development curve due to poor education and lack of opportunities to show their abilities. If selection and placement decisions are made on the assumption that all scores reflect students' top performance, an injustice is done to students who are from a disadvantaged background, or from a cultural background in which the ability in question was not required and therefore not practiced (Taylor, 1987).

The rationale underlying this study is that students who attended black schools during South Africa's apartheid era are educationally disadvantaged in relation to the students who attended white schools. The black schools were further differentiated into different groupings, with the Department of Education and Training (DET) schools being the most

disadvantaged, followed by the schools for students who were classified as being Coloured and Indian respectively. Although apartheid has been abolished as a policy and a democratic government elected in 1994, the legacy of the apartheid system still results in tremendous disparities between white and black schools. For these educationally disadvantaged students it is often unfair and invalid to use school results as the basis on which they are selected for a course at tertiary education institutions. The use of alternative predictors, such as traditional and static intelligence or aptitude tests, tend to measure students' manifest level of functioning rather than their potential for development (Shochet, 1986). The educational background of these students put them at a disadvantage when competing for valuable resources such as entry into tertiary education institutions.

Dynamic tests usually make use of a mediated lesson which assists the students in coming to terms with the testing situation and both metacognitive and domain-specific guidelines to problem solving are provided to assist them with finding the correct solutions. Disadvantaged students have not had the opportunity to fulfil their potential and the measurement of the ability to learn and benefit from a mediated lesson could thus be a more valuable predictor of disadvantaged students' academic performance than the matriculation marks or a static test of cognitive ability. Given South Africa's cultural diversity there are bound to be concerns about any selection procedures that favour one cultural group over another because of a particular bias.

The next section will place the study in the South African educational context.

## **2. EDUCATIONAL CONTEXT**

In this study the term "higher education" is used to describe what in official terms is referred to as South Africa's post secondary education system. The information in this thesis refers to the education system in terms used by the previous government's segregation laws. The education departments designated for the different groups under the apartheid laws were:

- (1) The Department of Education and Culture, House of Assembly which reported to the White Own Affairs Minister;
- (2) The Department of Education and Culture, House of Representatives which reported to the Coloured Own Affairs Minister;

- (3) The Department of Education and Culture, House of Delegates which reported to the Indian Own Affairs Minister;
- (4) The Department of Education and Training (DET) which reported to the Black General Affairs Minister;
- (5) The Education Departments operating in the homelands that operated "independently" from the South African government.

In 1991 an announcement was made that the previous government proposed a single education system for the whole country to take the place of the segregated education system that had been in place before. At the beginning of that same year 205 white government schools admitted black pupils for the first time. Before this date only private white schools had admitted black pupils. In 1994 a new democratic government was elected which inherited a legacy of gross inequalities in all facets of education.

The study discusses advantaged and disadvantaged students in the light of the inequalities that existed and still exist between white and black education. The latter includes all the students who received schooling under the education departments that were not white. It is argued that although a new democratic government was elected in 1994, the legacy of the previous segregated education policies still places many students at a disadvantage. Students will thus still sometimes be referred to in terms of the old population register designation of White, Coloured, Indian and African.

The Race Relations Survey of South Africa (1992) reported that the gap between per capita expenditure on African and white education narrowed from 18 to one in the 1969/70 financial year to four to one in 1989/90. African expenditure improved from 6% to 25% of white expenditure over the same period. Per capita expenditure on Coloured education improved from 20% to 53% of white per capita expenditure over the same period, while that on Indian education improved from 27% to 71% of white per capita expenditure. The reduction in the gap between black and white expenditure did not fundamentally redress particular backlogs in education.

In 1990 the pupil/classroom ratios at black schools were still very high with total ratios of 48:1 for African, 25:1 for Coloured and 28:1 for Indian schools. This was in contrast to a ratio of 17:1 for white schools. The total pupil/teacher ratios in South Africa (including the homelands) for all schools were the following in 1990: African 34:1, Coloured 23:1, Indian 20:1 and white 17:1. Backlogs in African (DET) education were also evident in the

increase of 75% between 1987 and 1989 in the number of pupils involved in double sessions (one teacher taking two classes a day) and platoon sessions (one teacher for two classes in the same session). These backlogs were made worse by unrest in the townships where pupils' protest against the inequalities in education led to damages of millions of rands in classrooms and schools (Race Relations Survey, 1992).

An effect of the lack of compulsory education for African pupils was the high drop-out rate among pupils at primary school level, with 25% of pupils in 1990 leaving in sub A (grade 1) (the first year of school) compared to 8% in standard 6 (grade 8) and 12% in standard 10 (grade 12). The reasons given for the drop-out rate were poverty, disruptions in the school programme and poorly qualified teachers. Qualified teachers (teachers with three years of more training after standard 10 (grade 12)) in the secondary schools made up 53% of the total number of DET teachers in 1990 compared to 42% in 1988 (Race Relations Survey, 1992).

The African rural schools in the homelands were even worse off than the schools in the urban areas. The gap between the rural and urban schools had widened to such an extent in 1991 that certain observers estimated it to be wider than that between the DET and white education.

The proportion of students in each group that passed the matriculations (standard 10 or grade 12) examinations in 1990 was as follows:

Table 1.1

Proportion of Students passing the Matriculation Examinations

	Proportion passes	Proportion with matriculation exemptions
African	37%	8%
Coloured	79%	20%
Indian	95%	45%
White	96%	41%

A very limited proportion of African pupils take technical subjects. In 1989, whereas 44% of standard 10 (grade 12) pupils took history as a subject, a mere 0.4% took technical courses. Only 8% enrolled in accountancy as an example of a commercial subject. A high proportion of African pupils took biology (89%), followed by other science subjects such as mathematics (29%) and physical science (18%). Although significantly more pupils took science subjects than commercial subjects, very few passed these subjects. In the

1990 examinations, 35% of candidates wrote mathematics, of whom only 6% passed, compared to a pass rate of 58% for white students. Of 23% of African candidates writing physical science, 7% passed, compared to a pass rate 41% for white candidates (Race Relations Survey, 1992).

While the departments of education which had statutory responsibility for the education of whites in 1992 controlled only 13% of school places in South Africa (a proportion in line with the share which whites have of the total population), it controlled 85% of places in technikons, 77% of places in universities and 71% of places in technical colleges. This led to the problem of unequal access to post-school education in South Africa. In 1992 white scholars had a 12% share of the total school enrolment in South Africa, while in contrast, white students had 60% and 50% shares of the enrolments at technikons and universities respectively. Black scholars in 1992 had a 74% share of school enrolments and black students only 25% and 37% of the enrolments in technikons and universities respectively (Bunting, 1994). The inequality of educational opportunities is clearly illustrated by these figures. Many institutions of higher education had to have a relook at their selection criteria in order to admit more students from educational disadvantaged backgrounds.

The higher education institutions in South Africa are faced with the practical problem of finding valid predictors of academic performance for the selection of disadvantaged students. Two problems need to be addressed in the selection debate. In the first place the selection procedure must ensure that only students with a predetermined probability of success will be selected and secondly it must ensure that the selection procedure is unbiased in that it does not place one group of students at an advantage or disadvantage. In other words the student selection procedures must satisfy the criteria of accuracy and fairness (Miller, 1992). South African tertiary education institutions face the further challenge of ensuring that the racial composition of their student bodies resemble the broader South African population. A dilemma exists however. On the one hand pressure is mounting to admit an increasing number of black students who had largely been denied access to higher level education in the past. On the other hand, declining state subsidies together with increasing pressure to compensate for an inadequate school system for disadvantaged black students in the form of academic support programmes have increasingly put teaching staff at institutions of higher learning under pressure.

### 3. SELECTION OF STUDENTS

There seems to be consensus that the student selection system in higher education should be perceived as fair by both the community and the student body. In this regard Nunns and Ortlepp (1994) mention distributive fairness (were the right students selected?) and procedural fairness (was the process of selection fair?). For this reason it seems important that the institutions establish a fair selection process and set of criteria. Using the criteria of the students' probability of passing a course as a basis of selection not only ensures that the limited teaching resources are optimised, but also that the impact of students' failure is minimised (Bokhorst, Foster & Lea, 1990). Institutions have the responsibility to admit only those students with a reasonable chance of success.

Different methods of selection can be used:

- (1) random selection,
- (2) selection based on a hypothesised relationship between predictors and performance,
- (3) selection based on a demonstrated relationship between predictors and effective performance (Nunns & Ortlepp, 1994).

For white pupils research has indicated that academic performance in schools is an adequate predictor of academic performance at tertiary level (Shochet, 1986; Bloomberg, 1984). On the other hand, academic achievement in black schools is a poor predictor of academic performance at tertiary level (Mitchell & Fridjhon, 1993; Shochet, 1986; Visser, 1978). The lack of predictive validity of black school results has led to the use of standard tests of ability to predict academic performance. The scores of these tests are often interpreted as if they reflect the ceiling of the testees' abilities. They are consequently as inappropriate in predicting the potential of disadvantaged students as school marks. Both these measures tend to assess the manifest ability and not the potential ability of the students (Boeyens, 1989b).

There are increasing indications that the psychometric test results of disadvantaged students are not truly comparable with those of advantaged students (Taylor, 1987; Gardner, 1982; Feuerstein, 1980). Many educational institutions are adopting a dynamic model of cognitive competence by offering bridging courses and academic development programmes, but are forced to rely on a static conception of human ability and learning when they use psychometric ability tests to select candidates for enrichment

programmes. The development of more appropriate selection procedures for disadvantaged students requires a reconsideration of some of the assumptions underlying the concepts of ability, potential and mental development.

The low predictability of DET matriculation grades and the traditional bias of static psychometric tests have produced a lottery arrangement at the University of the Western Cape (Van den Berg, 1990) where random selection is done of students obtaining below a certain mark in the matriculation examinations. These new selection arrangements reinforce the view that one of the only mechanisms for the assessment of educational achievement in the twelve years of schooling is illegitimate. The use of both matriculation marks and aptitude or intelligence tests seem to be inadequate in providing fair and valid predictors for selecting all disadvantaged students. The use of the matriculation marks as predictor will be discussed firstly, followed by the use of aptitude and intelligence tests.

### **3.1 MATRICULATION MARKS**

The pressure on institutions to select students who will be academically successful is increasing. At the same time the expectations of black students in gaining access to institutions of higher learning have increased since the 1994 elections. At the moment the use of the matriculation based points system used by most institutions is not providing the complete answer, because the school system still does not prepare students for tertiary education on an equal footing. Research has shown that the matriculation scores of black students do not correlate with first year university results (Rutherford & Watson, 1990; Shochet, 1986). The poor quality of the black education system, and in particular of the DET system, has placed these students at a disadvantage when competing at an academic level for places at institutions of higher learning. The establishment of a single matriculation system in 1997 has not solved the problem, because the legacy of apartheid has led to continued differences in educational experiences of students. Market forces have in some instances widened the gap due to the establishment of private and élitist schools. Those who can afford to, send their children to those schools with superior resources and facilities, while the schools in the black townships show little, if any, improvement under the new democratic government.

The results of the matriculation examinations written at the end of 1998 showed only 50.7% of the candidates passed the examinations. One of the disturbing aspects of the

results was the significantly higher number of female students that failed (52%) as opposed to the male students (45.8%). This gap becomes even wider in the regions that have a high population of poor, rural dwellers. The figures for the Eastern Cape, for example, are 50.1% male students who failed as opposed to 59.2% female students who failed (Bowler, 1999). Some of the reasons for these differences have been attributed to gender stereotyping regarding chores in the house and expectations of parents regarding the education of their children.

For a majority of pupils in South Africa the matriculation examinations in 1998 still epitomise an irrelevant system dominated by gross disparity of provision. The present poor results in matric is merely a symptom of an underlying malaise. In most schools there has been a pattern of rote learning from the first year of school. This is hard to break, and has led to a loss of interest and a deadening of curiosity on the part of both the teacher and the pupils. The generally poor training facilities for teaching staff and the financial problems facing provincial education departments, which has led to severance packages for some of the more experienced teachers during the past few years, have only weakened an already parlous situation (Steyn, 1999).

The poor matriculation results in the 1990's is a continuation of a trend which started in the 1980's. There was a steady increase in the number of candidates of the former Department of Education and Training (DET) from about 72 000 in 1985 to 230 000 in 1991 to 341 000 in 1993, accompanied by a gradual but steady decline in performance from 48% passing in 1985 to 41% passing in 1993. The number of candidates country-wide increased from 272 000 in 1988 to 560 000 in 1997 (Calitz, 1998). Such increases put a tremendous strain on resources and a high degree of dedication is required to maintain success under these conditions. This dedication exists in only a small number of schools, while the bulk of the schools are subjected to conditions which are not ideal for learning.

The fact of the matter is that the situation in black education has not changed much since the days of apartheid. There are still serious deficiencies in facilities, text books and the quality as well as the quantity of teaching in these schools. The schools are overcrowded and the situation at many schools is not conducive for teaching or learning. Teachers do not respect rosters or syllabi and decide for themselves when the next lesson will be and whether it will take place at all. Very few pupils seem to be motivated to learn. Many of them arrive late for classes and leave school as much as two hours before closing time. A general lack of discipline and order is found in the high schools, which leads to

undisciplined behaviour both in the classroom as well as outside. The teachers spend more time in the staffroom than in the classroom. Pupils do not want to read text books and refuse to do homework. Teachers blame a lack of pupil motivation and parental neglect for this situation (Calitz, 1998).

From these reports it is clear that the system of apartheid education left a legacy of disadvantage that many schools are finding difficult to cope with. Far fewer black than white students pass matric; which is the minimum requirement for entry into an institution of higher learning. Linked to this is the fact that very few students do Mathematics and Science as subjects in matric. The performance of those students who do take them as subjects are often so poor that they are excluded from following courses in Science, Engineering and Commerce at tertiary level. A further debilitating factor is that many black students speak English as a second or third language which severely limits their access to the academic content they have to study.

Some of the schools in the disadvantaged areas did well simply because they maintained discipline and had high expectations. The matriculation results of those well managed schools were evident. In 1997 the educational officials identified teacher and pupil commitment, discipline, and time spent teaching and learning as determining factors in school and pupil pass rates. There is no doubt that abysmal schooling provided to the majority of students under apartheid produced abysmal results and that the legacy of apartheid is perpetuating this trend under the democratic government. The difference in resources allocated to schools still dominates explanatory analysis of matriculation results and will continue to do so for a number of years to come.

Students from schools of the old black (African, Asian and Coloured) educational departments can thus be seen as being at a disadvantage when competing for admission against students from schools in the traditionally white educational departments. This inequality is compounded by the fact that many institutions select their students on the basis of the matriculation marks or make use of static tests. The Higher Education Act (1997) ushers in a new dispensation in education in South Africa in an effort to redress past inequalities. One of the implications is that the Matriculation Examination Board will fall away and the only qualification needed to enter institutions of higher learning will be the new further education certificate. The practical implications of this is that institutions are bound to institute specific entry requirements or admission tests to ensure that scarce places are allocated in an equitable way.

### 3.2 CONVENTIONAL STATIC TESTS AND INTELLIGENCE

Some institutions have already started to move in the direction of using aptitude or admission tests as alternative to or in conjunction with the matriculation results. An appeal that these tests have is that because they are associated with "scientific methods" they are seen to be more fair and accurate (Miller, 1997). The admission tests used at most institutions will usually consist of an English language component, an abstract reasoning component and a content-specific component such as mathematics performance. The results of these tests usually favour the mainly white and in some cases other non-DET students and lead to a disproportionate number of these students being admitted. The reason why DET students may tend not to achieve the same performance levels as the non-DET students could be due to a host of socio-economic factors ranging from poverty to poor schooling, all of which are likely to influence performance on a test that would still correlate with academic performance. This model displaces the matriculation marks as a selection criteria, but replaces it with tests that still reflect the inequality in schooling background of students. The items of traditional tests are still dependent in some way or other on prior learning and schooling experiences of students.

Many studies have been done in an attempt to predict academic performance with measurements of intelligence and aptitude and in general the review results have been disappointing (Kotzé, 1994; Shochet, 1986). Only in exceptional cases have researchers been able to explain more than 25 per cent of the variance in academic performance. These results have usually come about with multiple correlation and when school results have been included. There has been ongoing concern about the use of intelligence and aptitude tests among black and disadvantaged students (e.g. Baggaley, 1974; Davis & Temp, 1971; Sedlacek & Brooks, 1970). Questions can be raised about the culture-fairness of intelligence tests when used with people from different cultures or from disadvantaged backgrounds. The debate about intelligence testing and the IQ controversy (geneticists vs. environmentalists vs. interactionalists) has been going on for a long time. In spite of this controversy it seems that both extremes of the debate essentially adopt a static view of intelligence that does not take the modifiability of individuals into account. A particular definition of intelligence is the ability to learn (Hamers & Sijtsma, 1993), but very few static measuring instruments take this aspect into consideration.

This study argues that IQ tests represent a static paradigm and do not measure the ability to learn. The idea that intelligence is an inborn stable quantity that is measurable with great accuracy, has been popular since the pioneering investigations into intelligence (Das, Kirby & Jarman, 1979). Binet, the inventor of the first true test of intelligence, was against this notion, but his objections were largely overlooked. Shochet (1986) suggests that the genetics movement is largely responsible for the popularisation of the idea that intelligence is biologically determined, genetically transmitted and highly stable over time. The arguments and research findings presented by this movement constitute a vast amount of evidence for genetic and race differences in IQ performance (e.g. Jensen, 1980). Only recently, with the advent of information processing theory has a better understanding emerged of what IQ tests do and do not measure.

The geneticists (e.g. Eysenck, 1973, 1985; Jensen, 1972, 1980, 1985) argue that intelligence tests measure intelligence (g) and that intelligence is hereditary and therefore static and unchangeable. They argue in addition that blacks do worse in IQ tests than whites and this, according to Jensen (1980), is not a result of test bias, but rather of inherited intelligence.

The environmentalists (e.g. Evans & Waites, 1981; Kamin, 1981; Simon, 1978; Block & Dworkin, 1976; Cronbach, 1975) argue on the other extreme that the environment affects intelligence and intelligence tests are inherently biased towards blacks or individuals of another culture. Poverty and institutional deprivation negatively affects intelligence and a change in circumstances and environment could create a change in intelligence. For the environmentalists, traditional intelligence tests do not merely reflect genetically-based differences in IQ, but also experience and environmental inequalities. Many of the environmentalists question the validity of IQ tests when used with people from different cultural backgrounds or disadvantaged environments (e.g. Eels, Havighurst, Herrick & Tyler, 1971). Practitioners have attempted to modify traditional IQ or aptitude tests in order to make them more culture-free or culture-fair. These attempts have included:

- (1) Altering the language or content of the tests to make them more familiar to the culture being tested.
- (2) The use of statistical manipulations, such as the creation of special norms for different cultural groups, or the use of regression lines in particular ways (e.g. Huysamen, 1996; Cole, 1973; Thorndike, 1971).

These attempts at culture-fair testing still incorporate a static view of intelligence.

Intelligence can be defined only in terms of its manifestations within a cultural milieu. Adaptability as proposed by Schafer (1982) proposes a more superior concept of intelligence compared to the static model offered by theories based on the IQ test performance model. Nickerson, Perkins and Smith (1985) argue that adaptability refers to the ability to change one's behaviour effectively. They equate the ability to adapt with intelligence. Measures of ability (such as IQ scores) are only reflections of a culmination of past adaptations. There are strong links between the contention that adaptability is always toward better cultural adjustment and Feuerstein's (1980) and Vygotsky's (1978) view of human cognitive ability as socially mediated.

#### **4. DYNAMIC ASSESSMENT AS ALTERNATIVE**

The use of dynamic assessment procedures reject genetic and environmental determinism. For Vygotsky (1978) and Feuerstein (1979, 1980) intelligence is not a static concept. The environment alone is not responsible for explaining individual differences in intelligence but rather the extent to which the environment is mediated for the individual. Students who have been educationally disadvantaged are still intellectually modifiable and have not been irreversibly affected by their past educational experiences. Feuerstein (1979) argues that one should be looking at the ability of the individual to benefit from the mediated learning experiences that might have been missing during earlier years. For Vygotsky and Feuerstein intelligence is not a product but a process. Static IQ tests fail to measure this process or the ability for learning or learning potential. Feuerstein is particularly critical of those attempts to create special norms for different cultural groups (or the same norms for different groups). The results will always indicate that those individuals (blacks) are inferior to a comparison group and thus implicitly support the views of unchangeable genetic factors which determine lower levels of cognitive functioning.

Problems around selection testing criteria for minority/disadvantaged students has been a topic for research in the United States of America for a number of years. The Scholastic Aptitude Test (SAT) was introduced in the USA to provide a measurement on which prospective students from a diverse background could be evaluated on an equal footing. The content of the SAT was designed in such a manner that it did not rely heavily on high

school syllabi. Students inhibited by poor schools could thus be provided with an alternative opportunity to display their preparedness for tertiary education. This was intended as a way for everyone, regardless of their inequitable high school background, to reveal their true potential. Although the SAT is the most extensively used aptitude test used for admission purposes, its predictive construct and population validity has been in doubt (e.g. Jencks & Crouse, 1982; Slack & Porter, 1980). Seen from a dynamic assessment viewpoint, the SAT would only manage to measure the students' manifest ability (Shochet, 1986) and not their potential ability, because of the static nature of the test. The argument would be that the SAT measures current levels of academic achievement and in no way attempts to ascertain future performance.

In the past tests in South Africa were standardised for each different race group and subsequently different norms were developed for each group. The black students tended to score at the lower end of the cognitive or ability tests, which seemed to perpetuate the notion that they were inferior to the white students. These static intelligence or aptitude tests tended to measure the present level of functioning and abilities of individuals rather than the potential future level. This use of static assessment has been to the detriment of those individuals who have not had the optimal opportunity to acquire the knowledge and skills necessary to perform well in the test (Hamers & Resing, 1993). Prior learning has always been considered a good predictor of future learning, but this assumption depends on the equality of the prior learning experiences.

There is an urgent need to find alternative predictors of academic performance for disadvantaged students. Although the abolishment of apartheid and a democratically elected government has led to the opening of all tertiary education institutions to all students, the legacy of apartheid still creates tremendous disparities between black and white students. These differences have made the use of the matriculation marks and static tests for selection purposes both invalid and unfair. Most institutions of higher learning would not like to discriminate against educationally disadvantaged students and are searching for alternative predictors.

The question to ask is whether there are students that might presently not be functioning at a high level, but who have the potential to develop and benefit from enriched educational opportunities. One of the assumptions guiding the study is that disadvantaged students should not be treated as a homogeneous group, but that different subgroups could be identified with regard to prediction of academic performance. The

study would like to argue that it should be possible to distinguish between those disadvantaged students who have the potential to do well, if provided with the necessary mediation, and those students who do poorly because they are unable to benefit from mediation. This study will attempt to differentiate between the different groups of students by analysing their response to mediation and assessing their cognitive and learning profiles and level of modifiability. Students who are able to benefit from a mediated lesson show that they possess the potential to benefit from an enriched academic environment and are able to be academically successful.

One solution to the problem of differential performance is to use different procedures for specific target groups. Many institutions have already adopted this approach by using some alternative means of selection for DET students, while retaining the matriculation system for non-DET students. This approach is based on a quota system where a certain number of places are reserved for a particular group. Miller (1992) mentions a number of problems linked to a quota system. The first problem is deciding on the size of the quota; the second is that one still needs to find a test that satisfies the criteria of accuracy and fairness to select the students for the quota. In this regard statistical manipulations are often used to identify the cutoff point when selecting the top students in a particular group (Huysamen, 1996). A third problem is that there might not be enough students meeting the cutoff point score on the test that represents a probability index of success of 50%. If more students are taken to reflect the number of DET matriculants as a proportion of the total number of matriculants, it could mean accepting students that have less than a 50% probability of success. It could also mean excluding non-DET students whose probability of success is greater than 50%.

The debate on the influence of genetics as opposed to the environment informs the interaction between the role that hereditary factors and the environment play and the differential impact of this interaction for each individual. Intelligence considered from the viewpoint of interaction, stresses the importance of a stimulating environment. In an optimal environment, or with specific training programmes, it would be possible to bridge the gap between actual or manifest intelligence and potential intelligence (Hamers & Resing, 1993). The environmentalists and interactionists working in the dynamic paradigm have developed specific intervention and enrichment programmes in an attempt to raise the intelligence of individuals or groups. Examples are Head Start, Bright Start, Cognet and Follow Through in the United States (Haywood, 1997) and the project Education and Social Environment in the Netherlands. Training programmes have also

been developed in the tradition of the information development approach (e.g. Sternberg, 1984; Whimbley & Lochhead, 1980). These programmes have facilitated the construction of training phases in learning potential tests as well as the development of training programmes that are linked to these tests (e.g. Lidz, 1991; Feuerstein, 1980).

A number of programmes based on the dynamic assessment procedure have been established at tertiary education institutions in South Africa. These programmes are usually an alternative to selection procedures using the matriculation marks and are focused mainly on African (DET) students. Examples of these programmes are the Teach-Test-Teach (TTT) programme at the University of Natal and the Alternative Admission Programme (AARP) at the University of Cape Town (Griesel, 1992; Yeld & Hartman, 1992).

## **5. THEORETICAL BACKGROUND OF DYNAMIC ASSESSMENT**

The concept of dynamic assessment and learning potential assessment is based on Vygotsky's (1978) theory of the zone of proximal development (ZPD) and Feuerstein's (1980) belief in the modifiability of individuals through a mediated learning experience (MLE). The ZPD refers to the difference between the level of achievement that can be attained by an individual without assistance (actual level of development) and the level of achievement that can be attained with assistance from a more capable person (potential development level). With dynamic assessment it is possible to distinguish between two persons who might show the same present measured ability, but who differ with regard to their potential future development. Those individuals who benefit from the mediated lesson incorporated in a dynamic assessment procedure could be described as modifiable.

The zone of proximal development (ZPD) is a social construct that represents development itself. ZPD literally translated should be zone of nearest development (Minick, 1987). The test-train-test paradigm has been used to obtain a quantitative measure of improvement or progress through ZPD. Researchers do not claim to be measuring ZPD as the concept does not lend itself to quantitative measurement. According to Das and Conway (1992) the purpose for using the ZPD would be twofold:

- (1) Studying cognitive development as a product and investigating the consequences of the individual learning in collaboration with others.

- (2) Using it for diagnostic purposes and for establishing whether children increase their performance after a period of mediation.

The ZPD is also known as the zone of sensitivity to instruction. In the process of providing mediation a ZPD is created which should lead to improved cognitive performance. ZPD determines the domain of transitions that are accessible to the child. Some children show large improvements after a period of mediation while others show less improvements. In terms of individual differences the depth or width of the ZPD varies and reflects a child's learning potential.

Learning potential can be described as the ability of an individual to learn something new and comprises the sum of the actual level of knowledge and skills and the width of the zone of proximal development. In this investigation the term is seen as an index of the zone of proximal development and is viewed as the potential of the testee to profit from instruction or directed intervention. This would include the flexible application of the learned material in an effective way. Learning potential could be both domain-specific and domain-general.

The quality of the child's response to mediation is operationalized by the concept of structural cognitive modifiability (Grigorenko & Sternberg, 1998). The term used in this investigation views the modifiability of individuals as an indication that they are able to benefit from a period of mediation and improve their performance in specific problem solving tasks. It is not seen as the modifiability of the individual's cognitive structure, but only as a way of measuring an individual's response to mediation. Further and more intensive intervention would be needed to bring about deep structural changes.

Vygotsky (1978) argues that the intellectual climate of a child's environment is more important than biological maturation or readiness. Mental development is brought about by the quality of the learning opportunities available to the child. He actually advocates against the popular assumption that the level of complexity of useful instruction should never exceed the present capabilities of the learner. Within this theoretical perspective the individual's potential to benefit from instruction is the most important variable. The current intellectual ability of an individual assumes secondary importance. This theory is the basis of a body of research on the relation between intelligence, learning potential and academic performance (Campione & Brown, 1987; Brown & Campione, 1986; Shochet, 1986). However, with a few exceptions these and other studies have concentrated on

retarded and/or pre-adolescent children. Vygotsky's theory suggests a way of measuring learning potential. After the assessment of the unaided problem solving efficiency of a testee, the problem solving efficiency after intensive intervention is again assessed. The difference is the individual's learning potential score.

The ZPD allows for a more comprehensive picture of the person's current developmental state (pretest) and for predicting development of potential in the immediate future. Individuals who have had optimal opportunities to develop their abilities will probably show a high initial pretest score and a higher posttest score following a period of training, which leaves for a small increase in the difference score. Individuals who have not had optimal opportunities to develop their problem solving abilities will probably show a much lower initial pretest score and a higher posttest after a period of training, which allows for a larger difference score. The mediated lesson provides an opportunity for some students to bring their posttest score up to a required level of performance. These students are able to benefit from mediation.

An analysis of the ZPD in a tertiary education setting would be looking at the social interaction taking place between the students and the support (development) provided to them by the institution (Craig, 1996). It is an evaluation of how students learn and their response to interventions. It would also include investigating the relationship between instruction, as part of mediation and the students' subsequent development. The ZPD has implications for student selection, but also for academic development and how disadvantaged students respond to mediation. Learning potential tests are less sensitive to environmental influences than intelligence scores and reduce the effects of non-cognitive components such as anxiety (Guthke, 1993).

Feuerstein (1979, 1980) distinguishes between two forms of learning: learning by direct exposure to a stimulus, which means a continuous form of learning in which stimuli are perceived by trial and error, and mediated learning where the stimuli are mediated by a more capable person. This person selects, structures and interprets the stimuli for the child and influences the perception of the stimuli. Mediated learning experiences are essential for the development of the child. A lack of mediated learning experiences means that a child has a diminished ability to profit from direct learning experiences which then results in deficient cognitive functioning. This deprivation manifests itself in a reduced level of modifiability, a passive attitude towards cognitive tasks and a negative self-concept.

Feuerstein rejects both genetic and environmental determinism and sees intelligence as a dynamic, changeable phenomenon. Individual differences in intelligence cannot only be attributed to the role of the environment, but rather the extent to which the environment is mediated for the child. Educationally disadvantaged students would still be intellectually and academically modifiable and not have been irreversibly affected by their past educational experiences.

In analysing the nature of the underpreparedness of disadvantaged students it is possible to use Feuerstein's distal and proximal causes. Distal causes lie in the environment while proximal causes are closer to the individual's own functioning. Mediation and the student's response to mediation link the distal and proximal causes. Disadvantaged students develop cognitive deficiencies due to a lack of mediated learning experiences during their early education. This results in students with poor abilities and students with potential showing the same deficiencies in problem solving. It is argued that it would be possible to differentiate between these two groups of students by analysing their response to mediation and assessing their level of modifiability. Students who are able to benefit from a mediated lesson, show that they possess the potential to benefit from an enriched academic environment and are able to be academically successful (Miller, 1992).

The use of learning potential assessment is an alternative to the static approach and provides an opportunity to measure the ability of the individual to learn and integrate new knowledge into an already existing knowledge base (Hamers & Resing, 1993). The mediated lesson forms an integral part of the learning potential assessment procedure and is usually preceded by pretest and followed by a posttest. During the mediated lesson students usually receive a lesson including general metacognitive and also very specific problem solving elements. In dynamic assessment the learning process tends to be more important than the product, which seems to be the opposite to the approach in static tests. Thus learning potential tests may provide additional information on how students learn and how current levels of functioning can be improved.

Many researchers consider the concept of learning potential as identical to the concept of learning ability (Guthke, 1993; Resing, 1993; Ruijsenaars, Castelijns & Hamers, 1993). In recent years there has been a paradigm shift in analysing how students learn and the importance of metacognitive abilities in processing information (Biggs, 1985; Entwistle & Ramsden, 1983). The deep-comprehensive learner summarises and integrates new information into an existing knowledge base. The operation-surface learner tends to list

and memorise, while the achievement type uses the strategies that they believe will bring them rewards (Blunt, 1992). The difference between successful and less successful students is often not the study method used, but whether students are aware of why they use a specific approach or strategy. The most successful students tend to be those versatile learners who are able to adapt their learning strategies according to the situational demands. Biggs (1987) postulates that students' metalearning or meta-cognitive abilities act as a mediator between personality factors, the situational context, approaches to learning and the quality of learning outcome. His model emerges in terms of the motives students have for engaging in a learning task and the strategies adopted to realise their intentions.

Linked to underprepared students' ability to benefit from a period of mediation and demonstrate their potential to learn, is the question whether the more modifiable students show differences in their approaches to learning, motivation and learning strategies as opposed to those students who are less modifiable (and also show poor ability). Another question is whether it would be possible to establish different correlation patterns for the different groups of students. In other words would there be significant differences in which factors correlate with academic performance for the more modifiable group of students. This study attempts to provide answers to these questions and to ascertain how the construct of the zone of proximal development can be practically applied to the problem of the selection and development of disadvantaged students for tertiary education. Identifying those factors which differentiate between successful and less successful students would assist in designing the kind of intervention facilitating academic development.

## **6. TWO SOUTH AFRICAN STUDIES USING DYNAMIC TESTS**

Two research studies done with disadvantaged students in South Africa informed the present study. The first one was by Shochet (1986) and the second by Boeyens (1989b).

Shochet (1986) developed a lesson, based on Feuerstein's (1980) Learning Potential Assessment Device (LPAD), for a traditional ability test to enable students to develop skills in answering a second version of the test. The difference score would represent the students' learning potential or modifiability. His results indicated that with the less modifiable group a strong and significant relationship was found between the pretest

score and their academic performance. The pretest can be viewed as representing the traditional static testing. The opposite was found for the more modifiable group of students, where the results showed negative correlation between the pretest score and academic performance. The concept of cognitive modifiability did not play a simple main-effects role in prediction, but served a more complex role as a moderator of a traditional predictor. It enabled the identification and differentiation between less and more modifiable students and the prediction of the performance of the less modifiable students on the basis of a traditional test. The implications of Shochet's findings were that the static version of the test was a good predictor for the less modifiable group but not for the more modifiable group. Shochet was unable to find predictors for the more modifiable group of students. He argued the case that there seemed to be two different groups of students who need to be treated differently with regard to predictors of academic performance (Shochet, 1994). His suggestion was that future research could focus on exploring differences between the groups on approaches to learning and metacognitive abilities.

Boeyens (1989a) developed a Learning Potential Test (LPT) to improve on the defects inherent in the use of traditional ability tests as predictors of academic performance. He established a satisfactory reliability for the difference score between the pre- and posttest which is one of the methodological problems hampering the use of learning potential tests and which practitioners are grappling with. Boeyens designed his test in such a manner that the difficulty level of the homogeneous series items could be established beforehand. His results with a group of adult matriculation students generally supported the findings of Shochet (1986). A qualitative investigation of how students applied the lesson in the posttest, indicated that there were three distinct groups of students. The first group rigidly and inappropriately applied the lesson and the students in this group actually obtained lower marks on their second test as opposed to their first test. The second group did not apply the lessons received during the mediation phase. They either continued using their own method or half-heartedly some of the principles learnt in the lesson. The third group applied the rules learnt in the lesson in a flexible way. They were able to use the lesson to their advantage in assisting them in solving the problems.

The correlation between learning potential (modifiability) and improvement in a Mathematical Achievement Test was strongest in the group that applied the lesson in a flexible way. This group of students seemed to possess superior metacognitive skills as

opposed to the other two groups. Boeyens suggested that further research should focus on investigating students' motivation, approach to learning and metacognitive skills.

In summary: This study would like to argue that in order to cut out any bias in favour or against any particular group in the selection process, a differentiation of criteria should take place. Rather than differentiating between students according to their past educational experiences and performance, the differentiation should be done on the basis of students' ability to benefit from a mediated learning experience. Selection of students would then be based on which students will best respond to the kind of programme that an institution has to offer and how the potential of students can best be developed.

## **7. STATEMENT OF PROBLEM AND METHODS OF INVESTIGATION**

The development of dynamic assessment procedures have provided the opportunity to differentiate between groups of students who are modifiable as opposed to less modifiable. This study argues that it is possible to make this kind of differentiation and to show that differences exist as to which factors will best predict academic performance. Traditional predictors, such as high school grades and static tests of intellectual ability, would be unfair and invalid to use when selecting disadvantaged students for tertiary education and it might be more valid and fair to make use of a learning potential test.

The following research questions come to mind and an attempt will be made to answer most of them in this thesis.

- (1) Which dynamic tests are best suited for measuring students' learning potential on different cognitive domains?
- (2) Which learning and cognitive factors are to be selected in relation to their substantial influence on learning potential?
- (3) Is a reliable and valid measurement of students' learning potential possible?
- (4) What is the actual influence of some learning and cognitive factors on the students' learning potential and academic performance?
- (5) What are the advantages of dynamic testing as opposed to static testing and previous academic achievement (matriculation marks) in order to develop more fair and valid predictors of academic performance?

Some of the questions should be answered by the review of other researchers' findings while some will be addressed by the problem statement.

A dynamic test or learning potential test (LPT) is an example of a marriage between psychometric and mediational theories. A LPT has the psychometric properties of a regular test, but differs from it with respect to its administration procedure, because of the incorporation of a teaching/mediation phase. An assumption in the use of learning potential tests is that learning in the teaching/mediation phase of the test is an indication of learning performance in an educational setting. The test aims to predict success or failure in learning (Ruijsenaars, Castelijns & Hamers, 1993). The LPT was developed either to use as a tool for predicting academic performance and selecting students or as a diagnostic instrument, to assess how students learn and respond to mediation.

Four different measures of academic performance were used in the study. The year mark is calculated from the tests and assignments completed during the year. This mark is used together with the end of the year examinations mark to calculate a final mark according to the following ratio: year mark 40%, examinations mark 60%. The students have to obtain at least 50% in the examinations for a particular subject to enable them to pass. The grade point average of the year, examination and final mark for each student was calculated and used in the study. The fourth indicator of academic performance utilised is the number of credits obtained. A credit is obtained for each of the subjects passed in the course. A student would have to obtain at least 50% of a final mark to pass a particular subject as well as passing the major subjects in order to advance to the next year of study.

The subjects in the different studies were all first year students at the Peninsula Technikon (a tertiary education institution focusing on career-orientated technological education). The following study disciplines were included in the study: Education (Commercial and Science), Engineering (Electrical), Information Technology, Business Management and Science (Food Technology). The statistical analysis was done using the SPSS for Windows and Statistica programmes. The Information Technology, Business Management and Electrical Engineering students were selected firstly by means of the matriculation score and secondly by way of the dynamic and static test scores. Those students who could not gain entry, because of a lower matriculation score, could still be admitted on the basis of their test scores. Making use of students at the Technikon inevitably make them a preselected group.

In order to achieve the aim of the study, as expressed in the first paragraph of this chapter, the problem statement was divided into several subproblems and various studies were conducted to address these subproblems. The following is an outline of the problem statement and the various subproblems:

### **Problem Statement**

The purpose of this investigation is to analyse disadvantaged students' learning potential in order to be able to differentiate between groups of students as regards the cognitive and learning factors that predict academic performance.

### **Subproblem 1**

To assess the mediated lesson in the dynamic assessment instruments for its effectiveness in identifying modifiability.

### **Subproblem 2**

To evaluate the use of dynamic assessment instruments as opposed to static assessment instruments and previous academic achievement in the form of the matriculation marks in order to develop a more fair and valid predictor of academic performance for different groups of disadvantaged students.

### **Subproblem 3**

To analyse the various learning and cognitive factors that influence disadvantaged students' learning with reference to the following:

- (1) response to mediation
- (2) schooling
- (3) gender
- (4) language
- (5) study discipline
- (6) year of study

in order to identify the critical elements that would act as moderators in predicting academic performance.

The following hypotheses can be formulated from the statement of the research problems:

### **Hypothesis 1**

There will be a significant difference between the scores of those students who received the mediated lesson as part of the dynamic assessment instruments as opposed to those students who did not receive the mediated lesson in both the dynamic tests.

### **Hypothesis 2**

There will be a significant enhancement in the predication of students' academic performance with the use of dynamic tests as opposed to the use of static tests and previous academic achievement in the form of matriculation marks.

### **Hypothesis 3**

There will be significant differences in patterns of corelation with academic performance as well as in learning and cognitive profiles between the following groups:

#### **(1) Modifiability**

The more modifiable group of students will show significantly higher scores on a deep as well as an achieving approach to learning as opposed to the less modifiable group. With the less modifiable group the matriculation marks and static tests will be significantly better predictors of academic performance, while with the more modifiable group dynamic tests will be significantly better predictors of academic performance. Modifiability will have a moderator effect on the tests predicting academic performance.

#### **(2) Schooling**

With the DET students the dynamic tests will be significantly better predictors of academic performance, while with the non-DET students the matriculation marks and static tests will be significantly better predictors of academic performance. Schooling will act as moderating factor in the prediction of academic performance.

#### **(3) SES, gender and language**

There will be no significant differences between the correlation patterns between groups of high as opposed to low SES students, male as opposed to female students and English first language users as opposed to English second language users. SES, gender and language will not have a moderator effect on the prediction of academic performance.

(4) Year of study and discipline

Third year students will have significantly higher scores on a number of learning factors as opposed to a group of first year students. Engineering students will have significantly higher scores on a number of cognitive and non-cognitive factors as opposed to Business Studies students.

The measuring instruments used in the study to operationalise the constructs are the Conceptual Reasoning Test (CRT), the Learning Potential Test (LPT), the Reading Comprehension Test (RCT), the Study Process Questionnaire (SPQ), the Motivated Strategies for Learning Questionnaire (MSLQ), the Mental Alertness Test (MA) and the Electrical Aptitude Test (EAT). These instruments are discussed in more detail in Chapter 6. The researcher was responsible for conducting all the tests.

The decision to use the LPT and CRT was based on the fact that they represent two different examples of dynamic tests. The tests both consist of non-verbal reasoning tasks and make use of novel material that is generally not found in students' previous academic experience. This tends to make it culture-fair and a more reliable indicator of general intelligence or "g" (Jensen, 1980). The LPT makes use of a lesson between the pre- and posttest while the CRT only uses a lesson with hints in the first part of the lesson.

The scope of the tests regarding the different cognitive functions being measured had to be restricted due to the time limitations not only of the investigation but also of the selection process itself. The LPT and the CRT are group tests with standardised mediated lessons. The lessons consist of written material and verbal interaction between the testees and the researcher. The aim of the lesson was to familiarise the students with the content of the test and in that way attempting to equalise their experiences. The investigation is based on the assumption that some students are more capable of learning than conventional indicators such as matriculation marks and static tests would suggest. If disadvantaged students are provided with the opportunity to learn how to solve a problem through organised and specialised instruction at least some of them will demonstrate improved performance above that shown by static tests. The method used is test-centred coaching in a group setting and the format is formal pretest, followed by standardised training and formal posttest.

The SPQ and the MSLQ were selected as measurements of students' learning and represent affective and cognitive processes involved in learning. Non-cognitive measures

seem to play an important role in how students respond to an intervention or mediation. Part of the investigation would be to assess how students with different approaches to learning and different learning strategies would differ in their response to mediation. These processes develop within the zone of proximal development. An assessment of the students' learning and motivation processes is an effort to link students' learning strategies and approaches to learning they tend to use when functioning in the zone of proximal development. This will enable the researcher to establish which learning factors differentiate between more and less modifiable students. The written lesson and verbal interaction between the testees and researcher form part of the zone of proximal development created by the interaction.

The constructs used in the study were operationalised in the following way:

**(1) Learning potential / modifiability**

This construct was operationalised by using the score on a test that is based on dynamic assessment procedures where a mediated lesson is included as part of the assessment. In the case of the Learning Potential Test (LPT) it meant using the posttest score, while with the Conceptual Reasoning Test (CRT) one test score was used. The difference score of the LPT was not used because of the reliability problems associated with it.

**(2) Static measurements of aptitude or cognitive ability**

This construct was operationalised by the use of traditional tests that do not make use of dynamic methods of assessment and do not include a mediated lesson. Examples of these are the Reading Comprehension Test (RCT), the Mental Alertness Test (MA) and the Electrical Aptitude Test (EAT). In some cases the pre-test of the LPT was also used as an example of a static test, because no mediation is present at that stage yet.

**(3) Previous academic achievement**

This construct was operationalised by using students' matriculation marks as reflected in the last examination of their last school year. A point scoring system, the Swedish Rating System (SR) was used. The system is explained in more detail in Chapter 7.

**(4) Academic performance**

This construct was represented by the results that students obtained in their first year of study at the technikon. Various indicators were used: year mark (tests and assignments during the year), examination mark (end of year examinations), final mark (a combination of year and examination marks in the ratio 40:60) and the number of credits obtained (number of subjects passed with 50%).

**★ (5) Disadvantaged students**

All those students who had attended schools of the black education system (Department of Education and Training (DET), House of Representatives and House of Delegates) were seen as being disadvantaged by the inequalities in schooling due to the legacy of apartheid. Students who went to private schools or schools of the old white Department of Education were not included.

**(6) Motivation**

This construct is operationalised by the motivation scale of the Motivated Strategies for Learning Questionnaire (MSLQ). The MSLQ is a self-report questionnaire. It includes the subscales: values, expectancy and affect.

**(7) Cognition and metacognition**

These two constructs are operationalised by the cognition scale and metacognition subscale of the MSLQ.

**(8) Management of resources**

This construct is operationalised by the management of resources scale of the MSLQ.

**(9) Test anxiety**

This construct is operationalised by the affect subscale of the MSLQ.

**(10) Approaches to learning**

The three approaches to learning: deep, surface and achieving are operationalised by the three scales of the Study Process Questionnaire (SPQ).

The method of presentation consists of a theoretical and empirical component. The literature study deals with a discussion of cultural bias and fairness, the development of

dynamic procedures and the use of cognitive and non-cognitive factors in predicting academic performance. The empirical component consists of a number of initial studies investigating the effectiveness of the mediated lesson in the dynamic assessment procedure, the role of past academic achievement and cognitive as well as non-cognitive factors in predicting academic performance. Further studies focus on the students' response to mediation and various group comparisons. The results of the studies and the practical implications of the findings are discussed in the final two chapters.

## Chapter 2

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# TRADITIONAL COGNITIVE FACTORS AS PREDICTORS OF ACADEMIC PERFORMANCE

## 1. INTRODUCTION

The attempt to predict academic performance has been a major area of interest for educationalists and psychologists, and became particularly important with the end of apartheid and the election of a democratic government in South Africa. The tension between the need to find suitable predictors of university success and the relative incapacity to do so, remains as high as ever. The primary constraint in the lack of success in the area of tertiary academic prediction seems to be the paradigm adopted by researchers. The research on cognitive predictors such as aptitude testing, has primarily made use of a static concept of testing and the emphasis tended to be on product rather than process (Shochet, 1986).

In this chapter the focus will be on the different cognitive factors influencing the academic performance of students, the measurement of cognitive attributes and the contribution that these factors make to the prediction of academic performance. Cognitive factors include the following variables: intelligence, aptitude and previous academic achievement. Variables, such as approaches to learning, cognitive styles and learning strategies, are seen as being part of non-cognitive factors and will be discussed in Chapter 4.

Generally cognitive factors are seen to be better predictors of academic performance than non-cognitive factors. Various researchers have reported 35% to 45% of the variance in academic performance explained by the measurement of cognitive attributes (Bloom, 1976; Daniëls & Schouten, 1970; Lavin, 1965). Previous school achievement usually make up a large part of the quoted figures. Various countries have developed their own selection practices.

## 1.1 SELECTION PRACTICES IN OTHER COUNTRIES

The use of psychometric tests for selecting students has a strong tradition in most countries in the world. At one stage psychometric testing was popular at colleges and universities in the USA. During the late sixties and seventies the use of tests was questioned on the basis of discrimination against disadvantaged minorities. This resulted in the validity, accuracy and practical value of the selection tests being put under scrutiny (Baird, 1987).

The standardised tests most often used in the USA are the Scholastic Aptitude Test (SAT) and the American College Test (ACT), which are respectively published by the Education Testing Service and the American College Testing Service (Rounds & Anderson, 1985). Conflicting results are reported on the predictive value of the different tests. The conclusion of most of the studies was that previous academic achievement seemed to be the single best predictor of academic performance at college and university level. In most cases the use of tests, such as the SAT and ACT, increased the effectiveness of predicting academic performance only slightly (Rounds & Anderson, 1985; Slack & Porter, 1980). Astin (1971), in his investigation into predictors of academic success, found that past academic achievement in the form of scholastic results proved to be the best predictor of academic performance at tertiary level. The contribution of aptitude and non-cognitive factors proved to be minimal. Johnson (1985) suggested that SAT scores be used in conjunction with the Grade Points Average (GPA) of the high school marks. The general consensus of researchers seemed to be that the prediction of academic performance becomes more accurate as the number of variables increase. Most countries tend to use a combination of high school results and admission tests in their selection of students into higher education.

The Swedish Scholastic Test (SweSAT) was developed in Sweden to establish a common benchmark to compare the preparedness for post-secondary education of older applicants with those who had just left school (Wedman, 1994). In Israel the social and economic development of the population led to the development of the Psychometric Entrance Test (PET) as an admissions test to universities. Most universities use the PET to complement the matriculation certificate (Bellar, 1994). The need for admission tests in the Philippines developed more or less along the same lines as in Israel. When the number of applicants, who qualified to enter universities by way of their school results, increased, new ways of selecting students had to be found. This led to the use of the College Admissions Test in conjunction with the high school performance (Klitgaard, 1986).

## **1.2 SELECTION PRACTICES IN SOUTH AFRICA**

A review of the selection of students in South Africa (Kotze, 1994; Volschenk, 1990) indicates that most of the selection methods are based on the matriculation marks (either the GPA or symbols for the different subjects), psychometric tests and interviews. As regards the matriculation marks, most universities and technikons use the Swedish Rating system or a variation of it (Fourie, 1990; Louw, 1990; Behr, 1985). The rating works on the basis of allocating points for selection purposes. Each discipline would have its own cutoff point for admitting students. Some disciplines would include non-cognitive factors – like interest, study habits and personality traits – together with cognitive factors, such as aptitude, in the selection criteria. Most of the cognitive measures are examples of traditional static tests and only recently have some universities started experimenting with dynamic assessment procedures to provide fair and valid selection criteria for disadvantaged students. Examples of these universities include Natal, Witwatersrand, Cape Town and Rand Afrikaans University. These changes came about because the matriculation symbols and traditional static tests were seen as invalid criteria to assess disadvantaged students' potential to be academically successful. Despite this, past scholastic achievement still plays the most important role in selecting students for admission to universities and technikons in South Africa. Most of the tertiary education institutions are presently searching for fair and valid alternatives.

## **2. INTELLIGENCE**

### **2.1 DESCRIPTION OF INTELLIGENCE**

The term intelligence has become a controversial subject amongst psychologists and educators. Intelligence is a complex construct which can be approached from different angles. The main differences in approaches to intelligence focus on intelligence as hereditary and innate on the one hand, and as a reflection of a person's learning experiences and environment on the other hand. The latter approach argues that the environment and learning factors play a determining role in the performance in intelligence tests.

Cattell (1971) distinguished between fluid and crystallised intelligence. The first kind of intelligence is seen as being genetically determined, that is the given qualities of an

individual's central nervous system and non-verbal. The second type is primarily regarded as the result of experience, learning and environmental factors and reflects skills and specific abilities. Cattell even went so far as to distinguish between the two types of intelligence by way of tests. This led to much criticism, as all tests measure a mixture of the two types of intelligence and it would be impossible to measure genetic potential that is not influenced by learning or environmental variables (Lohman, 1989).

Another method to bypass the nature/nurture issue was to define intelligence as that entity that is measured by intelligence tests. Both Jensen (1980) and Eysenck (1982) refer to this definition of intelligence as the most acceptable. The problem with this definition is that there are too many different intelligence tests and varied views on the pros and cons of the different tests. Uniformity would have to be reached on the tests or combination of tests that should be used in measuring intelligence for this definition to be useful. It also falls in the trap of the circular argument that intelligence is that which is measured by intelligence tests. The definition of Thorndike and Hagan (1969) tried to combine aspects of both the nature and nurture factors in the controversy. According to them intelligence is the readiness to learn, and this readiness is dependent on both the genetic traits of individuals as well as their whole life history which consists of the physical environment and previous learning experiences.

Later theorists took the influence of the environmental context into consideration which resulted in more dynamic definitions. Sternberg (1985:1) in comparing the information-processing approach with the psychometric approach stated that the former "... seeks to study the mind, in general, and intelligence, in particular, in terms of the mental representations and processes that underlie observable behaviour."

Estes (1981:171) views intelligence or intellectual behaviour as referring to "... adaptive behaviour of the individual, usually characterised by some element of problem solving and directed by cognitive processes and opinions." He viewed intelligence not as a static entity but as a ability to learn that can be changed. Learning was seen as all systematic processes of acquiring information or knowledge. With the emergence of the information processing approach the emphasis was on investigating ways in which cognitive processes and operations enter into performance of intellectual tasks.

Gardner (1985) argues for the inclusion of a far wider and more universal set of competencies to describe human cognition than has been considered by most theorists.

Most of the competencies do not lend themselves to measurement by standard verbal methods which rely heavily on a blend of logical and linguistic abilities. He formulated a definition of an 'intelligence' as "... the ability to solve problems, or to create products, that are valued within one or more cultural settings." (Gardner, 1985:X). Gardner challenges the notion of large general powers and argues that the mind has the potential to deal with several different kinds of content. Human beings have the capabilities for several intelligences and do not draw variously on one flexible intelligence. He also strongly believes in cultural variations in cognitive competence.

According to Haywood and Switzky's (1992) view the more native intelligence one has, the more easily cognitive processes are learned, and the greater the proportion that can be learned by direct experience as opposed to the need for intense mediated learning experiences. Motivational processes are seen to be crucial in that they are important in developing thinking abilities, which can be described as the acquisition of the knowledge base and general and specific skills for using that knowledge base. The motivational processes also direct the cognitive processes that underlie the application of reasoning, creative thinking, and problem solving to learning and performance.

The development of different intelligence theories will be discussed in the next section.

## **2.2 INTELLIGENCE THEORIES**

The following are the more popular theories used to describe the measurement of intelligence: psychometric, developmental, information processing and multiple intelligences.

### **2.2.1 Psychometric models**

The traditional or psychometric theories accept that cognitive abilities consist of one or more static entities. These entities or factors lead to individual differences which are evaluated by IQ tests and scholastic achievement (Sternberg, 1984). The psychometric models are based on test results and the use of factor analysis as statistical technique is emphasised.

The structuralists had a strong influence on the psychometric approach. Some exponents of this approach were Spearman, Thurston, Guildford, Vernon and Cattell.

- **The two factor theory of Spearman**

Spearman (1927 in Sternberg, 1982) is seen as the initiator and first user of the factor analytical methods. He formulated his well known two factor (or g-factor) theory in 1904.

The two factor theory describes intelligence as a function of two factors or abilities. The one factor is seen as a fundamental intellectual ability which is common to all forms of intellectual behaviour. This factor is known as the so-called g-factor which can be described as general intelligence. Each cognitive task will have a loading of g.

Besides the g-factor Spearman also admits to the existence of certain specific s-factors. Achievement in any task or test is not only a function of g (general intelligence), but also specific factors (specific intelligence) which links with the specific task that has to be completed. It means that individuals' achievement in mathematics is not only dependent on their general intelligence, but also on their specific ability in mathematics. Activities in thinking, such as reasoning and learning, is also the result of the g-factor and at least one s-factor. The relative contribution of the g- and s-factors depend on the kind of activity to be performed. Generally people with a higher g-factor will also have more s-factor available to them (Mouton, 1990).

For Spearman the g-factor provided the only meaningful basis for the prediction of academic performance, because it performs the essence of all mental activities. He reported a correlation of 0.83 between the g-factor and academic performance. The s-factors according to him, have a limited generalising value and cannot easily be linked to academic performance. As regards the measurement of intelligence, Spearman contends that g would be the common attribute that is measured by the different measuring instruments of mental ability. The s-factor is linked to each individual sub-test (Sternberg, 1982).

- **The multiple factor theory of Thurston**

Thurston (1924 in Sternberg, 1982) used more sophisticated factor analytical methods and argued for the existence of seven primary mental abilities (or group factors) which form the basis of individuals' intellectual ability. He identified the following factors: verbal comprehension, word fluency, spatial visualisation, numerical fluency, memory, reasoning, and perceptual speed. These factors formed the basis of the different sub-tests in Thurston's test of primary mental abilities (Butcher, 1970). They correlated with each other and a second order analysis could be performed on them. The correlations indicated a general super factor (general intelligence) which is common to the primary mental abilities.

Whereas Spearman started off with a general factor (g factor) and later identified specific and group factors, Thurston started off with group factors and later had to admit the existence of a g-factor. Neither side has been able to gain an upper hand.

According to Gardner (1985) the reason is because the issues surrounding the interpretation of intelligence scores are mathematical in nature and not susceptible to empirical resolution. Given the same set of data and using a particular set of factor-analytical procedures, it is possible to come up with a picture supporting the idea of a g factor, while when applying another method, it is possible to support the notion of a family of relatively discrete mental abilities. As Gardner (1985:17) states: "When it comes to the interpretation of intelligence testing, we are forced with an issue of taste or preference rather than one on which scientific closure is likely to be reached."

- **Hierarchical models**

The hierarchical model was developed through the use of even more sophisticated methods of factor analysis. Burt (1970) and Vernon (1970) were the main exponents of this method and tried to develop alternative schemes for organising mental abilities. Vernon distinguished two primary group factors from the g factor, namely verbal-educational (V:ed-factor) and the practical mechanical-spatial-physical (K:m-factor).

Each of the primary group factors splits up into secondary group factors. The v:ed-factor contains the following factors: reasoning, verbal and numerical subgroups, while the k:m-

factor contains subgroups such as spatial, science-technical and mechanical. The mathematical factor belongs to both the verbal and kinesthetic factors. These group factors can be broken down into specific factors which are involved with specific activities such as spelling, reading and arithmetic (Vernon, 1950).

- **The three dimensional theory of Guilford**

Guilford (1967) expanded on the work of Thurston and used multiple factor analysis. He developed the idea of specific factors with his three dimensional model of mental ability (Structure-of-the-intellect-model). His model distinguishes three dimensions of intellectual functioning: activity, content and product factors.

**(1) Activity factors**

The intellectual activities mentioned are cognition, memory, evaluation, convergent thinking and divergent thinking.

**(2) Content factors**

Four types of content (information according to which the intellect functions) are distinguished, namely symbolic, semantic (verbal abilities), figurative (image) and behaviour. Guilford does not believe that content can be categorised into verbal and non-verbal. He also identified a spatial factor. Three parallel content categories are identified, namely figurative, symbolic and semantic. The figurative category includes spatial tests, the symbolic category includes numerical and the semantic category includes verbal tests. The fourth category, behaviour, has links with the social intelligence of Thorndike.

**(3) Product factors**

Products are the results of intellectual processes and come about when an activity combines with a specific content. It is the form that information takes when it is processed by the individual. The six types of products are units, classes, relations, systems, transformations and implications.

Each unique ability can be expressed in terms of a combination of an action, content and product. A verbal comprehension factor is formed by the interaction between the semantic content factor, unit products and cognitive action. The complete model

of Guilford consists of a three dimensional structure with five intellectual processes of thinking activities, four of contents and six of products. After further research Guilford (1982) replaced the figure content factor with an auditive and a visual content factor.

The model of Guilford emphasises the complexity of intelligence and indicates the interdependence of the different mental factors. This theory also implies that the total personality forms the basis of intellectual performance.

- **The gf-gc-theory of Cattell**

Cattell's (1948 in Brody & Brody, 1976) theory can be seen as a synthesis of Spearman and Thurston's work. He emphasises the importance of g, while he also sees g as a second order factor. He distinguishes seventeen primary mental abilities and postulates that g can be measured from these factors.

Cattell splits general intelligence (g) into two components; fluid intelligence (gf) and crystallised intelligence (gc). Fluid intelligence (gf) can be seen as the basic biological or inherited ability of the individual and is primarily reflected in non-verbal tasks and adjustments to new situations. It is genetic in nature and not dependent on cultural factors and previous learning experiences. Examples of these intellectual skills are memory and mental alertness.

Crystallised intelligence (gc) is the result of interaction between fluid intelligence and environmental and cultural stimuli. It consists of learned knowledge and skills such as vocabulary, mechanical knowledge and logical thinking. The abilities have much in common with Vernon's v:ed abilities which are measured by most standardised tests (Stanley & Hopkins, 1972).

Although clear differences exist between gf and gc, the two factors show moderate correlation. This can be attributed to the fact that many first order-factors have more or less the same loadings of both gf and gc. The significant relationship can be seen as support for Spearman's original idea of a single g factor. The development of gc is, to a certain extent, dependent on gf. The development of individuals' mental ability is not only dependent on cultural and educational experiences, but also on the level of fluid abilities that enable them to benefit from educational opportunities (Stanley & Hopkins, 1972).

Further second order factors to be distinguished are visualisation ability (gv), retention ability (gr) and cognitive speed (gs). The latter indicates the ability to perform well in less complex tasks where speed is essential.

There seems to be support for the multidimensional nature of intelligence in the results of psychological tests. No person is equally proficient or deficient across all areas of ability. It appears that it takes one kind of intelligence to learn languages, another to understand and manipulate spatial relations and yet another to play a musical instrument. This does not deny the existence of a g factor or general intelligence. The psychometric tradition has provided some support for this notion of multidimensionality. The classical factor analysts have found both a general g factor and a set of group and specific factors (Haywood & Switzky, 1992).

- **Evaluation of the psychometric approach**

An evaluation of the psychometric approach is important, because of its frequent use in the selection of students. The psychometric approach is based on the factor analytical identification of cognitive factors such as a general g factor, which is an indication of general cognitive abilities, and s factors which are an indication of specific abilities. Most static measuring instruments are developed by using the psychometric approach.

Although the psychometric approach has some merit in quantifying cognitive abilities within a static paradigm, there are certain limitations which must be taken into consideration:

- (1) A general point of critique is that psychometric intelligence tests are limited to what they can measure. Cognitive abilities consist of a variety of mental factors of which only some are measured by the tests (Mouton, 1990).
- (2) Psychometric tests are unable to measure the construct "intelligence" in its pure conceptual totality (Hatch & Gardner, 1986).
- (3) Development psychologists, such as Piaget, are of the opinion that the psychometric approach does not allow for the development of cognitive abilities and is therefore unable to measure the development of complex mental abilities (Carrol, Kohlberg & De Vries, 1984).

- (4) Information-processing theorists concede that the psychometric approach is able to show the difference between individuals, but that it does not indicate similarities between individuals' intellectual abilities. Sternberg (1985) reasons that it is important to investigate both aspects for a clear picture of individuals' mental abilities.
- (5) The structural model of factor analysis provides a limited and incomplete picture of intelligence (Gardner, 1985).

For various reasons the initial enthusiasm over intelligence (IQ) testing since the days of Binet and Simon have since waned. There are numerous limitations in the IQ tests themselves and in the uses to which they can be put. For one, the tasks are skewed in favour of individuals in societies with schooling and particularly of individuals who are accustomed to taking paper-and-pencil tests featuring clearly delineated answers. In other words they tend to favour those individuals who have had experience in testing and have developed a certain level of test wiseness.

The IQ movement is blindly empirical, based simply on tests with some predictive power about success in academic settings, and only marginally on a theory of how the mind works. There is no view of process and product; whether one arrives at the correct answer or not, becomes all important. The tasks in the test are usually not related to each other and often remote from tasks in everyday life. They also rely heavily upon language and verbal skills. These tests tend to have relatively little predictive power outside the school context. As regards the heritability of IQ, few authorities would claim that the IQ is in no degree inherited, but excessive claims on heritability within and across races have been discredited to a large degree (Gardner, 1985). Intelligence tests reveal little about individuals' potential for further growth because of their static nature. In terms of Vygotsky (1978), intelligence tests fail to yield any indication of individuals' zone of potential or zone of proximal development. This restricts their usefulness in the selection of educational disadvantaged students.

### **2.2.2 The developmental approach**

The difference between the psychometric approach and the developmental approach is that the former places emphasis on the quantifying of cognitive abilities, while the developmental approach focuses more on the qualitative aspects of mental abilities. Jean Piaget is seen as the important leader in this area. His theory is grounded in biological

laws and emphasises organisation and adaptation as two basic processes in the development of intelligence (Piaget, 1977).

Piaget's view of intelligence, has to a large extent, replaced the previous pre-occupation with intelligence testing. He became interested in the errors children make when doing items on an intelligence test and concluded that it is not the accuracy of the child's response that is important, but rather the lines of reasoning that bring about erroneous conclusions. He postulates that the cognitive processes necessary for mature or logico-mathematical thought develop spontaneously from interaction between the subject and the object of knowledge. Learning and teaching is constrained by the learners' cognitive structures which are a product of the equilibration process. Children receive information via language or education only if they are in a state to understand the information. They must have the mental structures which enable them to assimilate the information (Moll, 1989).

Piaget's theory employs both the concept of structure (forms of cognitive activity) and the concept of function (the processes of assimilation and accommodation) which constantly transform these structures. Cognitive growth is understood to be an aspect of the biological adaptation of the child to its environment. Children pass through stages of development in the following universal and necessary sequence:

- (1) sensorimotor thought
- (2) pre-operational thought
- (3) concrete operational thought
- (4) formal operational thought.

The formal operational thought is the abstract thinking skills demanded from students by academic courses at institutions of higher education.

Piaget observed and described the evolving capacities of internalisation and symbolisation as reaching a peak around the age of seven or eight when a child becomes capable of concrete operations. A final stage of development comes into being during early adolescence, when being capable of formal operations, individuals are able to think in a completely logical fashion. They are now capable of that form of logical-rational thought which is prized in the Western world.

- **Evaluation of the developmental approach**

Certain weaknesses about Piaget's theory have become clear. His model of development assumes relatively less importance in non-Western and pre-literate contexts. According to Gardner (1985), the steps needed in achieving other forms of competence, for example those of an artist, are ignored in Piaget's emphasis upon a certain form of thinking. Most tasks claiming to entail concrete operations can be solved by children in the pre-operational years once various adjustments have been introduced into the experimental paradigm. While Piaget's tasks are more molar and complex than those favoured in intelligence tests, many are still remote from the kind of thinking in which individuals engage during their daily lives.

Eysenck (1986) criticises Piaget's theory in that it does not provide an acceptable alternative to Spearman's g factor theory. Sternberg (1985) postulates that knowledge of the characteristics of different stages of thinking, adds nothing to the improved understanding of cognitive functioning.

While the Piagetian school of thought maintains that adult cognition is typically formal operational in character, it recognises that socio-cultural conditions can inhibit optimum individual cognitive growth. In order to account for the particular development of minds within specific socio-cultural constraints it is necessary to integrate Piaget's theories with Vygotsky's which allows for a dynamic approach.

### **2.2.3 The information processing approach**

Robert Sternberg is one of the leaders in the information processing approach (Eysenck, 1986) and has done more than any other contemporary psychologist to investigate the fundamental questions on intelligence.

While the psychometric approach emphasised the different factors involved in cognitive functioning, Sternberg focused on the underlying processes involved in the performance of intelligence tests (Sternberg & Gardner, 1982). Intelligence is seen as those abilities that are deliberately used to ensure socially acceptable behaviour.

Sternberg's (1985) theory of intelligence consists of three inter-related subtheories:

- (1) The contextual subtheory in which intelligence is viewed as mental activity directed towards the purposeful adaption to the environment relevant to one's life. The implications are that the intelligence of an individual's activities must be considered in a cultural context.
- (2) The experiential subtheory proposes that performance on any task is an indication of intelligence only to the extent that it requires the ability to deal with novel tasks and automatise the processing of information as two points on a continuum of tasks.
- (3) The componential subtheory specifies the mechanism of information processing.
  - (a) Metacomponents are executive processes used to plan, monitor and evaluate individuals' strategies for problem solving.
  - (b) Performance components are used to carry out the instructions of the metacomponents to solve problems.
  - (c) Knowledge acquisition components are used to learn how to solve the problems in the first place.

The three subtheories differentiate between aspects of intelligence that are universal and those that are cultural. Comparisons between different socio-cultural groups cannot be based on a single frame of reference, such as traditional aptitude or intelligence scores (Kail & Pellegrino, 1985).

Sternberg (1985) developed a contextual approach to intelligence in order to escape the circularity of intelligence definitions: Intelligence is what intelligence tests measure. His view, inherent in his triarchic theory of intelligence, is that intelligence should be related to real-life problems and tasks.

Two studies by Sternberg, Torff and Grigorenko (1998) tested the efficacy of the triarchic theory of intelligence as applied to classroom learning and performance. The one study was done with students in the 3<sup>rd</sup> grade and the other with students in the 8<sup>th</sup> grade. Three different types of instruction were compared: traditional instruction (memory based), critical thinking instruction (analytical based), and triarchically based instruction (involving infusion of analytical, creative and practical instruction). The results showed that triarchic instruction was superior on a number of different measurements. The students in the triarchic theory class tended to learn more than the students in the other two classes.

Borkowski (1985) developed a general model of intelligence first proposed by Campione, Brown and Ferrara (1982) which has a strong metacognitive element. The model distinguishes between two systems:

- (1) The architectural system depicts the biological, genetically based properties necessary for processing information such as memory, retention of stimuli traces and the speed of encoding and decoding information.
- (2) The executive system depicts the environmentally learned components guiding problem solving such as long-term knowledge and its retrieval, Piagetian schemes, control processes and metacognition.

Like Sternberg, Borkowski also stresses the importance of metacognition in the development of pupils' successful learning. He discusses three perspectives of metacognition.

- (1) Metacognition as one component of general intelligence interacting with other components throughout life.
- (2) Metacognition as the process which promotes the generalisation of thinking strategies.
- (3) Metacognition as a possible link between intelligence, self-knowledge and self-regulation.

Metacognitive abilities are likely to be culturally mediated during childhood. Examples of metacognitive activities include: planning, checking, reality testing, monitoring, evaluating and individuals controlling their own learning (Flavell, 1985).

- **Evaluation of the information processing approach**

A critical evaluation of the model shows that it is a complex theory covering a wide area of cognitive psychology with the different sub-themes describing different aspects of intelligence. The use of the terms fluid and crystallised abilities, as distinguished by Cattell, is also found in the componential subtheory (Sternberg, 1985). Fluid ability is seen as the reasoning ability of a person, which includes inductive and deductive reasoning. Crystallised ability refers to the ability to develop verbal ability and a vocabulary. It is subdivided into knowledge acquisition and real knowledge acquisition (Carroll, 1986).

Many researchers see the triarchical theory not as a theory, but as a conceptualisation of intelligence, and that it only helps to understand people's behaviour in general. Eysenck (1986) raises the following points in this regard:

- The theory does not explain the hereditary basis of intelligence.
- Sternberg includes a wide range of factors, such as personality, previous learning and experience, in the theory.
- From a psychometric point of view no correlation has been found between neuroticism and intelligence.

Researchers have also been critical of the way Sternberg developed instruments to measure intelligence. He uses tests that try to measure everyday practical intelligence. His verbal test scores generally do not correlate with verbal intelligence (Lohman, 1989).

According to Gardner (1985) the information-processing approach lacks an articulated theory within which different forms of cognition can be convincingly related to. Most of the problems examined by the information-processing psychologists tend to be of the logical-mathematical kind. In this sense the problems seem to have been borrowed from Piaget's list of intellectual tasks. Relatively little work has been done with tasks involving practical abilities (in the sense of those that can be applied) and creative problem solving. Gardner (1985) also feels that the information-processing approach does not make enough contact with the biological basis of intelligence.

On the positive side, the information-processing approach attempts to describe in detail the steps used by a person in a problem solving exercise. In its focus on the details of processing and its analysis of the structure of a task, information-processing intelligence theory is an advance on earlier directions. It allows for a much more dynamic view of what happens in the course of problem solving, with the suggestion of executive functions or "metacomponents" determining the problems to be tackled, the goals to be achieved, the operations and order of the operations to be applied.

The shift to a cognitive information processing perspective of human functioning in psychology can be viewed as a paradigm shift in that it has helped to move away from a black box conception of functioning. Testing, according to the black box model, involves eliciting gross responses to crude and ill-defined inputs, and interpreting these responses in a crude way. Taylor (1987) argues that people differ in the way they process

information and that the imposition of a single model of intellect is not possible. This often results in confusing and uninterpretable results being obtained. Different samples have different proportions of various type of information processors, which lead to the failure of factor analytical studies to produce results which can be cross-validated. The information processing approach can help to overcome some of the problems encountered with the more gross approaches.

The information processing approach has been used in cognitive research in a number of areas: developing a new theory of intelligence (Sternberg & Gardner, 1982), problem solving (Chi & Glaser, 1985), memory models and knowledge representation ( Craik & Lockhart, 1972) and learning (Biggs, 1985; Chipman & Segal, 1985). Pelligrino and Glaser (1979) report on two areas of information processing research. The first approach seeks to specify the information processing abilities that are differentially related to high and low levels of aptitude and intelligences. The second approach focuses on the cognitive components approach which is task analytical in nature and attempts to directly identify the information processing components in these tasks which have been generally used to assess mental abilities. Both these approaches still rely on the static approach to cognitive assessment.

Traditional approaches of assessing individual differences view the cognitive domain and abilities of individuals as relatively stable, which can be used to predict their future performance. In South Africa, with its diversity of cultural backgrounds and its widely varying quality of education, it cannot be assumed that everyone has reached an optimum level of development by late adolescence or early adulthood. An ability which is exercised in the school curriculum, such as reading comprehension, can be used as an example of an ability where an inequality of past educational experiences would not make it justifiable or fair to apply it as a selection criterion for higher education.

Learning theorists are increasingly moving in the direction of developing dynamic models of learning and the acquisition of meaningful knowledge (Glaser & Glaser, 1989; Campione, Brown & Bryant, 1985). Taylor (1987) argues that the static models which are currently used in psychometrics have reached a point of maturity, while no refinements of tests will significantly improve the predictive power of conventional tests. It will be necessary to look at approaches incorporating dynamic elements in order to improve on this level. Much of the research into change and learning would have to be done within the paradigm of information processing. The components and metacomponents used in

information processing theory are suitable vehicles to study strategies used in student learning.

#### **2.2.4 Multiple intelligences**

Gardner's (1985) perspective of multiple intelligences evolved from the symbol systems approach. Some of these intelligences are not new and are known as linguistic, logico-mathematical and spatial intelligence. The other intelligences that have not been described by previous theories include musical, bodily-kinesthetic and personal intelligence. Individuals differ in the level of development reached in each of these six intelligences.

The symbol approach focuses on a study of human symbolic capacities. Symbol use has been central in the evolution of human nature, giving rise to myth, language, art and science. Human cognition and information-processing is made distinctive by the deployment of various symbol systems, such as language. Gardner (1985) states that one of the questions to answer in this regard would be whether the operations of one symbol system such as language would involve the same abilities and processes as music or mathematics.

Cognitive accomplishments may occur in a range of domains. Certain domains, such as the logical-mathematical domain, are universal. They must be confronted and mastered by individuals worldwide in order to cope with the physical and social environment. Other domains are very specific and restricted to certain cultures. The capacity to read is seen as essential in many cultures, but unknown or minimally valued in other cultures. Placed at the opposite extreme from universal domains are unique domains. These are areas of skills in which initially only a few individuals make progress but which might, in time, be made accessible to other individuals. Much of the information essential for development is situated in the culture itself rather than simply inside the individual's mind. According to Gardner (1985) it is the culture that defines the stages and fixes the limits of individuals' achievement. Some individuals pass through the stages quicker than others. An example is the child prodigy who could be brilliant in only one area, such as music.

One of the strengths of the multiple intelligences approach is the emphasis on culturally based intelligences. Each culture could have different factors that are valued and

developed in that particular context. This has particular value in the South African context with its different cultures.

### **3. CONCEPTS RELATED TO INTELLIGENCE**

Two concepts closely related to intelligence are aptitude and achievement testing. Traditionally the distinction made between intelligence and aptitude was that aptitude developed from intelligence. While intelligence indicates global or semi-global abilities, aptitude is focused on the differential cognitive abilities of an individual. Cooley and Lohnes (1976) describe the distinction between aptitude, ability and achievement as a functional one. When a test is used to assess the effects of past instruction and learning experience, it functions as an achievement test; when it is intended to measure competence, it serves as an ability test; when it is designed to predict future performance, it is an aptitude test. Bond (1989) is of the opinion that Cooley and Lohnes' (1976) distinction fails to capture the essence of the differences between aptitude, ability and achievement tests. He proposes that admissions tests, such as the SAT (Scholastic Aptitude Test), differ from typical achievement tests, such as the ACT (American College Test), in that they tap procedural rather than declarative knowledge and that they do not rely on subject content, but are intended to measure problem solving and reasoning.

There is a strong link between intelligence and aptitude. Where in the past intelligence focused on the measurement of a global or general factor (g) (Spearman model) this has recently shifted to the measurement of group factors (Thurston model), which made the difference between intelligence and aptitude appear less. Aptitude seems to have more to do with the differential abilities of an individual, rather than a global ability.

#### **3.1 APTITUDE TESTS**

Two types of aptitude tests were developed: multiple and specific aptitude tests. The latter measures special abilities such as motor functions, mechanical and clerical aptitude. Multiple aptitude tests provide a profile of test scores for a number of relatively independent abilities as identified through factor analysis (Anastasi, 1976). A move took place from the measuring of general abilities to the development of more differentiated measuring instruments with the specific goal of predicting future academic performance.

The Senior Aptitude Test (SAT), and the High Level and Intermediate Batteries (Lombard, 1975) are examples of South African aptitude tests that were developed using factor analysis. The reliability of aptitude tests is usually very high – an indication of homogeneity. These tests are still used by some tertiary education institutions for selecting their first year students.

Aptitude tests were developed to predict academic performance. The type of validity used in aptitude tests is predictive validity. Generally the total scores of aptitude tests have a high predictive validity as regards academic performance in a homogeneous society. These tests do less well when it comes to differential predictor validity (Anastasi, 1976) and a heterogeneous environment, such as found in the South African context.

### 3.2 APTITUDE TESTS AS PREDICTORS

Various researchers (Kotzé, 1994; Fourie, 1990; Monteith, 1987; Botha, 1971) have found in a South African context that aptitude, and specifically academic aptitude, proved to be a valid predictor of academic success for white students. In this regard Mouton (1990) argues that the closer the aspect being measured is to the one which has to be predicted, the stronger the relationship between aptitude and academic performance. In the case of disadvantaged students where their schooling had not adequately prepared them for higher education, they would be at a disadvantage when aptitude tests are used, because it would reflect their lack of academic preparedness. If these students then do badly academically it would correlate with their low scores on the aptitude test, and the strong relationship between aptitude test scores and academic performance would be vindicated (Miller, 1992).

Bloom (1976) argues that aptitude represents the learning ability needed to perform well in a specific subject. A person with a high numerical ability should be able to do well in algebra, while a person with abilities in reasoning should do well in geometry. High test scores in numerical and reasoning abilities correlate well with mathematic performance in the first year of tertiary education (Boli, Allen & Payne, 1985).

Aptitude tests with a high g loading tend to be the best predictors of general academic performance. Researchers have had mixed results regarding relationship between aptitude and academic performance. The correlations have varied between medium to

very low. Generally the matriculation marks still tend to be the best predictor of academic performance, although some aptitude tests have been shown to contribute the highest  $R^2$  when compared to other factors (Fourie, 1990). Aptitude measures are often used to predict subject specific academic performance (Mouton, 1990).

A particular type of aptitude or achievement test is the reading comprehension and language proficiency tests. There has been a body of research suggesting that English language proficiency examinations, like the Michigan Test of Language Proficiency, are not as reliable a predictor of academic success as previously expected (Sharon, 1972). They tend to show more or less the same correlation with academic success as aptitude tests (Friedenberg & Curry, 1981). Research done at the Peninsula Technikon on English language proficiency showed that its correlation with academic performance was of a minimal nature. An important finding was that those students who scored below a certain minimal level, were more likely to fail their first year (Himunchull, 1995). From this result one can assume that students need to have a certain minimal working knowledge of the English language to even attempt being successful at tertiary level. Research done by Entwistle and Hebel (1977) confirm the notion that reading comprehension seems to be more useful for diagnostic purposes and placement in reading courses, rather than for predicting academic success.

The literature shows that aptitude tests are commonly used in the USA for admission to institutes of higher learning and much research has been conducted over the past couple of decades on the role of aptitude tests in predicting academic performance (Halpin, Halpin & Schaer, 1981; Freeman, 1970). The aptitude tests most commonly used are:

- Differentiated Aptitude Test (DAT)
- General Aptitude Test (GATB)
- American College Testing Program (ACT)
- Scholastic Aptitude Test (SAT).

The use of aptitude tests for admission to insitutions of higher education has become a controversial issue in the USA with some criticism levelled against the use of the SAT (Rounds & Anderson, 1985; Weitzman, 1982; Bracey, 1980; Slack & Porter, 1980). Generally the results of the research with the SAT has been contradictory.

Slack and Porter (1980) questioned the value of the SAT in the selection of students. Previous academic achievement was found to be a better predictor of academic performance than the SAT. They found that the SAT increased the predictor validity of the high school marks with only 0.08. Slack and Porter also indicated that coaching had a significant influence on SAT scores. In this regard Shochet (1986) argues that the enhancement of African American students' SAT scores through coaching is an indication that the SAT, as an example of a static instrument, measures manifest performance and not potential performance.

Weitzman (1982) countered that the validity of the high school marks is not above criticism either and that there is a lack of objectivity in the school grading system which could place certain students at a disadvantage. He found the SAT and high school marks to have equal predictive validity. Fincher (1974) found that the SAT, when combined with past scholastic achievement, tended to significantly improve the predictive validity of the school results.

An overview of research done with the SAT in the USA indicates that for minority (disadvantaged) students, the SAT explains less than 15 per cent of the variance of academic performance (Breland, 1979) and that there has been a decline in the predictive validity of the SAT since the 1970's (Slack & Porter, 1980). The question of test bias against minority groups has not been fully answered, despite efforts to rectify it with statistical methods. Using different regression lines for different groups could lead to either over- or underprediction of members of one group (Sedlacek, 1976; Baggely, 1974).

Aptitude tests were designed to measure aptitude which is distinct from achievement. It is argued that in the case of the former, the potential capacity of individuals is measured (Huysamen, 1997). In practice the capacity to perform on the aptitude test is strongly related to previous scholastic achievement and does not differ much from the achievement test in this regard. The only difference is that the achievement test might be more curriculum related than the aptitude test. They both still operate in a static paradigm that works to the disadvantage of black students who are most likely to be excluded from tertiary education.

A review study by Sedlacek and Brooks (1972) found that, for students receiving academic support, the SAT was not a significant correlate of college grades. This finding can be explained in Feuersteins' terms, where, for students who benefit from mediation,

previous levels of cognitive functioning assume minimal importance. There are studies that show that even without providing specific academic support, exposure to university studies modify the intellectual functioning of students (Astin, 1977; Perry, 1970) which is an indication of the dynamic nature of intelligence.

Although there is a long-standing view that intelligence equals the ability to learn, IQ and aptitude tests have generally been static measures reflecting the end result of prior learning and not always providing diagnostic information on the potential for improvement in various areas (Brown & Ferrara, 1985). For individuals from an educationally disadvantaged background the static scores of conventional tests would be an underestimate of ability.

## **4. PREVIOUS ACADEMIC ACHIEVEMENT**

### **4.1 INTRODUCTION**

Previous academic achievement can be seen as a cognitive variable that could be used to predict future academic performance. It is a quantitative indication (examination marks) of the knowledge and skills that students have in a particular subject or discipline. Previous academic achievement can be operationalised in different ways: grade point average for each subject or a combination of subjects, the position that a student achieved in class in relation to classmates, points system (points allocated to symbols achieved in the different subjects). The grade point average and class position are commonly used in the USA for selection purposes.

In South Africa the grade point average is the most common way of selecting students for higher education. The matriculation examination symbols are often quantified by way of the Swedish formula points system (Nunns & Ortlepp, 1994; Van Wyk & Crawford, 1984). Most institutions of higher education in South Africa use different varieties of the Swedish points system. Besides allocating different points to the symbols obtained by students, a differentiation is also made between the level on which the subject was passed at school (higher or standard grade). A more detailed description of the Swedish points system is given in Chapter 7.

## 4.2 PREDICTIVE VALIDITY OF PREVIOUS ACADEMIC ACHIEVEMENT

Some researchers have found previous academic achievement to be the best single predictor of academic performance (Booyesen, 1996; Nunns & Ortlepp, 1994; Bokhorst, Foster & Lea, 1990), while others (Skuy, Zolezzi, Mentis, Fridjhon & Cockcroft, 1996; Shochet, 1986) have found the matriculation marks to have a poor record in predicting the academic performance of disadvantaged students. The varied results could be an indication of how the different school systems in South Africa prepare the students for tertiary education.

According to Bloom (1976) high school marks explain 50% of the variance of the undergraduate academic performance of university students. Behr (1985), in a South African context, found that 72% of the success in the first year at university can be attributed to the knowledge gained at school level. Fourie (1990) reports the same high correlation between school results and academic performance. These results were mainly obtained with white students. Scholtz (1985) argues that school performance can be seen as a product of all those factors that determine performance. The university can be regarded as an extension of the school learning tasks and thus the school performance should be a good predictor of university performance. This argument would not be true for students from a disadvantaged school background where the school learning tasks did not adequately prepare the students to be successful in tertiary learning tasks (Miller, 1992).

Fourie (1990) found that successful first year students tended to have significantly higher matriculation symbols than those who were unsuccessful. The result of a discriminate analysis indicated that the successful students were correctly classified 62.7% of the time, while the unsuccessful students were correctly classified 77.8% of the time when the matriculation results were used as classification variable. The same results were achieved using a variation of the Swedish rating system.

As regards the predictor validity of specific subjects, Fourie (1985) found the first language, Mathematics and Physical Science to have significant relationships with the academic performance of first year engineering students. Jacobs (1985) reports the same results, where matriculation symbols (quantified by using the Swedish Rating system) correlated significantly with Physics 1.

Mitchell and Fridjhon (1993) argued that the matriculation examinations cannot be used as a predictor of academic performance, because of the difference in predictive validity of the different educational departments. This was reinforced by the inequality of resources due to past apartheid policies. The use of examination results as predictors could be discriminating if there are large differences between school resources, as is the case of South Africa.

Review articles on predictive research indicate that school performance still seems to be the best cognitive predictor of academic performance in most countries (Watkins, 1982; Slack & Porter, 1980; Entwistle, Percy & Nisbet, 1977). This seems to be more so with the natural rather than social sciences. At the lower range of school results (less than B aggregate) the relationship tends to break down. Most of the disadvantaged students who apply to the Peninsula Technikon fall into the lower ranges. Specifically for this group it has become necessary to find alternative predictors. The use of school results as the only criterion still leaves tremendous room for false positives and negatives in the selection process.

## 5. CONCLUSION

There seems to be widespread agreement for the need to supplement school results with alternative predictors. The different viewpoints of intelligence led to the development of different instruments. Most of the instruments are static in nature and tend to discriminate against educationally disadvantaged students.

Psychologists designed their tests to conform with the thinking characteristics of Western education and found that the tests tended to measure the kinds of capabilities involved in academic success. From this the psychometrics made the assumption that the common element in their tests, and also in academic performance, was intelligence. They settled for the definition that intelligence is simply what intelligence tests measure (Jensen, 1980). In contrast to this is Gardner's (1985) view of multiple intelligences and Sternberg's (1985) description of intelligence as being context orientated and that individuals' culture and race must be taken into consideration.

Conventional static tests (most of them based on a factorial model) are moderately successful at predicting academic performance (Taylor, 1987). However, their use to

establish why certain individuals fail to achieve success or how training can be modified to improve individuals' chances of success, is severely limited. An alternative approach is looking at dynamic and process assessment. There are a number of individual differences in the way individuals process information. Useful information on cognitive processing can be obtained by measuring differences in the application of metaprocesses or cognitive strategies. Cultural factors play a major role in the way information is processed. The development of dynamic tests has to take into consideration the integration of psychometrics, the mediational paradigm and the information processing paradigm. In the mediation phase instruction and non-cognitive variables, such as students' approaches to learning and learning strategies, would become important.

The next chapter (Chapter 3) deals with the issue of culture and the influence it has on the fair and accurate measurement of mental ability.

## Chapter 3

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# CULTURAL BIAS AND FAIRNESS

### 1. INTRODUCTION

The history of separate education departments for different population groups in South Africa has resulted in underprepared applicants from especially the black departments of education. Students from these departments are at a disadvantage when they have to compete with white applicants for admission to institutions of higher learning. These groups, who in the past have been underrepresented at tertiary level and for whom admission is sought, are the very groups who have been exposed (and no doubt will be exposed for some time to come) to an inferior high school education. The contentious issue in a multi-cultural context is the question of how institutions should assess which students have the potential to be academically successful. This question becomes even more complex when different cultures have varying views of what constitutes intelligent behaviour and how mental abilities should be assessed and developed.

An important issue in the psychometric assessment of minority or disadvantaged groups is that mean test scores of the dominant groups are usually higher than that of minority groups (Huysamen, 1996; Jensen, 1980). One explanation for the differences is that the tests are culturally biased and that they only address abilities relevant to Western, middle-class populations. The bias approach contends that minority groups do not obtain lower scores on intelligence tests due to lower ability but rather because of the inherent cultural bias of the tests. Consequently the tests are more difficult for minority group members. The main causes of bias are considered to be the white, middle-class orientation of test authors and the lack of relevant experience in taking tests (test wiseness) of the testees (Hessels & Hamers, 1993).

This chapter deals with the influence of culture on the measurement of cognitive abilities and the inherent cultural bias of many static intelligence and aptitude tests. The implications of the finding that many blacks do worse than their white counterparts on tests of intelligence and aptitude is debated. The influence of learning, in the form of

practice and coaching, on the assessment of mental ability is discussed in order to find a more fair way of selecting disadvantaged students. The geneticists versus environmentalists debate regarding development of intelligence, which lies at the heart of bias and fairness, will be discussed in the next section.

## 2. GENETICISTS VERSUS ENVIRONMENTALISTS

Differences between races as regarding performance on static tests have often been attributed to biased tests. The debate around the use of static tests has been between those who are anti-test and those who want to adapt tests to be less biased to disadvantaged individuals. The two theoretical views that reflect this debate is that of the environmentalists and the geneticists.

One of the important protagonists of the genetic view is Jensen (1980). According to him there are no differences in the predictive validity for whites and blacks, and that, if anything, tests tend to overpredict for blacks. In his view this includes the use of the SAT in the USA (Blacks have lower SAT scores, but this is in line with their lower academic performance). The geneticists argue that if black students obtain lower scores on tests of cognitive functioning, this difference reflects predetermined genetic differences. In the selection of these students different compensation methods, such as statistical manipulation and differential norms, would have to be used. According to this view compensatory educational programmes such as academic development and support programmes would also not have a big impact.

Herrnstein and Murray (1994) contend that heredity plays the major role (60% or more) in the determination of intelligence. The implications of this assertion is that the lower IQ scores of black Americans are largely determined by genetic factors. Criticism directed at this viewpoint would argue that people of the same socio-economic class would not necessarily be exposed to the same environmental factors. There is evidence that the difference of up to 15 IQ scores between white and black Americans can be eradicated by improved environmental conditions (Brody & Brody, 1976).

The comparisons of identical twins reared separately to those reared together, has shed some light on the traits most subject to hereditary influences. Scientists observing the same set of data can reach widely divergent conclusions. Some would place the

heritability of intelligence (as measured by IQ tests) as high as 80 per cent. Others, operating on different assumptions, would estimate heritability at less than 20 per cent. Most estimates are somewhere in between, with 30 per cent to 50 per cent commonly cited. There is agreement that aspects of temperament are largely genetic, but that when it comes to aspects of cognitive style or personality, the case of high heritability is far less convincing. Gardner (1985) speculates that certain individuals might have a predisposition or potential for developing certain intellectual capabilities, but that it needs an optimum environment for development.

Haywood and Switzky's (1992) view is that intelligence comes largely from individuals' genetic endowment and possibly from a polygenic mechanism. The individual differences in the development and expression of intelligence have been accounted for in a multidetermined way. Some of the variables involved are genetic variations, differences in levels, patterns and sequences of experiences, ecological conditions, and the interactions among these dimensions. Other variables that seem to be associated with individual differences in the expression or application of intelligence are motivational patterns and social class. According to Haywood and Switzky (1992:32):

The greatest intellectual deficits can be expected to occur among children who have the combination of poor nutrition, poor biomedical history, and poor environment, as well as a polygenic inheritance that disposes to low IQ.

Although the environmentalists have drawn the attention to the influence of the environment and the need for culture-free testing they have not devised an adequate model of testing to be used in predictive studies.

Intelligence tests in their present form might not be measuring intelligence and seem to be biased against disadvantaged students. Spearman's *g* is based on factor analysis and possesses no theoretical basis (Borkowski & Maxwell, 1985). Most of the perceived differences in IQ scores are a function of cultural bias in intelligence tests, thus discriminating against minority groups. The environmentalists argue that the IQ differences between black and white are a reflection of the differences in their environment and not of innate group differences. The anti-test movement asserts that tests are culturally biased and the validity and reliability of intelligence tests in different cultural and racial groups are brought into question. Sternberg (1982) argues that a case could be made for certain universal cognitive processes, but that at the same time there would also be items in

intelligence tests that would be very culture-specific. The role of culture in both the assessment and development of mental abilities seems to be particularly relevant in the South African situation.

### **3. THE ROLE OF CULTURE IN THE DEVELOPMENT OF MENTAL ABILITIES**

The inability to specify what constitutes equal opportunity to learn, fuels the controversy over racial differences in intelligence. One way of explaining the differences in performance on IQ tests is by way of differential learning ability. The socialisation that is done in the different cultures is linked to particular cognitive styles and styles of responding. Different cultures have different definitions of intelligence according to what is valued and what leads to good adaptation in that particular culture. Sternberg (1982) states that people with different cultures tend to develop and maintain different sets of skills – the concept of intelligence would differ from one society to another. The idea of a culture-free test is futile in so far as it is hoped to find an universally valid test. Most of the cognitive tasks to assess intelligence are from Western designs and concepts and would be biased against individuals from another culture.

Wood (1998) talks about the development of a scientific world view involving the construction of a set of mental models relating to patterns of causation, natural forces and methods of observing these. The development of such a world view involves the alteration of previously constructed models and it constitutes a cultural shift for individuals. The verbal tradition is an example of the development of a certain way of thinking that has been formed through experiences in a particular culture and that would have to be adapted to meet the demands of tertiary institutions.

~~W~~, Students tend to bring a certain amount of cultural and educational experiences into their studies (Mandew, 1993). This refers to the cognitive resources that have been informally acquired through individuals' socialisation, experiences of life and exposure to learning situations. Although disadvantaged students may have very rich experiences of life, they find that very little of this experience is viewed as valuable or academically relevant in the tertiary institution. Students are advantaged if their culture and socialisation are more compatible with the Western intellectual view of science and technology. Students from a

disadvantaged background often do not have the shared knowledge and beliefs that are assumed by lecturers at tertiary institutions.

✦ The poor schooling that disadvantaged students receive means that the world view of many of the students remain untouched by the modern scientific age. A description of the underpreparedness of students would include a lack of cognitive development to meet the specific demands of a science and technology orientated tertiary education system. The cognitive development of disadvantaged students is a unitary entity involving all of language, culture, background knowledge, learning strategies and academic performance. In reading any text students need to make many inferences in the course of interpreting it and this involves activating various kinds of knowledge structures. If students have not developed the necessary mental models to do this the writer's message will be cryptic to them. The same principle applies to the comprehension of a verbal text such as a lecture (Wood, 1998).

There has been some evidence of content preference in classification tasks with different cultures. Western children felt bewildered using rice in a problem solving exercise, while African students found geometrical shapes strange. African children were better at rice sorting than American children (Irwin & McLaughlin, 1970). Children from non-industrial societies tend to do badly on standard psychology tests while doing well on assessments of culturally specific skills. Aboriginal children were compared to Western children on spatial memory strategies and skills (Kearins, 1981), and were found to do consistently better. They also had a different approach to solving problems than the white Australian children. Aboriginals used visual perception strategies, while whites used verbal strategies.

These results emphasise the belief that the cultural context plays an important role in the development of cognition. Differences in knowledge can masquerade as differences in process. It would seem that cultural differences in cognition arise more from differences in contexts than from differences in basic psychological processes. "Cultural differences in cognition reside more in the situations to which particular cognitive processes are applied, than in the existence of a process in one cultural group, and its absence in another." (Cole, Gay, Glick & Sharp, 1971:233). The more familiar and culturally relevant the situation being observed, the more likely people are to perform competently (stimulus familiarity). What one seeks is functional equivalence in natural tasks with which to assess different cultures. The differences between cultures are found in the application of intelligence in different contexts rather than in genetic differences.

Goduka (1998) argues that individuals' culture and child-rearing practices within that culture has an influence on the development of their cognitive processes and learning strategies. This would subsequently have an influence on how individuals learn and respond to the mediated lesson in a dynamic assessment procedure. In a culturally diverse setting students bring their language and culture with them to school and later to higher education, which inevitably affect how and what they learn. Language is strongly linked to culture. It is the lens through which individuals view their world and is a medium that is used for thinking and production of meaning. It is often tempting to attribute the poor academic performance of students from diverse backgrounds to their lack of proficiency in the English language. The positive influence of knowing a language other than English has often been overlooked as being the basis from which to develop cognitive skills. These cognitive skills should be able to be transferred to the use of other languages or non-verbal settings. The instructional arrangements at schools often do not capitalise on the cultural strengths of students from a diverse background.

In looking at the role that culture plays in determining students' approaches to learning, researchers have studied the role of socialisation practices within a particular culture. Ramirez and Castaneda (1974 in Goduka, 1998) conducted research indicating that cultural values influence socialisation practices which in turn determine learning behaviour in children. Teaching styles reflect a certain set of values held by parents and family. These values tend, in many cases, to be culturally determined. It is thus fair to infer that cultural differences in learning style preferences develop through children's early learning experiences. Learning styles can be viewed as a component of cultural behavioural styles, the habits, values, predisposition and preferences that develop during a child's cultural socialisation process. Individuals of the same intellectual potential who grow up in different environments learn to manifest their mental capacity in different ways according to what is valued in that culture (Goduka, 1998).

As a theoretical formulation that encompasses all the elements of culture and cognition the theory of Vygotsky and his students is worthy of further consideration. His idea of a zone of proximal development, combined with his general views on the central role of interaction in development, provides a very useful framework to investigate the relationship between mental ability and culture. According to Vygotsky (1981) adult human functioning emerges from culturally organised forms of social interaction. The processes enabling the transition from social to individual functioning in his general law of cultural development are described in the following way:

Any function in children's cultural development appears twice or on two planes. First it appears on the social plane and then on the psychological plane. First it appears between people as an interpsychological category and then within the individual child as an intrapsychological category. This is equally true with regard to voluntary attention, logical memory, the formation of concepts and the development of volition. (Vygotsky, 1978:86)

Culture influences the organisation of children's environments in four ways:

- (1) It arranges for the raw occurrence or non-occurrence of specific basic problem-solving environments. Pre-schoolers learn to model with wire or to draw.
- (2) The frequency of the same kinds of events is culturally organised in these learning environments. The frequency with which children work with clay is established.
- (3) Culture shapes the patterning or co-occurrence of events. One culture provides for recalls of spatial arrays with rehearsal strategies, and another does without them.
- (4) Culture regulates the level of difficulty of the task. This increases the likelihood of crucial learning events taking place and failure being averted.

The regulative function of the culture can be seen as being part of the concept of the zone of proximal development. Vygotsky (1978:86) defines this concept as:

... the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers.

Problem solving and social regulation within the zone of proximal development are not restricted to formal instruction, but extend to day to day problems. Children are taught by starting with what they know and by then moving them nearer to a point defined by the teacher. In the interaction between the adult and the child the latter takes progressively more responsibility for doing more and more of a task. In this way the adult organises the learning environment of the child during the socialisation process.

The implications of the interaction is that the child is always a participant and the problem always gets done, so that development occurs in the zone of proximal development. The zone is dynamically achieved by the child and others in a social environment. This is what made Vygotsky assert that higher psychological functions begin as interpsychic functions shared between individuals. Only extensive practice permits a person to carry out the

same function intrapsychically. The initial structure of the internal process would be patterned after the external interactional one (Wertsch, 1981; Vygotsky, 1978). An environment for learning to take place is thus created by the adult.

Wertsch and his associates (Wertsch, 1981) have conducted a series of studies on the way in which mothers teach their young children an elementary task such as assembling a simple jigsaw puzzle. Initially the mother would assist a lot, but as the young child gained more experience, would leave the child to carry on alone. The content of the zone of proximal development changes as the child's experience with the problem increases. The mother always stayed a few steps ahead of the child. The interaction between mother and child thus aids in the development of the child. The mother arranges for or creates steps for learning to take place. Craig (1985) analysed the interaction between African mother and child dyads in a problem solving activity and found that child rearing practices and cultural factors play a role in the cognitive development of children. Zulu mothers guided their pre-school children in a type of problem solving that was not conducive for developing problem solving skills in a Western educational context.

Haywood and Switzky's (1992) transactional model of intellectual development uses Sameroff and Chandler's (1975) interactive model and Waddington's (1966) model of developmental trajectories to explain the gene-environment interactions. According to the former model the environments in which disadvantaged children are reared can either reduce or amplify the children's intellectual deficits, while the latter model suggests that all developing organisms have their trajectories (in the same manner as rockets) directed to specific mental goals or targets. The trajectories are governed by genetic endowment and are fueled by energy absorbed from the natural environment. Modification of the genetically determined trajectory of intellectual development is possible through environmental variation. Although the expression of intelligence may be blocked or inhibited by environmental events, it is performance that suffers and not intelligence itself, since restoration of previous intellectual levels may occur. Intelligence can be made accessible or inaccessible through the processes of perception, thought, learning and problem solving. Environmental circumstances remove obstacles or prevent the establishment of obstacles to the expression of intelligence.

Haywood and Switzky (1992) contend that intelligent behaviour requires two components: intelligence, which is largely genetically determined and only slightly modifiable, and cognitive processes, which are acquired through experience. Cognitive processes have

the same meaning as what Feuerstein and his colleagues (Feuerstein, Rand, Jensen, Kaniel & Tzuriel, 1987) mean by cognitive functions and what Piaget (1977) meant by cognitive structures and invariants. Cognitive processes are described as logically stable systems of interpreting quite fundamental classes of universal events. Everyone needs to learn a set of fundamental cognitive functions in order to have access to their intelligence. These cognitive functions include learned information processing components of intelligence: metacomponents, performance components and knowledge acquisition components. Other components of cognitive processes that should be taught include experiential components of cognitive functioning for coping with novelty, and automatising information processing components.

A comparison of intelligence and cognitive processes by Haywood and Switzky (1992) shows the following:

- (1) Intelligence is largely genetic, whereas cognitive processes must be taught and learned.
- (2) As regards modifiability, intelligence can only be changed on a modest scale and with great effort, while the modifiability of cognitive processes is high with teaching.
- (3) Intelligence is both global and specific and equals the ability to learn. Assessment of intelligence would indicate products of past learning. On the other hand, cognitive processes are generalised across content domains. Assessment is process-orientated and the learning taking place in the teaching situation makes it dynamic in nature.
- (4) Intelligence represents aptitudes such as verbal, spatial and memory, while cognitive processes are a mix of ability, work habits, attitudes, motives and strategies.
- (5) The parents' role with intelligence would be in provision of genes, nutrition, health and safety, while with cognitive processes parents could provide mediated learning or active and directed teaching.

The reciprocity between learning and intelligence (Estes, 1981) has implications for measurement of cognitive ability. The assumption has to be made that learning processes and the judgemental aspects of intelligence are interacting on a continuous basis in the course of mental development. When studying either cognition or intelligence the highly interactive character of the system has to be taken into account. Intelligent behaviour is implemented by cognitive operations which draw on products of past learning. The course of learning is modified by cognitive control processes. When the object is to test learning

ability, behaviour would have to be followed and evaluated over a longer period of time than is usual for a test of intelligence.

An interrelationship is formed between environmental input, learning abilities, motives, products of learning, and cognitive functioning and information processing abilities. Intelligent behaviour is dependent on both past learning abilities and present information processing abilities. Both abilities and processes contribute to intelligent behaviour. In this reciprocal relationship learning has an influence on intelligence and intelligence (information processing abilities) influences learning. The rate of learning would depend on the abilities of the learner. Learning abilities and information processing form the basis of intelligent behaviour. The more learning takes place and the higher the intelligence of the learner the higher the cognitive performance would be.

Estes (1981) reasoned that increasing amounts of learning yield products of increasing value for the mediation of cognitive performance. For intelligent behaviour to take place, cognitive functions and processes have to be activated. The dynamic testing paradigm makes a distinction between past learning and the potential for learning (learning strategies and processes) which happens in the zone of proximal development. It is easier to change processes in the zone of proximal development than past abilities and in that way increase cognitive performance.

Sternberg (1997, 1982) comes to the conclusion that intelligence will be different across cultures and also across contexts within cultures. Different kinds of problems need to be solved in the different cultures which makes it important to adapt in order to function and survive in that particular culture. In the sense that cultures interact, it would be possible to do a kind of conditional comparison to see how different cultures have organised experience to deal with a particular domain of activity.

#### **4. BIAS AND CULTURE-FAIR TESTING**

The use of traditional intelligence tests for the prediction of academic achievement with ethnic minority or disadvantaged groups has frequently been criticised for the following reasons:

- (1) The assumption with traditional testing is that individuals have had equal opportunity to attain the knowledge and skills required to solve the test tasks.
- (2) The alleged Western, middle-class bias of standard tests.
- (3) The lack of test experience of ethnic minority or disadvantaged groups.

Intelligence tests tend to discriminate well and predict scholastic achievement reasonably well within a culturally homogeneous group. However, for groups with different and poor linguistic and social backgrounds, intelligence tests do not reveal their true ability but merely reflect the results of their previous learning experiences. According to Hessels and Hamers (1993) intelligence and other special ability tests should be viewed as measures of achievement and not as indications of aptitude or future performance.

Hessels and Hamers (1993) state that some of the main problems regarding the use of tests with minorities or disadvantaged students are due to the following factors:

- (1) Cultural differences between the disadvantaged and dominant group and a lack of opportunity for development to take place. These differences may specifically be seen in child rearing practices, expectations and aspirations and informal and formal learning experiences.
- (2) A lack of language proficiency could discriminate against some groups.
- (3) Examiners from a different culture group to that of the examinees tend not to communicate well with them and might intimidate them.
- (4) Where the test material is geared towards white middle-class homes and values the content might be inappropriate for minority groups not exposed to it before.
- (5) Members of minority groups may lack test wiseness and show deficiencies in employing test taking skills and balancing speed and accuracy.
- (6) Ethnic minorities are usually underrepresented in the collection of normative reference group data and this might influence the interpretation of results.
- (7) Tests could measure different constructs than they were intended for when used with individuals from other than the white middle-class culture.
- (8) Tests that may accurately predict for white middle-class children, often fail to predict on an acceptable level for minority groups.

Snow and Yalow (1982) report that according to the findings of a large study done in the USA, on average, disadvantaged minority students scored lower on standardised

and achievement measures than middle-class white students. The achievement of the majority students also seemed less affected and that of the minority students more affected by poor school quality. This result tends to suggest that the disadvantages of the minority students were being compounded. Results of evaluations of compensatory education programmes suggested limited, if any, success. What gains there were in various compensatory programmes, tended to disappear in subsequent years. Enriched programmes produced modest short-term increases in IQ scores. On the issue of heredity versus environment the debate was whether substantive intellectual gain could be expected from compensatory education programmes if individual differences between minority (African-Americans) and majority students were interpreted to be largely genetic in origin (Herrnstein & Murray, 1994; Jensen, 1980, 1972).

Improvement in compensatory programmes seem to be produced in the teaching of specific skills, such as reading and mathematics. Long-term effects on general intelligence, achievement or various affective outcomes were still difficult to establish. The same pattern was noticed in the evaluation of Sesame Street (Bogatz & Ball, 1971 in Snow & Yalow, 1982) which suggested that most gains were on tests developed to assess specific programme goals. Small or no gains were associated with other cognitive tasks. The higher achievers tended to watch the programme more often than the lower achievers. Differences at posttest level could thus be attributed to pre-existing differences between viewers and non-viewers. Cook and his colleagues in a re-analysis (Cook, Appleton, Conner, Shoffer, Tamkin & Webber, 1975 in Snow & Yalow, 1982) did not think that Sesame Street was causing as large and generalised learning gains during 1970 and 1971 as were attributed to the programme. The results of Sesame Street showed that advantaged children gained as much as, and perhaps more than, disadvantaged children by viewing the programme. If the effect was to widen the achievement gap such programmes might not have been justified.

One of the critical issues in static testing relates to the test wiseness of individuals. Differential familiarity between groups regarding test materials, test items and test taking opportunities would lead to differences in test results (Anastasi, 1976). Language is another issue that could lead to cultural bias. Subjects are specifically disadvantaged on the verbal subtests if the tests are conducted in a language other than their first language or mother tongue.

Motivational factors can also affect testees' test taking abilities. Biesheuvel (1972a) found that blacks in South Africa tended to be either over cautious and delay their responses or too impulsive as a result of anxiety and then not reflect sufficiently on the task. Most tests have been standardised on white middle-class groups and are not designed to be generalised to other groups. Biesheuvel (1972b) argued for using the concept of adaptability rather than intelligence or mental ability for selection purposes. The advantage of adaptability is that it has a greater affinity with culture and what is being taught within a culture. Adaptability is thus a measure of what people can learn to achieve within a particular culture. The ability to learn must be seen in conjunction with the method of instruction used and the processes (strategies) required to learn.

Research with conventional static tests measuring cognitive ability has shown that different groups in the same country perform differently. African-Americans perform on average one standard deviation poorer on ability tests than whites (Ramist, Lewis & McCamley-Jenkins, 1994; Linn, 1990). The same results have been obtained between Israelis and Arabs, ethnic Chinese living in Indonesia and other Indonesians (Huysamen, 1997). In South Africa educationally disadvantaged groups (blacks) tend to score lower in terms of predictor variables such as aptitude and performance tests. This does not come as a surprise as aptitude tests do not measure anything in isolation of the sum of all formal and informal educational experiences that test-takers have been exposed to in the past (Pike, 1979). The poor performance of disadvantaged Israeli adolescents on static tests led to Feuerstein developing his dynamic assessment procedure. The dynamic assessment procedure gave a fairer indication of their potential to benefit from an enriched educational setting.

Cross-cultural researchers are interested in how the validity of traditional intelligence tests can be improved, what kind of learning processes will take place by way of repeated administration, and how the adverse impact of factors jeopardising the psychological equivalence of the test scores, such as different educational back-grounds, can be reduced. The culture free and culture fair test movements can be seen as responses to these challenges. An adequate instrument should measure abilities uncontaminated by the particular intellectual skills acquired in a given culture.

Attempts at culture fair testing have included the following:

- (1) Existing tests are adapted for other cultural groups, which usually also include establishing new norms for the target population. In the past this approach has been viewed with suspicion in the South African context, because of its connection with the policy of racial segregation.
- (2) Differential norms and judgements are used with different cultural groups. The implementation of different norms is a political decision to correct existing injustices in society. Differential norms are often part of a programme of affirmative action or equal opportunity, as is being implemented in South Africa at present. Many selection programmes in the post-apartheid era are run along these lines. The lack of validity of the matriculation marks have led to many tertiary education institutions using psychometric tests as a more subjective measure for selecting students. The problem is that traditionally these tests have been biased against black students. Huysamen (1997) suggests lower cutoff points for the fair selection of black students according to a quota system. The practical implementation of a differential norms system would require consensus that unequal decisions about members of different groups with equal performance be taken.
- (3) Statistical and linguistic analyses of measuring instruments used with multi-cultural groups could enhance the validity of intergroup comparisons. The suitability of instruments is established by studying the performances of the groups on every item separately. An item is considered to be biased if two persons with the same ability but from different cultural groups do not show the same probability of a correct answer. In a study done with Dutch and immigrant children (Turkish and Moroccan) linguistic item properties turned out to be an important source of bias (Hessels & Hamers, 1993). Many researchers assume that after the removal of biased items, intergroup test score differences reflect genuine, uncontaminated, intergroup differences in psychological functioning. However, cross-cultural psychologists are reluctant to accept this assumption. They are often inclined to look for bias scores at test rather than item level, such as stimulus familiarity, knowledge of the testing language and educational background.
- (4) Finally, new assessment instruments could be developed. Learning potential tests are examples of new instruments being developed. It has been argued that the adequacy of tests should be evaluated in terms of what they are used for. Learning potential scores can provide information on the learning potential of the testee and

about future academic success. Van de Vijver (1993) cautions against viewing the application of a learning potential procedure in a cross-cultural setting as being a culture free or culture fair instrument. The cultural differences between, for example, groups from the Netherlands and Malawi are too large to be overcome by the introduction of repeated testing or relatively short training procedures. Learning potential tests that are used for predicting academic performance have another limitation. These tests can be expected to load on a general intelligence or reasoning factor and although they are related to educational outcome they are not the best predictors of academic performance. More crystallised measures of intelligence such as vocabulary tests and achievement tests tend to have a better predictive potency.

A distinction has been made in the American literature between test bias, predictive bias and selection fairness (Reynolds, 1982). Tests may be biased towards some or other demographic group if they contain a large number of items that disfavour that group. Attempts to construct culture fair tests where items that may be biased are removed, have met with very little success.

In the case of predictive bias, not the individuals' scores on the predictors (tests) but their scores on the criterion (academic performance) and the correlation between the two are of importance. A test shows predictive bias towards a particular group when it consistently under- or overpredicts the criteria performance of the members of that group. Statistically predictive bias is revealed in the criterion-on-test regression lines being different for the various groups. Research studies seem to suggest that group differences in test means of different groups translate into comparably different criteria means on their academic performance. Huysamen (1996) contends that this would result in no predictive bias, because low test results would correlate with low academic performance. Methods, such as compiling different regression equations and setting different test cutoff scores for the different groups, are available for statistically removing such bias. According to this model, candidates are selected on the basis of their predicted academic performance and not on their scores on the test, or any other predictor.

A criticism of this model is that it operates within a static testing paradigm and tends to perpetuate the notion that black students do more poorly on ability tests because of genetically determined reasons. The use of dynamic assessment procedures would not

rely on the need for statistical corrections, but would provide an indication of students' ability to benefit from an enriched educational environment.

The next section will focus on forming an understanding of the interaction between intelligence and learning, and the role that practice and coaching play in assessment of mental ability.

## **5. PRACTICE, COACHING AND LEARNING**

There is considerable variance in the definition of practice, coaching and learning experiences. Anastasi (1981) identified three types of assessment intervention experiences:

- (1) test familiarisation or practice (increases validity of the test),
- (2) coaching (reduces validity) and
- (3) training in cognitive skills (does not affect validity).

A number of studies have been done on the effect of practice and coaching on testees. There have been suggestions that the most valid assessment of ability would be one that includes practice and coaching over repetitive testing sessions until the maximum performance is reached (Vygotsky, 1978). In the absence of equal preparation, differential bias related to cultural, ethnic or other differences may interfere with ability and learning assessments.

Jensen (1980), in a review of studies on the influence of practice on intelligence test scores, concluded that practice effects can produce increases from 2 to 18 IQ points. Although such effects seemed to be relatively lasting, they were not transferable to other tests. They also proved to be more pronounced for more able learners than for less able learners, as well as for timed or non-verbal tests as opposed to untimed or verbal tests.

Lidz (1987) reviewed the literature on practice versus coaching and cited a number of studies that showed significant improvements with practice for brighter children (higher initial scores), but not for lower scoring children. This result supported the findings of Egan and Greeno (1973), as well as Sullivan and Skanes (1971), who concluded that

bright testees benefit more from practice than dull ones. Overall the studies yield conflicting results regarding the benefits of coaching over practice alone. Some studies showed greater improvement with coaching and some revealed no improvement. Wiseman and Wrigley (1953 in Lidz, 1987) found that a practice group (repeating different IQ tests) made the most gains, followed by the coached group and then the control group. A further analysis showed a positive association between IQ gains with subjects' higher initial IQ making the most gains from practice. Vernon (1954) reported that practice or coaching did make a difference to children with borderline IQ's. The items that appeared more susceptible to coaching were in general non-verbal tasks. He concluded that children with higher initial scores tended to profit more from practice, whereas those with lower initial scores demonstrated greater response to coaching.

A review on the effect of coaching by Jensen (1980) come to the conclusion that attempts at specific coaching usually have relatively little effect over and above practice on a task. Some very specific effects were obtained on certain tasks, but they faded more rapidly than the practice effects. On the other hand, there are studies showing notable effects when students are coached to use abilities they possess, but do not recognise as relevant to the task at hand. This kind of effect has been called a "production deficiency" (Flavell, 1985) and is thought of as marking a transitional stage in strategy development for cognitive performances. The use of strategies and approaches to learning and problem solving could explain the difference in intelligence and performance on school tasks. Students with the potential for using these abilities could be seen as being more modifiable. Providing training in these strategies during a mediation phase could be a way of identifying the degree of modifiability.

From a review of the research it seems that coaching has large effects for some students on such major aptitude tests as the SAT (Snow & Yalow, 1982). Although the average effect of coaching, when compared with non-coached control treatments, appeared to be within the standard error of measurement of the test, the effect size varied considerably across different kinds of coaching treatments. The more a coaching treatment approximated extensive educational intervention, the more the score changed. It was also observed that treatment effects might be greater for some students than for others. Seen from a dynamic assessment paradigm, students differed in their response to mediation. Some showed themselves to be more modifiable than others (Shochet, 1994).

One generalisation from the research on coaching appears to be that abilities and strategies interact. Training of either component skills or strategies must link the training methods to an assessment of aptitude (student strengths). Another generalisation seems to be that simple practice and feedback, although not that effective on average, may provide the best training for students already somewhat proficient in the ability to be trained. Training that is cognitively more intrusive is often not helpful and sometimes seems to be harmful for more able students. That kind of intervention may disrupt the use of their own strategies that have developed over time.

Sternberg (1981) has shown that component processes can be identified in performance on the kind of tasks that appear in intelligence tests. It was also found that individuals adapt their processing strategies in such tests and may shift strategies according to their own self-monitoring (metacognitive abilities) or as task characteristics change. A second, higher level of strategic processing concerned with the selection and organisation of component processes to meet particular task demands, could be described as a form of executive control. This executive level has been referred to as metacomponential processes, determining the components, representations and strategies that will be supplied in a particular situation (Sternberg, 1979). A third factor that has been identified is management of memory load. The reasoning required in novel tests, such as the Raven Progressive Matrices, demands the use of these strategies during task performance where previously stored knowledge is of little or no use to the testee.

Resnick (1976) reports that children transformed the mathematical algorithms originally taught to them into more efficient routines with fewer steps. They developed efficient strategies, based on what they were taught, for themselves. It seems that the processes used by these learners involve lateral non-specific transfer or learning-to-learn abilities. The children used their learning-to-learn strategies to see the connection between other learning experiences and the one they presently face.

Rohwer, Ammon, Suzuki and Levin (1971) documented significant differences between low SES black children and high SES white children on both the Peabody Picture Vocabulary Test and Raven Matrices (IQ) measures, but not on the paired-associate learning test. They also found that whereas IQ differences for the ethnic/SES groups increased with age, differences in paired-associate learning decreased.

Rohwer (1971) explained the reason for the lower school success of low SES black children in the context of their ability to learn equalling that of the higher SES white children as being linked to learning tactics (strategies) and in particular spontaneous verbal elaboration. In a subsequent study Rohwer and his colleagues (1971) found that the low SES black children showed marked improvement with elaboration training, but showed no improvement with only practice (repeating the paired-associate test) being used. Rohwer (1971) concluded that learning proficiency and learning strategies play an important role in the interaction between race and academic achievement.

Haywood and Switzky (1974) found that low functioning children were able to respond at levels higher than previously thought possible when exposed to appropriate intervention. A significant body of research, directly related to dynamic assessment, was carried out by Carlson and Wiedl (1976) explaining the effectiveness of specific dynamic assessment procedure. Differences between groups of children were attributed to changes in reasoning and not simple pattern completion of the Raven. Later Carlson and Wiedl (1980) introduced the personality variable of introversion (neuroticism)-extraversion and the cognitive style variable of impulsivity-reflectivity into the study. The impulsive children tended to obtain poorer scores on the Raven. They also found that children who lack well-developed verbal skills require feedback as an optimising condition. The performance of impulsives, not reflectives, changed under conditions of verbalisation before and after problem solving and examiner elaboration. In a study with different ethnic groups, Dillon and Carlson (1978) found that differences between the ethnic groups (Anglo, Black and Mexican-American) markedly declined from near significance to clearly no difference under dynamic conditions. They were able to present evidence to support the usefulness of dynamic assessment as a non-discriminating approach. There were also indications that changes were taking place in the learners' abilities for reasoning and self-regulation.

Carlson and Wiedl (1980) integrated their empirical findings with an information-processing theory that suggested four factors of problem solving: structures, processes, components and levels. Research has increasingly focussed on the role of learning and cognitive processes in the application of intelligence. Subjects' flexibility and meta-cognitive abilities of subjects become important in assessing their ability to change (Lidz, 1987). In this way the development of dynamic assessment was able to bridge the gap between intelligence and learning ability.

Carlson and Wiedl (1992) present a useful perspective when considering the assessment of mental abilities. Differentiation is made between cognitive capacity, factors related to suboptimal performance, and principles of assessment.

- (1) Cognitive capacity is interpreted in the Hebb-Vernon framework of intelligences A, B and C. Intelligence A refers to the general potential to profit from environmental stimulation and is largely determined by the neurobiological (mainly genetic) make-up of individuals. Intelligence B is the actual intelligence of individuals and comprises the structural, motivational, attentional and metacognitive elements involved in thinking and problem solving within the genotype-environment interaction. Intelligence C represents the performance on a measure of mental ability.
- (2) Suboptimal performance can be related to two factors:
  - (a) Suboptimal genotype-environment interactions result in relatively stable deficits of intelligence B. Remediation at this level usually requires intensive and relatively long-term intervention. Concepts related to this interaction are zone of proximal development, learning potential and learning ability.
  - (b) Suboptimal application of actual intelligence represents performance levels on measures of mental abilities (intelligence C) that only poorly represents the individual's potential (intelligence B). Test fairness, test wiseness, familiarity and test orientation are some of the factors that might be involved.
- (3) Principles of assessment consist of two categories:
  - (a) Assessment of training gains refers to the modifiability of intelligence B through training remediation.
  - (b) Assessment of the effects of testing approaches that improve performance reflects suboptimal performance related to test-taking capabilities.

Intelligence A is considered to be theoretical and describes the general potential of an individual to profit from environmental stimulation. Intelligence B is conceived to be the actual intelligence that an individual uses in daily behaviour. This type of intelligence is viewed as the product of complex genotype-environment interactions that cannot be reduced to either environmental or hereditary factors. It is assessed through Intelligence C which represents the actual performance on a test of intelligence. If Intelligence C can be accurately measured estimates of Intelligence B and even general estimates of Intelligence A becomes possible.

The competence-performance distinction as described by Carlson and Wiedl (1992) can be used in an analysis of assessment models. Some dynamic assessment models (Feuerstein's approach is an example) assume that with appropriate and fairly long-term intervention, underlying cognitive abilities can be modified. Other dynamic approaches do not have structural changes as a goal, but emphasise bringing performance levels closer to individuals' existing level of competence and uncovering those factors (cognitive, metacognitive or motivational) that prevent individuals from performing optimally. Carlson and Wiedl (1992) argue that the competence-performance distinction can be used to differentiate between intelligence C and intelligence B in assessing mental ability. Traditional psychometric methods are useful to determine the item characteristics, the reliability and the validity of any measure of mental ability. This does not mean that if the test statistics are persuasive that it follows that intelligence C has been adequately measured or that the actual intelligence has been assessed:

Regardless of the statistical adequacy of a measure, if optimal performance is not elicited and the effects of nontarget, performance reducing factors not reduced or controlled for, veridical inference of intelligence B cannot be made. (Carlson & Wiedl, 1992:240)

The potential for change may come about from two conditions:

- (1) Suboptimal genotype-environmental interaction may be pervasive and of long duration, leading to deficits in mental functioning that would need substantial intervention.
- (2) Suboptimal representation of individuals' cognitive ability requires testing methods that will help individuals increase their performance to a level representative of their cognitive competence.

Practitioners of dynamic assessment agree on the goal of establishing the conditions that will result in improved performance.

The approach used by Carlson and Wiedl (1992, 1982) is based on a model of mental ability that differentiates between cognitive and metacognitive person variables and assessment variables. Their research with impulsive and reflective children has indicated that metacognitive person variables and assessment variables have a role to play in the assessment of mental ability. Changes in the methods of testing affected their processing strategies and, subsequently, their performance.

Brown and Campione (1981) have shown that metaknowledge or self-awareness about one's own learning can be developed and that transfer to different kinds of learning or problem solving situations is possible if subordinate strategies for doing this are also taught. Their training programmes focussed on executive functioning such as predicting, planning, checking and monitoring, rather than the perfection of a particular skill. Corno (1980) has demonstrated how a training programme on metalearning skills, designed to be used by parents and children at home, might influence classroom achievement. She found that training was more effective for classes of more able students and also for students showing high anxiety scores. The best attempts at training intellectual skills involved in more complex test performances come from an analysis of the processes involved in performing the particular task in the test (Resnick, 1976).

Certain contextual factors can play a role in the successful solving of a problem. Examples of factors which might have a bearing on the completion of a task are: time constraints, accuracy and the aim of the task (Taylor, 1987). Cross-cultural issues cannot be ignored in information processing research. Certain specific processes may be used by individuals in all cultures (Verster, 1986), but the choice and order of processes to achieve a specific task are likely to be influenced by cultural factors. This has implications for individuals who are required to operate in a cultural context which is secondary to them, where different task requirements are imposed. There are clear implications for a multi-cultural society such as South Africa. The cognitive style approach in cross-cultural research, as described by Berry (1981), assumes a position of cultural relativism where skills and strategies used in problem solving may be culture specific. Individuals from varied cultures may use a different sequence of cognitive steps and still arrive at the same solution. In this regard instruction should fit in with the cognitive routines already required, only providing remedial intervention where it appears that the individual has no other way to solve the problem (Glaser, 1976).

## 6. CONCLUSION

The argument in favour of using static psychometric tests in South Africa is usually that the matriculation results are not viewed as a fair measure for assessing the future academic success for disadvantaged students who had received inadequate schooling in the past. In using psychometric tests the influence of past learning is assumed to be minimised. A counter argument for not using psychometric tests is made by Katamzi

(1997) who expresses her reservations on the grounds that selection testing usually takes place by way of a written discourse making literacy and internalised print important elements in the selection process.

If learners are not regularly exposed to print and its demands they will have difficulty in engaging it successfully. Some of the psychometric tests completed by students during selection usually have a high verbal content. A certain amount of reading is necessary to be able to do well in the tests. Students with a disadvantaged educational background would tend to have a disadvantage in obtaining high scores.

Haywood (1997) is of the opinion that a too broad concept of intelligence denies the role of affectivity, as well as of those tools of learning and thinking that are acquired through experience and learning. His transactional perspective on individual differences in ability rests on three principal components: intelligence, cognitive process and motivation. Individual differences in learning, problem solving and social adaptation cannot be accounted for by intelligence only. Cognitive processes such as orderly perception, learning and problem solving, may be acquired through individual interaction with one's environment, through mediation or taught directly through transfer of one's culture from one generation to the next.

An integrated approach to assessment needs to look at the relationship between instruction and learning and the processing demands made by the instructional input. Pellegrino and Glaser (1981) state that instruction involves presenting students with a network of knowledge that can be assimilated into the students' existing network. The goal of the instruction should always be kept in mind. In the context of dynamic testing an approach that focuses on the understanding of certain underlying rules and principles would be the best method to use.

Learning potential tests seem to be a way of approaching problems such as inappropriate test content and lack of test wiseness by using familiarisation and training; inappropriate samples by providing local norms, and language bias by using non-verbal instruction and items. Hessles (1996) found that compared to IQ tests the Learning Potential Test for Ethnic Minorities (LEM) reduced the differences in mean test scores between Dutch and immigrant children. The LEM also strongly differentiated between children with low scores on an intelligence test. These children either scored low, moderate or high on the LEM; which implies that many children benefitted from the learning potential test procedure.

There seems to be a case for making a distinction between intelligence and learning ability. Whereas intelligence could be linked to genetic and biological factors, the ability to learn (and learning processes and strategies) can be improved with interventions and over a period of time. The improvement of students' cognitive and learning processes would lead to a better application of intelligence. The concept of dynamic assessment is an approach to assessment that provides individuals with an opportunity to show what they have learned. It has the potential to reveal important information about processes of learning and to provide suggestions for teaching.

The role of non-cognitive factors (learning strategies and approaches to learning) in the prediction of academic performance will be discussed in the next chapter (Chapter 4).

## Chapter 4

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# NON-COGNITIVE FACTORS AS PREDICTORS OF ACADEMIC PERFORMANCE

## 1. INTRODUCTION

Some investigators feel that non-cognitive factors play an important role in the prediction of academic performance and, in combination with cognitive factors, could increase the variance in academic performance (Kotzé, 1994; Louw, 1984; Smit, 1971). Non-cognitive factors usually include aspects such as motivation, interest, personality, study methods, learning strategies and attitudes. Study methods and learning strategies, combined with cognitive factors, could explain up to 75% of the variance in academic performance. Some studies show that non-cognitive factors are especially important for the prediction of black students' academic performance (Sedlacek, 1976).

McKeachie, Pintrich, Lin and Smith (1986) mention the following characteristics that students bring with them when they enter tertiary education and which could play a role in their academic performance:

- (1) intelligence,
- (2) personality and motivational factors, and
- (3) cognitive styles and strategies.

The role of intelligence was described in Chapter 3. The role of interest, personality, motivation, study habits, and approaches to learning and learning strategies will each be discussed separately in this chapter.

## **2. INTERESTS**

Various researchers report a positive relationship between interest and academic performance (Monteith, 1987; Van der Watt, 1982). The contribution of interest as a non-cognitive factor is estimated to be not more than about 10% of the explained variance in academic performance. The correlation between students' interest and academic performance was found to be in the order of 0.3 and lower (Stanley & Hopkins, 1972; Cronbach, 1970). Although stronger correlations are found between interests in a particular direction and academic performance in a selected study direction, interest generally tends to have lower predictive value than other non-cognitive factors.

## **3. PERSONALITY AND ADAPTATION**

### **3.1 PERSONALITY**

Personality is generally described as an unique combination of cognitive and affective characteristics that tends to present a relatively stable pattern of individual behaviour. Cattell (1971), one of the most important researchers in the area of personality, divides personality into three main areas: dynamic, cognitive and temperamental. Personality and motivation have a direct influence on the development and application of ability. Personality is determined by internal factors – genetic predisposition and biological development – and external factors such as social experiences and the environment (Meyer, Moore & Viljoen, 1996).

### **3.2 ADAPTATION**

Adaptation has an inter- and intrapersonal component. Interpersonal adaptation can be seen as the result of the individuals' interaction with other individuals and the environment. Intrapersonal adaptation indicates the interaction between the different personality characteristics and the satisfaction of the persons' biological needs. Successful adaptation means the effective management of external pressure and the satisfaction of internal needs (Lazarus, 1968). Goodstein and Lanyon (1975) describe

psychological adaptation as a continuous dynamic process, involving two factors: individual needs and situational demands.

### **3.3 RELATIONSHIP BETWEEN PERSONALITY AND ACADEMIC PERFORMANCE**

The contribution of personality to the explanation of variance in academic performance could be anything from 15-20% (Schoeman, 1981). Personality has an influence on the implementation and channelling of potential, and thus has a direct effect on academic performance.

Entwistle and Wilson (1970) investigated the influence of personality on academic performance in a large sample of British students. The results indicated that no significant relationship was found between emotional stability and academic performance. The most successful students scored low on a scale of extroversion. Entwistle (1972) reports that stable extroversion shows a positive relationship with academic performance in the primary school phase, but that in the late secondary school phase and at tertiary education level, introversion and, to a lesser extent, neuroticism showed a positive relationship with academic performance.

Conflicting results regarding the influence of anxiety on academic performance are found in the literature. Some researchers found a positive relationship between anxiety and academic performance (Cope & Hannah, 1975), while others found no relationship (Coetzee, 1977). Manageable anxiety seems to act as motivation for learning, while unmanageable anxiety could lead to poor motivation. Smit (1971) reports that anxiety has a greater influence on female than on male students. The latter tend to be emotionally more stable and less susceptible to anxiety.

The way in which individuals are able to manage anxiety might be superior to the amount of anxiety they experience (Louw, 1984). It seems that a stable introvert has a better chance of success than a neurotic extrovert. The type of course that students follow also plays a role. Stable students tend to do better in the engineering and science directions (Entwistle, 1972).

Personality factors from the 16 Personality Factor (16PF) Questionnaire that have a positive relationship with academic success are intelligence (factor B) factors Q2, A, C, F

and I (Botha, 1971). These students tended to be well adjusted. Louw (1984) found significant relationships between academic performance and factors G, I and M. Factor Q1 was the only factor that showed significant relationships with academic success in engineering. These students can be described as critical, analytical and experimental. Students who were successful in commerce showed correlations between academic success and factors F, G and L. Overall the 16PF only explains a small portion of the variance in the academic performance (Kotzé, 1994).

### **3.4 RELATIONSHIP BETWEEN ADAPTATION AND ACADEMIC PERFORMANCE**

Conflicting results were found regarding the relationship between adaptation and academic performance. Van der Watt (1982) reports no relationship, while Baker and Syrik (1984) found that adaptation to the academic environment had a significant influence on academic performance. Various researchers found a positive relationship between a positive academic self-concept and academic performance (Byrne, 1990; Bandura, 1986).

x Social isolation was identified as one of the factors that contributed to the drop out rate of students at tertiary education level. The more successful students tended to be more involved in the activities of the institution. The identity crisis that students experience during their first year could be one of the aspects that lead to poor academic performance (Van Dyk, 1978).

### **3.5 PERSONALITY AND COGNITION**

Taylor (1987) views impulsivity and rigidity as two constructs which lie at the interface between personality and cognition and have a major impact on problem solving. They can be regarded as affective styles of information processing and are more general than metaprocesses or strategies. Each has an effect on a wider range of metaprocesses.

Kagan (1976) sees impulsivity as the opposite of reflection and takes two aspects of performance into consideration when assessing reflection-impulsivity. The first aspect is response time and number of errors. Individuals who score below the median on response time and above the median on number of errors are placed in the impulsive

category. An impulsive style has a number of negative consequences for effective information processing and can affect the cognitive performance of individuals. An impulsive style limits the extent to which incoming information can be reflectively evaluated and stored for future use in problem solving. Impulsive behaviour results in poor performance in most problem solving exercises. Feuerstein, Rand, Jensen, Kaniel and Tzuriel (1987) took the impulsive behaviour of disadvantaged adolescents into account when providing mediated learning experiences. A mediator who interposes between the individual and the response is able to control the impulsive behaviour.

Cognitive rigidity-flexibility is the degree to which individuals can change strategies and modify production in order to perform a set of tasks successfully. Snow and Yallow (1982) associate this with fluid intelligence. Some problems require novel integrations of stored and new information and may lead to the modification of crystallised and well established ways of solving problems. Flexibility means that individuals should be able to select a representation of the problem for which fairly direct ways of solving exist. This would include the judicious selection and ordering of subtasks (Taylor, 1987).

## **4. ATTITUDES AND MOTIVATION**

### **4.1 ATTITUDES**

A distinction can be made between students' attitude towards studying, the motivation to study and the study methods implemented. Study attitudes consist of cognitive, affective and behavioural components. Students' affect in studying is largely influenced by cognitive factors and previous learning experiences. The cognitive components include students' positive or negative attributions of studying. The experience of success can lead to the development of a positive attitude, while the experience of failure can result in a negative attitude. The behaviour component is an indication of a student's readiness to implement and maintain a particular study method.

Emotional or affective factors play an important role in the learning process. Feedback by significant others is one of the important factors that influence the development of study attitudes (Scott, 1991; Pascarella, Walberg, Haertel & Junker, 1981). Students' academic self-concept has a big influence on the development of study attitudes. Students can

evaluate the effectiveness of using certain learning strategies for particular tasks through self-evaluation or observation (Bandura, 1986).

The feelings of self-efficacy dictate the students' choice and implementation of learning tasks. Students with low academic self-concept tend to choose easier courses, while students with higher academic self-concept have enough confidence to choose courses that include difficult problem solving tasks.

## 4.2 MOTIVATION

Motivation and study attitude are closely related concepts. Factors that are relevant to the development of study attitudes are also present in the development of motivation. These factors are self-concept, self-efficacy, positive feedback from significant others, emphatic study guidance by lecturers and the setting of goals (Scott, 1991).

Various investigators found that motivation is not only a determining factor in academic performance at tertiary level, but that it also offers an explanation for the wide discrepancy existing between academic performance at secondary and tertiary level (Behr, 1982).

Biggs (1987) describes different motives that relate to students' approaches to learning. Individuals with a surface approach to learning are instrumentally and externally motivated, have the need to complete their course within the minimum time and with the minimum input, focus on memorising and usually have no intention of getting to understand the material better or to increase their interest in a subject. A surface approach to learning is usually accompanied by a fear of failure. The deep approach to learning relates to motives that are intrinsic, and individuals study to actualise their interest and competence in particular academic subjects. The achieving motive is based on competition and ego-enhancement. These individuals strive to obtain the highest grades, whether the material is interesting or not.

Motivation can be seen as the extent to which students are willing to work to enable them to reach certain goals that they regard as being significant. It includes a number of aspects such as the processing of information, perceptions of feedback, metacognitive consciousness of a person's intentions to learn and to evaluate performance, and the

merging of consciousness and thinking processes when concentrating to achieve certain specific goals. Motivation is a complex concept that is influenced by both cognition and affect (Scott, 1991).

The expectancy-value theory was developed to act as a model for describing the determinants of motivation. The core of the theory is that actions such as the choice of tasks, work performance and perseverance have a relationship with the students' positive or negative feelings regarding a task or the results of a task. The expectations and values of the students are directly influenced by their goals, perceptions of self-efficacy and attributions to task performance. These constructs are in turn influenced by the students' interpretation of the demands of a task, previous learning experiences, behaviour of significant other persons, and perceptions of cultural roles and values (Scott, 1991).

McKeachie, Pintrich, Lin and Smith (1986) put forward a general expectancy-value model of motivation as one most relevant to student learning. Expectancy-value models are essentially cognitive models that link well with students' cognitive development. These models are derived from Atkinson's (1964) model of achievement motivation with later additions making the role of students' perceptions or cognitions central to achievement dynamics. It is the students' perceived probability of success, given their perception of the task difficulty and their perceived ability, that determine their expectancy for success. In this cognitive model of motivation, students' perceptions about themselves and the task are the most important components of motivation. The following eight student perception constructs are assumed to mediate the relationship between the academic environment, and student involvement and achievement:

- (1) students' goal orientation,
- (2) task value,
- (3) student efficacy,
- (4) control and outcome beliefs,
- (5) perceptions of task difficulty,
- (6) perceived competence,
- (7) test anxiety and affect, and
- (8) expectancy of success.

#### 4.2.1 Expectancy and task-value path

The expectancy path flows from students' efficacy, control and outcome beliefs to their perceptions of the task, and from their perceived self-competence to expectancy. Expectancy in combination with task value, is assumed to lead to task involvement with subsequent achievement. The task-value path flows from students' goal orientation to task values. The goal adopted (to follow a specific career) will influence the value students attach to certain tasks they would encounter in higher education.

The expectancy component of the model is defined as students' beliefs about their probability of success or failure on a particular task. Expectancies can be specific or general. A more generalised expectancy would be students' beliefs about their potential for passing their examinations. Perceived self-competence and perceptions of task difficulty play a direct role in expectancy formation. Self-competence is defined as students' perceptions of their ability to accomplish a particular task. It is the interaction of the students' perception of task difficulty and perceived competence that is assumed to lead to the students' expectancy (Eccles, 1983). The construct of perceived self-competence is related to self-concept and self-efficacy. The perceptions of task difficulty by students are important mediators of their achievement. Differing perceptions of task difficulty would lead to different expectations for success (McKeachie et al., 1986).

Test anxiety is generally assumed to have two components, a worry or cognitive component and an emotional component. Student beliefs influence test anxiety and this relates negatively to expectancy for success. Two general theoretical models explain the finding that anxiety interferes with performance:

- (1) The cognitive deficit model includes two components. With the first component research has indicated that the learning skills deficit component is consistently related to anxiety and performance. The learning skills included in the model are active reading, reviewing material, comprehension monitoring and metacognition (these can be seen as macro level cognitive processes) (Tobias, 1982), as well as micro level cognitive processes such as elaboration, rehearsal and imagery techniques for memory (Weinstein & Meyer, 1986). The learning skills deficit is seen as a mediator of the influence of anxiety on performance. The second component, a test-taking skills deficit, operate at the time of the examinations. Students with low

test-taking strategies become aware that they are doing poorly on the examinations and this results in their becoming anxious with subsequent poor performance.

- (2) The attention-interference model suggests that anxious students' drop in performance is due to the occurrence of interfering and distracting thoughts dividing the students' attention between irrelevant and relevant thoughts. A synthesis of the deficit and interference models (Tobias, 1982) states that good learning strategies and test-taking skills should reduce the cognitive demands on the students when taking examinations, while interfering thoughts increase cognitive demands.

Students' affect is also influenced by their beliefs about efficacy, control and outcome. Attributional theory proposes that students' causal attributions for success and failure, not actual success and failure, mediate future expectancies. Research has shown that students who attribute success to ability will expect to do well on future examinations because ability is assumed to be stable over time. In contrast, students who attribute their success to other causes, such as task difficulty or extra effort, will not have high expectations because the task or effort can change over time (Weiner, 1985).

#### **4.2.2 The role of self-evaluation and self-efficacy in study motivation**

According to McCombs (1987) there is some evidence that individuals' own interpretation of events tend to be stronger determinants than the event itself. The self-system processes become important in motivation and self-regulatory behaviour. The processes include:

- self-consciousness, self-evaluation, evaluation of the importance of certain abilities, success or failure expectations, self-development goals, and
- the evaluation of the personal worth value of the task as deduced in accordance with the goals and the results of other self-processes.

There seems to be consensus that self-evaluation is the most important process, because it is related to personal control, abilities in general and specific situations.

Self-efficacy is an important variable in motivation. It refers to the motivation to acquire and effectively apply knowledge and skills, and not only to solve problems (Schunk,

1985). According to Bandura (1982) self-efficacy is the personal evaluation of abilities to plan and execute activities that would lead to specific performance. It is not about what individuals know, but if they feel competent to apply their knowledge. The relationship between self-efficacy and activities can also be influenced by faulty knowledge about the self, not fully understanding or misconceptions of task demands and unforeseen situational circumstances.

Self-efficacy is domain-specific, which means that students' evaluation of their effectiveness in different subjects will differ. Students gain information of their efficacy through the interpretation of their own and peers' performance, feedback from significant others and certain physiological reactions (stress) (Schunk, 1985).

Another aspect that improves motivation is the experience of control (McCoombs, 1987). Control increases with age when behaviour is adjusted to reach personal goals. This in turn leads to personal competency.

#### **4.2.3 The role of goals and aims in study motivation**

The setting of goals and the striving to fulfil goals reinforce the students' feelings of self-efficacy and study motivation. Goal orientation is mediated by intelligence and feelings of self-efficacy. Dweck (1989) distinguishes between two goal orientations that influence study motivation, namely learning and performance orientation. According to Scott (1991) self-efficacy mediates the influence of goal orientation on behaviour, while individuals' attributes mediate the influence of goal evaluation on goal orientation.

#### **4.2.4 The role of attributions in study motivation**

Attributions can be seen as students' convictions on the reasons why certain things happen. Students' thinking about the events direct their behaviour. Weiner (1985) postulates that emotions, such as anxiety, could be the cause for or the reaction on behaviour. The effect of a attributional system on study motivation can be described in the following way: The expectations of students are based on their goal orientation, which in turn is influenced by their abilities, causal conditions and perception of self-efficacy. Expectations of success are mediated by perceptions of self-efficacy. Students'

evaluation of their abilities to do a task, indicate the amount of energy that needs to be invested to reach their goals (Scott, 1991; Bandura, 1986).

Some students tend to prefer performance goals above learning goals. These students are usually focused on the social rewards of academic performance and they avoid conceptual tasks that are aimed at skills development in order to avoid failure which could in its turn lead to a low self-concept.

Motivational processes have been seen as key components in energising the cognitive processes of children and the integration of the componential subsystems in Sternberg's (1997) triarchic theory of intelligence. If individuals lack the motivation to use information processing components, experiential components and practical contextual components, then the level of functioning of the componential systems will be reduced accordingly. A child may have the necessary procedural and declarative knowledge needed to solve a problem but will still be unable to bring this knowledge to bear in specific learning or problem solving situations because of motivational deficits and the expectation of failure.

Haywood and Switzky (1992) present a trait concept of intrinsic motivation. Individual differences in the tendency to seek principle satisfaction from task involvements and achievements may develop largely as a function of the outcomes of previous encounters with tasks and attempts to gain mastery over the environment. Differences in motivational orientation have been associated with dimensions of self-regulation, incentive selection, goal setting, work performance and satisfaction derived from tasks themselves. The development of an intrinsic motivational orientation results from positive reinforcement or approval by adults. This leads children to develop feelings of competence and of being in control of their success and failures, which then leads to the acquisition of cognitive processes that underlie effective learning (Bandura, 1982).

Wolters (1998) collected self-report data from 115 college students on their use of a variety of cognitive, motivational and volitional strategies. The findings of the study indicate that some students are not aware of, or consciously control, their use of volitional strategies. Students who more frequently reported intrinsic regulation strategies were also more likely to report using strategies associated with elaboration, critical thinking and metacognitive regulation. Wolters reports a positive relationship between students' bolstering of their intrinsic motivation and self-reported use of some cognitive strategies important for academic success. Students' use of intrinsic regulation strategies was not a

significant predictor of course grade. This suggests that these strategies might not be directly related to measures of performance. The conclusion Wolters (1998) comes to is that students' use of intrinsic regulation strategies may instead influence performance in an indirect way through students' cognitive strategy use.

Haywood and Switzky (1992) believe it would be possible to modify individuals' fundamental cognitive and motivational processes. This would lead to improved application of intelligence and performance. It is possible to train the information processing components of intelligence. Individuals who are strategy deficient can be taught to act more strategically and show more efficient problem solving behaviour (Campione, Brown & Ferrara, 1982). This training would have to include dealing with individuals' intrinsic motivation to apply the strategies in a given situation. If intelligence is the genetic potential of individuals, which is not always realised in the application of intelligence, then the logical process to follow would be to create optimal conditions for the best possible performance by providing training in cognitive processes and strategies.

Most of these processes and strategies are used in students' learning activities. The next section will focus on students' approaches to learning and learning strategies.

## **5. STUDENT LEARNING**

### **5.1 INTRODUCTION**

Learning is seen as an umbrella usually linked to specific goals and which could include study skills and habits as a sub-heading (Behr, 1980). There are also differences between learning styles and learning strategies. Schmeck (1988) and Entwistle (1981) view learning styles as fundamental traits of students that are relatively stable, whereas learning strategies can be changed and are more flexible than learning styles. Strategies are seen as the cognitive manner in which students process the learning material. Approaches to learning reflect a qualitative as opposed to a quantitative reflection of students' learning.

## 5.2 APPROACHES TO LEARNING

In their research on students' learning Marton and Säljö (1976) looked not so much at how much students learn (quantity) but rather at what they learn (quality). They distinguished between a surface approach and a deep approach to learning. With the surface approach to learning the learner simply wants to reproduce material in a test situation. With the deep approach to learning the learner tries to establish the underlying meaning of a piece of learning material. An approach to learning includes the intention as well as the process of learning (how the intention is performed). The qualitatively different ways students learn are influenced by the way they perceive the learning situation. The learning that takes place to meet set requirements with the minimal effort involved, will be qualitatively different from the learning done in order to compete for a special prize. This view accentuates the interaction between person and situation.

Research done by Entwistle and Ramsden (1983) with students who completed the Approaches to Studying Inventory (ASI) showed that positive relationships exist between a meaning orientation and academic performance, while the reproduction approach had a negative effect on performance. The results of the studies also indicated that an approach to learning is linked to the content of a subject or course. A surface approach seems to be better for use in social sciences rather than the pure sciences or engineering courses. A reproduction orientation is linked to bad results in the Arts. In general the deep approach seems to be the best for good academic performance. A relationship between intrinsic motivation and a deep approach to learning, and between extrinsic motivation and a surface approach was found. The deep approach is linked to personal interest, while the surface approach is linked to external demands, such as the need to pass the tests and examinations. A link was also found between a fear of failure and the surface approach to learning, where the affective life influenced cognitive functioning. The way students perceive the demands of tertiary education plays an important role in their approach to learning.

Meyer (1988) conducted a study with first year students at a South African university using the Awareness of Context (AOC) Inventory and the Approaches to Studying Inventory (ASI). The association found between approaches to studying and perception of context supported the general principle that students' awareness of the teaching and learning context in which they find themselves needs to be raised. The study demonstrated that a subset of the general perceptions that teachers express about learning context is shared by students. "... the results suggest that: the vast majority of

deep responding students are able to respond to stimuli which surface responding students do not understand the meaning of." (Meyer, 1988:81). It follows from a teaching perspective that there would be an opportunity for helping students develop wider and more deep and meaningful perceptions of the learning context.

Biggs' (1985, 1987) model of learning describes the interface between personal factors (motivation, abilities and locus of control to name a few examples) and the students' most likely approach to learning in a particular context. The elements of teacher, student and academic task are interconnected and changes in one area will affect the other areas.

His model emerges in terms of the motives a student has for engaging in a learning task and the strategies adopted to realise the students' intentions. Motive-strategy combinations comprise the common approaches to learning. According to Biggs (1985) metalearning plays a mediating role between ability, motivation, strategies used and academic performance. A lack of metacognitive awareness or abilities results in students not being effective in the use of learning strategies. A motive-strategy congruence means that students are able to interpret their own motives and be realistically aware of their own cognitive resources in relation to task demands. The dynamic link between personal situational, learning process and outcome variables is suggested to be a metacognitive process based on congruence of motive-strategy. Successful students tend to develop an awareness of their own abilities in relation to the situational context. The well motivated and high achieving students are able to select strategies that are congruent with their motivational state and employ them more effectively.

Biggs (1985) describes the role of metalearning or metacognition in students' approach to learning as follows:

- (1) An awareness of one's metamotivational state which translates into an awareness of what one wants to get out of a learning situation and then selecting the appropriate strategies to achieve this.
- (2) A greater awareness and increasing control over approaches to learning between the ages of 14 to 16 years.
- (3) The metalearning capability to use learning which indicates high reasoning and memory, a background that encourages planning and self-awareness, an internal locus of control, and high intrinsic interest and achievement motivation.

Students' encoding strategies of the learning context, or of the institution as a whole, is represented by their motives (to gain a qualification or to pursue academic interests). Students' self-regulatory systems are represented by the strategies adopted (reproducing the content of learning material). The kind of reflective self-awareness that is implied here is called metacognition or knowledge concerning one's own cognitive processes and products and the active monitoring and regulation of these processes (Flavell, 1979). The way in which individuals interpret their own motives are an indication of their meta-motivational state. If in a learning situation learners decide that a pass is sufficient, then it seems the best approach would be to rote learn only those facts and details which are judged as most likely to be tested. If, on the other hand, learners are interested in a subject it would make sense to find out as much as possible about the subject (Biggs, 1987). A third approach would be the strategic one where students adopt a strategic and flexible approach and which is aimed at obtaining as high marks as possible.

Entwistle, Hanley and Hounsell (1979) factor analysed the questionnaires of 800 British students and came up with three second order factors: understanding, reproducing and achieving. Understanding involves the search for meaning and is related to intrinsic motivation; reproducing involves memorisation of information in a rote fashion and is related to extrinsic motivation and the fear of failure, and achieving involves a high degree of self-confident and ruthless organisation. At a later stage an additional factor was added linked to being disorganised (Ramsden & Entwistle, 1981).

Watkins (1982) administered Entwistle's ASI to 540 Australian university students and found three factors, one deep and two surface (disorganised and organised). The components of the other three were spread over these three factors.

Learners with self-regulated motivation continuously ascertain whether they have the necessary cognitive abilities and competence to succeed in the courses they enrolled for (Scott, 1991). Students who are able to evaluate the difficulty level of a task are more able to judge their ability to perform the task (metacognition) and estimate the amount of effort they should put into the task (motivation). McKeachie, Pintrich, Lin and Smith (1986) see self-regulated learning as a combination of cognitive and metacognitive involvement, as well as motivated involvement with a task. The more students are meaningfully engaged in tasks, the more they will learn.

According to Biggs's (1987) model of student learning, students motivated in certain ways will tend to select learning strategies that are congruent with their motives. Congruent motive-strategy combinations will be more effective than non-congruent one's. More successful students will tend to have stronger correlations between motives and learning strategies.

### **5.3 LEARNING STRATEGIES**

Behr (1980) felt that students needed to learn the following strategies to be academically successful. These strategies are fairly broad and can be utilised in different learning settings:

#### **(1) Supporting strategies**

- time planning
- stress management and positive motivation
- creating right mood
- past experiences

#### **(2) Information processing strategies**

- repetition, learning and understanding
- organisation of learning material
- integration of learning material
- processing of learning material

#### **(3) Metacognitive strategies**

- monitoring of understanding
- planning of work
- self-evaluation
- reviewing.

Two factors that play a role in students' cognitive functioning are prior knowledge in learning and learning strategies. Although the content and structure of knowledge are important, they might not be sufficient for all learning or problem solving and a need has been identified for generalisable cognitive skills. Research on learning strategies deals

with how students acquire their knowledge and skills (Weinstein & Meyer, 1986). These authors define learning strategies as thoughts and behaviours that a learner engages in during learning and that are intended to influence the encoding process. This includes basic memory processes as well as general problem solving. This broad definition includes almost all cognitive processes. Tobias (1982) has made a distinction between macro level and micro level learning strategies. The micro level represents the more basic cognitive processes such as attention and encoding. On the other hand, macro level learning strategies concern the students' processing of instructional input. Examples of the latter are: reviewing, note-taking and comprehension monitoring. The differences between the two levels parallel Sternberg's (1985) distinction between meta-components and cognitive processes. In this study the focus is on macro level processes under the control of the individual, rather than the micro level processes.

A description of learning strategies includes both the use of as well as students' knowledge about them. Three types of knowledge about learning strategies can be distinguished:

- (1) Declarative knowledge concerns the content about tasks, strategies and the self.
- (2) Procedural knowledge involves knowing how to execute various cognitive strategies.
- (3) Conditional knowledge describes the use of strategies in a flexible and strategic manner.

Students need to access knowledge on all three areas.

Mckeachie and his colleagues (1986) grouped learning strategies into three broad categories: cognitive, metacognitive and resource management. Each of the categories will be discussed under its own heading.

### **5.3.1 Cognitive strategies**

Weinstein and Meyer (1986) outline the basic cognitive strategies as rehearsal, elaboration and organisational strategies. Basic rehearsal strategies involve reciting items from a list to be learned. Rehearsal strategies for more complex tasks, such as learning from a text book, include taking notes while reading and underlining or highlighting sections of the text. Elaboration strategies are used to store information into long-term memory by building internal connections between items to be learned. An example of an

elaboration strategy for basic tasks is simple imagery, while elaboration strategies that help students with complex tasks include paraphrasing, summarising, asking questions and answering them. These strategies help the student integrate and connect the new information with prior knowledge. Organisational strategies help to select appropriate information and also construct connections among the information to be learned. Clustering is used for basic memory tasks, while for more complex learning tasks techniques for the selection of the main idea from text are used. The analysis of the text structure assists students in understanding and integrating material with prior knowledge.

In his study with 140 first year chemistry students Postma (1993) used the Learning Activities and Study Skills Inventory (LASSI) to compare the learning strategies of high achievers (test marks > 65%) as opposed to low achievers (test marks < 45%). His findings indicated the high achievers' use of learning strategies were better than those of the low achievers. Interviews with the students showed that the good learners had a variety of learning strategies and were able to use the appropriate learning strategies to attain learning goals. Motivation played an important mediating role in the use of learning strategies. The internally goal-orientated learner tends to follow the deep approach to learning where effective information processing and metacognitive strategies are implemented (Schmeck, 1988). The conclusion that Postma (1993) comes to is that the instruction of learning strategies should be included in the curriculum for all students.

### **5.3.2 Metacognitive strategies**

The term metacognition has a number of definitions making it a "fuzzy" concept (McKeachie, Pintrich, Lin & Smith, 1986). It is most often used to refer to two aspects of cognitive life:

- (1) the awareness of and knowledge about cognition, and
- (2) the control and regulation of cognition (Flavell, 1979).

The awareness aspect of metacognition refers to the learners' knowledge of person, task and strategy variables influencing performance. The awareness of a person is closely related to motivational constructs such as perceived competence and self-concept. Task-variable knowledge includes information about the difficulty of tasks and different demands of academic tasks. Strategy-variable knowledge concerns the learners' know-

ledge about different strategies and how to use them. Metacognitive activities are made up of three general processes: planning, monitoring and self-regulation.

Planning activities consist of setting goals for studying, generating questions before reading the text, and doing a task analysis of the problem. The research suggests that good learners engage in more planning and metacognitive activities than poor learners (Pressley, 1986). Monitoring activities are an essential part of metacognition. A broad view of monitoring would include self-monitoring during a cognitive activity, tracking of attention as the students read, self-testing to ensure comprehension of text, use of certain types of test-taking strategies, and monitoring comprehension of a lecture. These monitoring activities assist the learner in understanding the material and integrating it with prior knowledge. Related to monitoring activities are self-regulating activities. As learners monitor the comprehension of a text, they can regulate their reading speed to adjust to the difficulty of the material. Other forms of self-regulation include rereading portions of a text to increase comprehension, reviewing material and using test-taking strategies. Self-regulating activities aim to improve performance by assisting learners in checking and correcting their task behaviour (McKeachie et al., 1986). Ablard and Lipschultz (1998) found in their study with high achieving students that female students reported more frequent use of self-regulated learning strategies than male students, suggesting that the two groups use different pathways to academic success.

Metacognition is a higher order cognitive function and relates to individuals' knowledge concerning their own cognitive processes and products (Flavell, 1985). It refers to the learner being able to constantly regulate the learning process and include, among other things, active monitoring and consequent regulating and orchestration of these processes. Metacognition is strongly linked to effective learning in as far as it encourages developing an awareness of the nature of learning and the learners' own learning process (Ford, 1981).

Metalearning as a subdivision of metacognition is the activity of learners who are consciously aware of their own learning activities. Biggs (1985:185) describes it as a prerequisite for effective learning:

Effective learning under institutional conditions requires first, that students are aware of task demands and of their intentions of how, or even whether, to meet those demands, and, second, that they assess realistically, and exert control over, their own cognitive resources. The fulfilment of such conditions involves a sophisticated kind of metacognition, here called metalearning.

Metalearning includes metalearning strategies such as planning, activating, monitoring and evaluating of one's own learning and ultimately leads to the development of independent learners. Metalearning is closely linked to the deep approach of learning (Biggs, 1985) and is often viewed as a core determinant of intelligence (Sternberg, 1981).

Slabbert (1989) describes metalearning as consisting of three components: meta-learning experience, metalearning knowledge and metalearning strategies. Metalearning experience is seen as becoming aware of and experiencing tension in confronting a task. Metalearning knowledge would include knowledge of the academic task, the skills needed to deal with the task, knowledge of the learner's own approach to learning and knowledge of different learning strategies to implement (McKeachie, Pintrich, Lin & Smith, 1986).

Metalearning strategies could be included in the planning, the process and product of learning. Planning of strategies is generally seen as forming an important part of meta-learning (Nisbet & Shucksmith, 1986; Nickerson, Perkins & Smith, 1985). Planning firstly involves learning task factors such as decoding and encoding of the learning task which makes it possible to select the appropriate lower order learning activities. Another aspect of planning involves the personal factors, which look at the learners' approach to learning and learning style. According to the students' view of learning they would tend to have a particular approach to learning (deep, surface or strategic) (Biggs, 1985). It would be important for both the learning task factors and the personal factors to be taken into consideration when planning an effective learning complex. During the learning complex an appropriate learning strategy is designed and time and effort allocated to the processing of the learning task.

The process part of metalearning consists of the learning strategy being continually monitored by reflection and self-management. The product is evaluated by the learner after completion of the learning task.

A student mediation or student cognition model investigates how students' cognitive and motivational perceptions about academic work mediate their essential achievement. The effects of instruction are mediated by students' cognitive and motivational characteristics. This model assumes that students are active processors of information. Student cognition includes students' general learning strategies for processing information, their knowledge about content, and their general problem solving and thinking skills. The model acknowledges that students come to the learning situation with a variety of cognitive and

motivational characteristics from previous educational experience. These characteristics will influence and interact with the instructional and task activities the students confront (McKeachie, Pintrich, Lin & Smith, 1986).

### **5.3.3 Resource management strategies**

Resource management resources include a variety of strategies that assist in managing the environment and the resources available. Some of these resources are time available for studying, the study environment, other role players such as teachers and peers, as well as the learners' effort, mood and persistence. Although these strategies could be seen as both cognitive and metacognitive in nature, they are different enough to warrant a separate category. Resource management strategies help students adapt to the environment as well as change the environment to fit their needs (McKeachie et al., 1986).

Time management is an important self-management activity in studying and the type of scheduling that needs to be done involves and regulates activities that are metacognitive in nature. The study environment is another resource that needs to be managed. Students also need to know how and when to obtain the support of either teachers or peers. This aspect links with Sternberg's (1997) notion of practical intelligence in that good learners form an idea of when they do not know something and are able to obtain assistance from others.

A study by Ames and Lau (1982) demonstrated that students' help seeking behaviour is related to motivational patterns. The general self-management in terms of effort, mood, self-talk and self-reinforcement is directly related to students' motivational patterns. Students who are able to regulate both cognitive and affective aspects of their behaviour can be seen to be self-regulated learners (Corno & Rohrkemper, 1985). Effort management seems to be another important learning strategy. Good students know when to increase and persist on a task. Meichenbaum and Asaranow (1978) have shown that positive self-talk is able to change students' mood and attributions for success and failure to help them succeed at difficult tasks. Another aspect related to the cognitive-behaviour modification model is self-reinforcement where students set up plans to reward themselves for accomplishing goals.

#### **5.4 ASSESSMENT OF LEARNING STRATEGIES**

Several instruments have been developed for the measurement of students' study skills (e.g. Brown & Holtzman, 1967), but Weinstein and Underwood (1985) have pointed out some problems with these type of instruments. There is no underlying theoretical framework for these instruments; items representing traditional areas of study skills such as note taking and time management are included, but very few items on how students learn or process material.

The Learning Activities and Study Skills Inventory (LASSI) and the Motivated Strategies for Learning Questionnaire (MSLQ) were developed to cope with this difficulty. The framework of these two instruments are in line with the process-orientated approach to learning strategies. There is a continuum running from what is usually termed "learning" to "problem-solving". Individuals have learned when displaying the effects of training in a context similar to that in which the learning occurred. Transfer of learning takes place when the learning is displayed in a different situation to the one in which the original learning occurred. Problem solving takes place when the transfer situation is so different that the use of the learning encounters some barrier or difficulty. The LASSI and MSLQ are linked with the paradigm shift away from assessing study methods and habits to the assessment of learning strategies and approaches (Cloete, 1985).

#### **6. THE RELATIONSHIP BETWEEN STUDY METHODS, HABITS, AND ATTITUDES AND ACADEMIC PERFORMANCE**

A number of researchers feel that a positive relationship exists between study methods, habits, attitudes and academic performance (Monteith, 1987; Bell, 1985; Watkins, 1984). More successful students tend to have better study methods and habits. They are more motivated, concentrate better, adapt better to their environment, have more self-confidence, spend more time on their studies and make better use of available resources (Botha, 1971; Blumberg, 1969). Nisbet, Ruble and Schurr (1982) demonstrated the effectiveness of predictors such as study habits to explain the variance in success of students in support programmes.

Conflicting results have been reported on the correlation between academic performance and study methods. Some researchers reported correlations between 0.34 and 0.49 (Bruwer, 1973; Brown & Holtzman, 1955), while Goldfried and D'Zurilla (1973) and Nienaber (1981) could not find significant correlations.

Lin and McKeachie (1970) emphasised the relationship between good study habits and academic performance and found that students with better study habits did significantly better academically than students with poor study habits. Students with poor study habits tend to under actualise their intellectual and social skills.

Entwistle and Ramsden (1983) found evidence that a positive study attitude and organised motivated study methods have a valuable contribution to make to academic success. Watkins' (1986) research showed that motivation significantly increased the prediction value of study methods combined with school results. Motivation was the non-cognitive variable that contributed most together with cognitive predictors. He found that surface learning strategies were linked to poor academic performance in economic study directions. The motivation strategies scales of the Approaches to Studying Inventory (ASI) contributed significantly to the prediction of academic success. Students' approaches to learning played an important role.

Students who use a wide range of strategies, tend to do better than those who just use a single style such as repetition. This links with the information processing theory which states that the learning material needs to be transferred into a form that has meaning for the student before it can be learned.

## **7. CONCLUSION**

Generally non-cognitive factors have contributed little to the prediction of university success (Entwistle, 1984; Entwistle, Percy & Nisbet, 1977). The research on non-cognitive predictors such as motivation, personality and study habits has had disappointing results on their own. The paradigm shift to the concept of information processing and metaprocesses (learning strategies and metacognition) has placed the emphasis on the cognitive processes involved in mental abilities which links with the dynamic assessment paradigm.

The assessment and development of affective and cognitive processes in the form of learning strategies and approaches would become important when analysing the mediation process. In the research on instructional methods more attention needs to be paid to applying process concepts both to the instructional material and to the procedures used by the individual to master the material. The role of assessment in this context would have to be of a process nature with the emphasis on metacognitive processes (Taylor, 1987). Within a dynamic assessment paradigm the mediator would take over the metacognitive load of the learner or testee.

The effects of the specific learning strategies and approaches to learning on the mediation phase and the diagnostic use of learning potential tests have hardly been studied. Some studies on the interaction of the method of teaching and the traits of students indicate that certain forms of training give some types of students an edge while putting others at an advantage. Non-cognitive factors, such as motivation, learning strategies and approaches to learning, seem to play an important role in the mediation phase of dynamic assessment procedures.

The theoretical background and development of dynamic assessment procedures will be discussed in the next chapter (Chapter 5).

## Chapter 5

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# DYNAMIC ASSESSMENT

### 1. INTRODUCTION

An assumption underlying all forms of dynamic assessment is that failure to perform is at least partly due to deficient instructional procedures and learning experiences (e.g. Feuerstein's mediated learning experiences) rather than to primary, causal deficits within individuals. The origins of these deficiencies are traced back to poor instruction which plays a vital role in the cognitive development of the individual. Mediation is a way of overcoming these deficiencies. Evidence that an individual can learn effectively in a dynamic assessment context is an indication that the major problem has been the quality of past instruction and learning experiences, rather than a lack of ability (Bransford, Declos, Vye, Burns & Hasselbring, 1987).

The approach of assessing individuals' responsiveness to mediation is arguing against the basic tenet of traditional assessment: that the best predictor of future learning is prior learning. This assumption depends on the equality of prior learning experiences, which is not the case for minority groups, and socially and educationally disadvantaged individuals. It seems important to investigate how individuals learn and how they respond to mediation, before they can be categorised according to their learning ability.

Dynamic tests were developed to quantify the learning potential underlying the processes and products of learning. It provides the opportunity of measuring abilities that are still developing and modifiable rather than actualized and fixed.

Dynamic testing is based on a method of combining the testing and intervention phases which examines the learning process as well as the learning product. Grigorenko and Sternberg (1998) describe three major differences between static and dynamic testing. The first difference is that dynamic testing focuses on quantifying the psychological processes involved in learning and change, whereas static testing is primarily concerned with products formed as a result of past skills. Secondly, instruction and assessment are

combined and subjects are provided with feedback on how they have performed on a problem solving test. The third difference is found in the quality of the examiner-examinee relationship. The conventional attitude of neutrality in the test situation is replaced by a paradigm of teaching and helping. Dynamic tests aim to assess the capacity to master, apply, and reapply knowledge and skills taught in the dynamic testing situation, rather than assess previously acquired knowledge. The goal of dynamic testing is to see whether an individual will change if an opportunity is provided to do so.

Vygotsky (1978) and Feuerstein (1980) are the two important theorists in the development of dynamic assessment. Both the theories of Feuerstein and Vygotsky are opposed to the assumption of fixed intelligence. Feuerstein (1980) asserts that individuals' cognitive ability is to a large extent determined by their social experiences. Vygotsky (1978) goes much further by arguing that the learning brought about by the child's social experiences is a prerequisite for mental development.

Both theories are essentially theories of internalisation. The mediation by a more capable person plays an important role in this process. The mediator takes over the metacognitive load of the learner, while at the same time teaching metacognitive skills. What is learned by the child is internalised to be used again later. Both theorists regard environmental and socio-cultural experiences as the most important influences affecting cognitive development.

## **2. VYGOTSKY'S CONSTRUCT OF THE ZONE OF PROXIMAL DEVELOPMENT**

Vygotsky's (1978) is considered as the founding father of dynamic assessment. One of the major concepts of his theory is the zone of proximal development (ZPD). The ZPD reflects development itself. It is not what one is but what one can become. The ZPD is a social construct as it exists only in social interaction and is created by that interaction. Some of the implications of this construct can be seen as mature as against maturing cognitive functions as well as learning versus development. The ZPD is described as the distance between the actual development level as defined by independent problem solving and the level of potential development as determined through problem solving

under adult guidance or in collaboration with more capable peers (Forman & Cazden, 1985).

Experimental validation of the ZPD is very scarce, but the concept has had varied interpretations and uses. One broad interpretation of the ZPD views it as the main mechanism of vertical transmission of cultural knowledge. The ZPD is viewed as a means of providing good teaching where performance is assisted through the ZPD. The teacher provides instruction that helps students take on additional responsibility for managing their own learning activity. Teachers constantly evaluate whether students are ready to move to the next level of self-regulation. Another educational use of the ZPD refers to it as the construction zone in which the child's cognitive system opens up and where new cognitive functions are constructed as a shared activity. Still another broad interpretation of the ZPD sees it as a place where development, stimulated by learning, takes place. Teacher guided activities conducted in the ZPD (for the development of metacognitive and self-regulatory processes) start with external mediation and eventually lead to an internalisation of the processes by the child (Grigorenko & Sternberg, 1998).

The ZPD is also used as a way of improving the individual's performance on a test of mental functioning. Within this framework, the external space formed between a student and a teacher is initially utilised to teach cognitive skills which are internalised and later used as part of the problem solving process (Das & Conway, 1992). Intervention and mediation take place within the ZPD. The ZPD theory provides an opportunity to create competencies before performance is assessed. It is this aspect of the ZPD that has formed the basis for the development of the dynamic-interactive testing paradigm on which the design of many of the dynamic tests are based. Dynamic testing has the goals of both testing and education and is used largely in the context of socially and educationally deprived children and adolescents.

The notion of mediation offers an understanding of how new cognitive skills are always being mediated to even well developed learners. Moll and Slonimsky (1989) argue that it is possible to develop a theoretical position that understands disadvantaged students to be potentially abstract thinkers who have not gained access to the cognitive learning skills that are demanded in the unfamiliar learning environment of tertiary education.

Vygotsky (1978) suggested three classes of mediators: material tools, psychological tools and other human beings. The symbolic aspect of tool-mediated activity gave rise to an

important class of mediators called psychological tools (concepts and methods of solving different problems). Psychological tools mediate humans' own psychological processes. Counting fingers can be seen as a form of psychological tool that is used for the organisation of higher mental processes involved in simple arithmetic operations. An example of higher order symbolic mediators is natural and artificial languages as well as discourses.

Vygotsky described two approaches where mediation took place through another individual. The first was based on the statement that every function in the child's cultural development appears on both the social level and later on the individual level. First between people and then inside the child. The second approach emphasised the role of the other individual as a mediator of meaning. In Vygotsky's theory the human mediator appeared as a carrier of signs, symbols and meanings and the activities of human mediators were viewed as vehicles of symbolic tools.

Vygotsky's followers developed his ideas into the contention that acquisition of psychological tools involves not only the acquisition of certain verbal knowledge, but also the ability to effectively use these tools (Karpov & Bransford, 1995). Mastering of a concept as a psychological tool means that the children have mastered the processes underlying this concept and that they are capable of using this concept for solving concrete problems. The processes underlying a psychological tool are internalised in the course of the acquisition of the tool. In the course of learning, children move from performing certain processes at the practical level in collaboration with an adult to performing these processes by themselves in their minds.

Vygotsky (1978) took the opposite view of Piaget's (1972) stage conception of human development. The Piagetian view contends that the child is able to solve increasingly complex problems as a result of biological maturation. In contrast to this Vygotsky's view is that learning causes mental development. His theory of proximal development runs counter to the view that instruction should be adapted to accommodate individuals' current biological level of development or attained intellectual proficiency. Instead it suggests that instruction can facilitate mental development (Moll, 1990).

Two distinct developmental levels can be distinguished when determining an individual's learning potential:

- (1) The actual development level that the child has reached. Typical ability tests, such as IQ tests, assess this level of current ability. They measure the acquired problem solving skills and strategies available at a given time and are typically used to predict future cognitive development within a static assessment system.
- (2) The potential developmental level is the level of problem solving that the child can reach when assisted by an adult or by more capable peers. The difference between the actual development and the potential development functions within the zone of proximal development (ZPD) (Vygotsky, 1978). The level of problem solving proficiency that the individual is able to reach with help, i.e. the potential level of development, is indicative of the actual level of development that may be reached in future.

The ZPD is an indication of the improvement in ability that the person is capable of if provided with the necessary intervention. The ZPD thus represents the level to which an individual can benefit from a period of instruction. It is therefore not the ZPD alone that predicts the future performance, but the level to which the ZPD can potentially increase current ability. The extent to which previously disadvantaged students will be able to benefit from an enriched educational setting will depend on their potential to benefit from instruction within the ZPD.

Efforts to develop dynamic assessment procedures have their roots in the practical problems that arise in evaluating and educating children who perform poorly in school or on a traditional static test of psychological development. In outlining the ZPD Vygotsky was proposing a theoretical framework for analysing the child's current state of development and for predicting the next or proximal level of development that the child might be expected to achieve. According to Minick (1987) Vygotsky was not so much concerned with the quantitative assessment of learning ability or intelligence, but with the qualitative assessment of psychological processes and the dynamics of their development. Analysing how the child responds to instruction provides diagnostic information that cannot readily be obtained with more conventional and static assessment procedures.

The ZPD indicates the functions that are in the process of maturation. With help from adults some children are able to master tasks meant for older children. Children's fully mature functions are manifested in their independent cognitive activity which can be assessed by using traditional static assessment techniques. The measurement of those

functions that are in the process of reaching maturity requires an analysis of the ZPD. This entails analysing the activities with which children are receiving adult help in order to obtain a more comprehensive picture of the child's current development, as well as for predicting the dynamics of development in the immediate future (in the next or proximal phase of the child's development).

Vygotsky's views on the mediation process and Feuerstein's concept of mediated learning experiences are compatible and have potential for mutual enrichment. The maturing functions and ZPD are characteristics not of the child as such, but of the child engaged in collaborative interaction. The child's current (initial ability as indicated by a static test) state of development still limits the extent to which problem solving behaviour can be improved (Minick, 1987). Wertsch (1979) has argued that although the ZPD is defined by social interaction, the kind of social interaction the child can become involved in is determined by the current level of development. The assistance and social interaction provided to the child do not exist apart from the developmental state of the child. They are defined and created by the child's needs and capabilities.

The concept of ZPD should always be seen in relationship with instruction as one form of social interaction. Vygotsky supported the view that social interaction and instruction require appropriate levels of development to be successful, but he rejected the notion that instruction must await the development of all the mental functions required for the independent performance of the task. The most universal and developmentally significant characteristic of instruction is its tendency to introduce conscious awareness into many domains of the child's activity. An example illustrating this is children's lack of conscious awareness of the linguistic rules and sounds when going to school, although they use them everyday on a spontaneous basis. Conscious awareness of the concepts appear in the domain of scientific instruction which creates the foundation for a new form of verbal thinking. A reorganisation of children's psychological activity occurs in collaboration with adults. This results in the children being able to apply the strategies that they learned spontaneously, in a more formal educational setting (Budoff, 1987).

The practical implications of an analysis of the ZPD is that it provides access to the internal dynamics of the developmental process itself. The analysis of individuals' activity in the ZPD can be used as a tool for making diagnostic assessment of individuals' cognitive or affective processes within the ZPD. Feuerstein (1979) outlined a "cognitive map" of the kinds of psychological processes that he sees as basic to mental functioning.

Mediation is a way of developing these processes. In a dynamic assessment session the adult would often have to provide assistance related to motivation, metacognitive, analytical and organisational skills or to memory and attention. An analysis of these psychological processes is useful in diagnosing individuals' potential for future development and for designing interventions. The use of dynamic assessment techniques could assist the need to understand the process of learning and problem solving which is central to cognitive development.

### **3. FEUERSTEIN'S THEORY OF STRUCTURAL COGNITIVE MODIFIABILITY**

Feuerstein's (1980) theory of structural cognitive modifiability is rooted within the broader field of cognitive development and has adopted much of the vocabulary of both Vygotsky and Piaget. He has extended their theories into a framework that accounts for deficient cognitive functioning of population groups often defined as disadvantaged. His concept of modifiability rejects the static views of intelligence and distinguishes between high and low modifiability. Feuerstein's model of assessment, known as the Learning Potential Assessment Device (LPAD), differs from the traditional intelligence or aptitude tests in that it reflects potential rather than manifest performance (Sharron, 1987).

Feuerstein (1980) indicates two types of learning:

- (1) learning through direct exposure to the environment, and
- (2) learning that is facilitated and managed by a mediator who interprets the environment for the child.

With direct learning the child directly interacts with the environment. In the mediated learning situation, adults or more competent peers place themselves between the environment and the child and so drastically change the conditions of the interaction. The mediator selects, amplifies, and interprets objects and processes for the child. There is a qualitative difference between learning based on direct exposure to stimuli and learning mediated by another person. The interaction between the individual and the environment is always mediated by meanings that originate outside the individual and that exist in the world of social relationships. An essential feature of human cognition is that it is based

on the internalised forms of what originally appeared as social interactions (Kozulin & Presseisen, 1995).

The mediator acts as a model for learning from direct environmental exposure, until children are able to do this on their own. In a problem solving situation their attention and thinking is guided by adults or more capable peers. Mediated learning experiences can improve the cognitive abilities of individuals during any stage of their development. Even when individuals' background indicate very little mediation from parents, they may nevertheless exhibit a degree of modifiability. This suggests that when proper mediation is provided at a later stage, individuals' cognitive effectiveness can improve.

Mediated learning experience (MLE) refers to the process by which cultural characteristics of thinking, perceiving, learning and problem solving are transmitted to children by parents, grandparents, older siblings or other teachers. The mediation of children's experiences includes functions such as stimulus selection, focusing on relevant aspects of a stimulus complex, repeating exposure to important stimuli, perceiving and understanding similarities and differences, sequential relationships, dimensionality, antecedents and consequences, commonalities in experience, and operations like comparing, categorising, relating past, present and future, and grasping the concept of generalisation of experience to new situations (Haywood & Switzky, 1992).

A lack of mediated learning experiences eventually results in the deprived individual becoming unable to learn from direct environmental exposure. Feuerstein (1980) ascribes this state of affairs to cultural deprivation where individuals are deprived of their own culture. Cultural deprivation occurs when the effective transmission of the culture to the new generation breaks down. Black individuals in the South African context can be seen to be in such a phase due to the transition to a Western orientated education system. Cultural deprivation should not be confused with cultural differences or with the supposed inferiority of one culture to another. Some members of disadvantaged groups still manage to achieve distinction within the dominant culture.

The learning potential of individuals is affected by the degree to which they are exposed to MLE. A mediator transfers and frames stimuli for the child and in this way takes over the metacognitive burden of problem solving, leaving the child free to concentrate on lower level cognitive processes. The end goal would be for the child to eventually internalise the metacognitive strategies needed for learning and problem solving.

Deficient cognitive functioning is reversible by providing the MLE that was lacking during childhood. Primary care-givers play an important role in the quality of MLE provided.

Some of the important determinants of a lack of MLE are poverty, low educational level of parents, rapid urbanisation and changes, and the breakdown of the extended family. Disadvantaged students who have had a lack of appropriate learning experiences in the past, manifest cognitive deficiencies such as a lack of spontaneous comparative behaviour, lack of a need for precision, lack of monitoring of progress and impulsive behaviour which impedes on successful learning and problem solving activities (Shochet, 1986). Mediation at tertiary education level provides the opportunity for students to become aware of and gain insight into these learning deficiencies.

Feuerstein's use of dynamic assessment focused on diagnosing specific areas of cognitive deficiencies and to aim interventions directly at rectifying such deficiencies (Feuerstein, Miller, Rand & Jensen, 1981). The Learning Potential Assessment Device (LPAD) is geared toward the identification of deficiencies in cognitive processes that can potentially be changed. The LPAD can be used to identify potential for improvement. The improvement in performance resulting from the mediating input of the psychologist indicates the potential of the child or adolescent. The learning aspect of the LPAD is emphasised when it is defined as a dynamic assessment approach designed to evaluate individuals' capacity to change structurally through both formal and informal learning opportunities (Feuerstein, Rand, Jensen, Kaniel & Tzuriel, 1987). The definition underscores the structural nature of the change, and thereby distinguishes the LPAD from other dynamic assessment procedures, which might only focus on functional change. The dynamic intervention is limited to the enhancement of individuals' functioning as it relates to interaction with a specific psychometric task.

Research indicated a positive correlation between the quality of mediation children received at home, their cognitive functions and their capacity to learn at school, as well as between mediated learning and transmission of culture at home. In instances where parents reject their old culture and had not yet internalised the new industrial culture, very little culture is transferred to the young, and as a consequence very little mediated learning takes place. In cases where the pre-industrial culture was mediated at home, the children were able to cognitively master the industrial culture, provided it was actively mediated at school. South Africa is going through changes that involve some of the people moving from a pre-industrial to an industrial and information era, as well as

changing from a rural to an industrialised urban life style that tend to mirror the changes Feuerstein and his co-workers were talking about.

Skuy (1997) argues that the MLE could be used to promote the achievement of a pluralistic model of cultural coexistence. The mediation of individuals' own culture acts as a departure point for modifiability and adaptation. "The mediator provides the kind of link between historic and present reality that grounds the individual firmly in her culture, while providing the basis for her to reach out beyond it and function autonomously." (Skuy, 1997:129). The Instrumental Enrichment (IE) programme of thinking skills (Feuerstein, Jensen & Rand, 1985) acts as a tool to provide appropriate MLE in all its dimensions: cognitive, emotional and cultural. Skuy, Goldstein, Mentis and Fridjhon (1997) demonstrated the effectiveness of a programme of multicultural education with a group of African students which led to intercultural accommodation and harmony being facilitated. In this regard the concept of mediation links up with the concepts of metacognition and meta-emotion which Skuy (1997) regards as fundamental to the concept of MLE and the IE programme.

#### **4. COGNITIVE DEFICIENCIES AND DEVELOPMENT**

A number of researchers pointed out the role of cognitive functioning in dynamic assessment procedures. Feuerstein (1979) developed a list of cognitive deficiencies based on his input-elaboration-output model. He stressed the need to link assessment of deficiencies to an intervention and development programme and used mediation as a way of assisting unsuccessful problem solvers acquire cognitive skills. Lidz (1987) emphasised the link between dynamic assessment and individuals' cognitive functioning and classified Feuerstein's deficiencies according to styles, processes, strategies, motivation and need. The differences between successful and unsuccessful problem solvers often include some or all of these deficiencies (Sternberg, 1984).

Feuerstein sees a cognitive deficiency as a lack or failure to use a prerequisite function or strategy that is necessary to solve a problem. These deficiencies result from inadequacies in mediated learning experiences (MLE). Any observable deficiency may involve structure, process, strategy or motivation deficits, each involving both biological and experiential aspects. Intervention usually starts at the strategies level. Inferences regarding structure can usually be made from observations of the child's response to

remedial efforts, that is, from the degree of modifiability. Any intervention also involves attitudinal and motivational factors. Lidz (1987) speculates on a continuum of modifiability that relates to a continuum of structure-process-strategy, with deficiencies at the structural end being most resistant to attempts at modification. It is difficult to separate the products of structure (neurological, biological) and process (functional aspects). The existence of structure implies selection, recording, organisation and response. The manner in which this is done is a matter of process, style and strategy. Cognitive processes serve to internalise environmental information and allow self-regulation of the individual. It is this internalisation that can be viewed as the hallmark of learning, adaptation and intelligence (Brown & Campione, 1986).

Day, French and Hall (1985) extended Vygotsky's original development theory and postulated that while the zone of proximal development is created by learning, the content of this learning is primarily metacognitive. Metacognition is defined as those thoughts that result from, and reflect on, ongoing cognitive processes (Flavell, 1985). This would include all knowledge and processes that direct and control thinking and learning and enable individuals to benefit from past learning experiences. With successful learning interaction (between learner and teacher) the learner is able to focus on the procedural processes, because the metacognitive burden has temporarily been taken over by the teacher.

The successful learner is eventually able to take over and internalise the metacognitive activities, and later has less need of the teacher's input (Wertsch, 1985). The attainment of this ideal would lead to self-regulated learning. Self-regulated learning is a combination of cognitive, metacognitive and motivated involvement with a task. The learners would be able to apply the metacognitive and problem solving skills that were taught to them in appropriate analogous situations so that a flexible transfer of knowledge and skills takes place. The difference between normal and retarded children is that the latter experience problems in utilising the metacognitive knowledge (use of appropriate strategies) available to them (Campione & Brown, 1978). The metacognitive differences between truly retarded children and learning disabled children can be labelled as differences in the ability to benefit from instruction.

A lack of mediated learning experiences (MLE) during the early childhood years results in cognitive deficiencies which translate in students not being able to organise and elaborate stimuli to facilitate their future use in problem solving. MLE comprise the major

determinants of flexibility which enables individuals to adapt to new modes of functioning and produce a propensity to learn how to learn (metalearning). In this regard Feuerstein (1980) agrees with educational researchers who have identified metacognition as an important determinant of success and quality in learning. The quality of learning is clearly a function of the extent to which students employ deep approaches to learning. A deep approach to learning is in turn dependent on the ability to engage metacognitively with both the content and context of a particular learning task (Biggs, 1979, 1987). The strategies needed to solve a particular problem are made explicit during a mediation phase.

Piagetian stage theories (Piaget, 1977) assumed that development consists of the addition of capacities to the child's already existing abilities. Later views of development also acknowledge that children actually become more effective at organising information, applying strategies and solving problems. Theorists who are exploring the issues argue that many of these abilities simply emerge from the acquisition of new knowledge and development of effective metaprocesses. This is different from the assumption that structural capacities have been added to increase individuals' repertoire of skills.

The advances in the role of knowledge and strategies in problem solving seem to suggest that thinking abilities are not simply added on top of existing domain-specific competencies, but that competencies and the ability to think go hand in hand. The implications of this is that besides developing individuals' general strategies, there will also be a need to develop domain-specific knowledge and skills. Students have to be helped in becoming efficient in their ability to access relevant knowledge and skills, otherwise they will be overwhelmed by new tasks, because of attentional and metacognitive constraints.

There is accumulating evidence that modification of strategies can increase learner performance (Haywood & Switzky, 1992; Lloyd, 1980) and that spontaneous use of strategies accounts for a good deal of the differences between developmental levels that differentiate retarded from non-retarded persons (Chi, 1978), and between good and poor learners (Bauermeister & Brooks, 1981). Most learners differ in the application of process, strategies, styles and efficiency of functions (Das, Kirby & Jarman, 1975). Strategies are under the conscious control of the learner and can be equated with executive control process. It is often the flexible application of strategies that distinguish successful from unsuccessful problem solvers (Rowe, 1985). In a dynamic assessment setting the mediator would assist the individual in establishing which strategy fits in best with a

particular task. Cognitive style describes the individuals' unique and characteristic approaches to a task's demands. It is a combination of selection of strategies, employment of process, knowledge base and style variables, within the context of needs and motives, that contributes to differentiation of one learner's performance from another learner's performance (Keating, Keniston, Manis & Bobbit, 1980).

Skuy, Mentis, Durbach, Cockcroft, Fridjhon and Mentis (1995) assessed the effectiveness of the IE for different groups of primary school pupils (30 Afrikaans-speaking whites, 27 English-speaking whites, 27 Coloured and 37 African). The programme was separately implemented to each group over a period of one year and consisted of three dimensions:

- (1) A trained teacher implemented the Organization of Dots, Comparisons and Orientation in Space for a total period of 20 hours during the year.
- (2) The teachers involved with the different classes received seminars on mediated learning during the year which encouraged optimal pupil-teacher interaction.
- (3) Stimulus packages prepared for the teachers were used to bridge the thinking skills contained within the IE programme into the actual curriculum.

Pre- and posttest measures on intellectual ability, creativity, self-concept and a teacher's report on scholastic achievement were used to compare the groups for differences.

The results indicated that the cognitive performance of all the groups improved after intervention. The improvement of the African group was significantly greater than that of the others. No significant differences were found between the Coloured group and the two white groups on the cognitive measures. Generally, all the groups, except the English-speaking white group, achieved consistently positive and significant post-intervention changes on most of the measurements. Skuy and his associates (1995) mention the quality of implementation of the different dimensions of the programme as a possible reason for this group not showing significant improvements. This study provides evidence of the usefulness of the IE programme (as an example of a dynamic procedure) for different socio-cultural, ethnic and language groups.

Intervention programmes such as those of Feuerstein (1980) involve the taking over of metacognitive activities by the tester. Over time the testee learns to apply these strategies for themselves. In this context the generalisation of metacognitive skills are encouraged by making the testees aware of the wide applicability of the strategies being

learned. The intervention can be seen as a metalearning exercise (Biggs, 1985) where the testee learns to learn and knowledge and skills can be applied in future problem solving exercises.

## 5. DEVELOPMENT OF DYNAMIC ASSESSMENT PROCEDURES

An interpretation of Vygotsky's concept of the zone of proximal development (ZPD) implies that cognitive performance with optimal aid should provide the most valid assessment of learning potential. In addition to the use of the ZPD, cognitive psychology made an important contribution to learning potential assessment in that insights into cognitive development could be applied in training procedures incorporated into the tests (Hamers & Sijtsma, 1993). Past learning experiences of a test greatly influence the score on a test of ability, but because it would be extremely difficult to establish how effectively individuals have used past learning experiences available to them, it would be unfair to use this score as an indication of learning ability. A number of researchers have attempted to develop dynamic assessment procedures to obtain more meaningful measures of the potential to learn.

Grigorenko and Sternberg (1998) believe there are three major clusters of dynamic testing approaches:

- (1) metacognitive intervention targeted at teaching generalisable concepts and principles (e.g. Feuerstein's mediated learning),
- (2) learning within the test (e.g. Brown's graduated prompts approach),
- (3) restructuring the test situation (e.g. Budoff's training tests, Carlson and Wiedl's optimising of test administration).

Budoff's (1987) approach to measuring learning potential was based on the assumption that educable disadvantaged children are more capable of learning than their conventional test results indicate. He believed that if given the opportunity to learn how to solve a problem through organised, specialised instructions, at least some of the disadvantaged students will demonstrate improved performance beyond that predicted by static ability tests. The underlying belief of the approach is that the performance of disadvantaged students are usually underestimated on traditional static tests and that they have more learning potential than is identified by these tests. Budolf (1987) made a

concerted effort to standardise the training component of his approach. The aim of the training was to familiarise the students with the demands of the test and to equalise their learning experiences. The procedure was designed to act as alternative to conventional intelligence tests in the selection of students. He views learning potential as a measure of general ability which does not directly relate to school activities and is trainable (Grigorenko & Sternberg, 1998).

Budoff and his co-workers focused on the first non-clinical approach to the measurement of learning potential in their efforts to find alternatives to traditional IQ testing. Budoff and Corman (1974) found that the performance of educable mentally retarded children on the Kohs block design test could be differentiated into what they called gainers and non-gainers. The potential of a testee to profit from intervention was found to be independent of current ability. Although socio-economic class indices correlate with typical ability measures such as the Stanford-Binet test scores, learning potential scores correlated with neither socio-economic status nor race. Budoff and Hamilton (1976) found that although pre-training scores on the Kohs block design test scores correlated with IQ scores, improvement scores were unrelated to IQ scores.

Babad and Budoff (1974) used a series learning potential test on three groups of children: bright-normal, dull-average and educable retarded. Three analogous tests were completed with a training session between the second and third tests. The results indicated that gain scores on the series learning potential test correlated better with academic performance than traditional IQ measurements. The post-training score alone predicts academic performance better than typical IQ measurements. After the intervention a 20% increase in standard deviation of scores was reported. The result suggests that there were large individual differences in learning potential, which may prove useful indices of students' potential to benefit from academic instruction. An additional interesting finding was that while subjects with higher initial ability may benefit more from practice than subjects with lower ability, no mean differences in learning potential (benefits from instruction) were found between subjects of higher and lower ability. This supports the notion that ability and learning potential are two independent variables.

The graduated-prompts approach was developed primarily by Campione and Brown (1987) to establish a supportive framework that would gradually help individuals until they could solve a test problem. The main concept of this approach is transfer (maintenance of learning) or an individual's ability to use learned information flexibly and in a variety of

contexts. The operationalisation of the theory is in the quantification of indicators of learning and transfer. In this approach the child is not directly taught anything, but rather provided with a combination of general metacognitive and task specific hints or mediation. The graduated-prompts approach operates with standardised measures that do not assume any special training and are easy to administer (Grigorenko & Sternberg, 1998).

Brown and Ferrara (1985) follow a neo-Vygotskian approach in the testing situation. The process is as follows: The child is presented with a problem after which progressively more explicit clues for solving the problem are provided, until the child generates the correct solution. The number of hints the child requires for each problem represents the amount of transfer the child is achieving. This is viewed as an index of ZPD. Measures of transfer have been shown to differentiate between retarded and normal individuals, as well as between average and above average subjects. Brown and Ferrara (1985) used a clinical approach where children were assessed individually.

Carlson and Wiedl (1992) developed what is known as a testing-the-limits approach. They attributed poor test performance partly to participants' inability to understand what was expected of them in the test situation and to a set of personality variables such as test anxiety and self-esteem. Test performance is seen as a result of the dynamic interaction between the individual, the test materials and the test situation. Characteristics in all three of these could contribute to better performance on a test and act as a more sensitive measure of abilities. They found that training had the greatest effect on items requiring reasoning by analogy – those items for which higher level cognitive processes can be modified. Differences by race and test anxiety declined markedly under dynamic testing conditions (Grigorenko & Sternberg, 1998). Optimal results were obtained with training when using both verbalisation and feedback of answers to problems.

Kar, Dash, Das and Carlson (1993) used planning, which was operationalised by visual search, as an individual-differences dimension in their research with groups of children of different ethnic backgrounds representing mental retardation, learning disabilities and neurological impairments. The design of the study was based on the restructuring of the test situation by using different combinations of verbalisation and feedback. The researchers specifically examined the effect of verbalisation on task performance. The results indicated that no main effect of verbalisation was shown, but that there was a significant interaction effect, in the sense that only poor planners improved their performance. The conclusion was that overt verbalisation compensated for individual

variability in planning and yielded an interaction between individual differences and test condition. The indications are that this approach appears to be most appropriate for assessing higher level cognitive functions in individuals whose level of performance on corresponding tasks is initially low.

The dynamic assessment approach responds to the attempts to assess culturally different or disadvantaged populations by attempting to change the individuals confronted with the test. In the dynamic approach an intervention prepares the individual to cope with the task. The dynamic construct can be defined by two terms, describing its goals as either functional or structural (Feuerstein, Rand, Jensen, Kaniel & Tzuriel, 1987).

The functional goal refers to a dynamic assessment where the major goal is limited to the enhancement of the individuals' functioning as it relates to interaction with the specific psychometric task. Models included in this functional definition are: coaching of tasks, or intervention aimed at facilitating the individuals' functioning within the zone of proximal development (Haywood, Tzuriel & Vaught, 1992). The goal is enhancing and modifying the functioning of the individual in an area considered critical at a particular point in the assessment:

The unidimensionality of the static approach is meaningfully bypassed in favour of a two-dimensional approach that gives a sense of depth to the concept of intelligence and to the outcome of its interaction with experience. (Feuerstein et al., 1987:42)

The second definition of the construct of dynamic assessment has at its centre the concept of structural cognitive modifiability. Here the goal of change in the individual goes far beyond immediate levels of functioning into changes in the structural nature of the cognitive processes that directly determine cognitive functioning in more than one area of mental activity. This definition has as its basic assumption the belief that the individual is an open system, accessible to structural change. A shift of responsibility for modifiability is made from the examinee to the mediator. A legitimate goal of dynamic assessment would be to modify the cognitive style of individuals, or their preferential mode of functioning.

The general aim with learning potential assessment would be to modify test performance rather than to bring about an enduring change in the individual's ability, which would involve extensive training over a longer period of time (Embretson, 1987). In traditional

test applications, changes in ability are regarded as a threat to the standardisation of the psychometric properties of the test. In learning potential testing, however, score changes are seen as a way of increasing test validity.

Hessels and Hamers (1993) stress the importance of using non-verbal tasks to assess reasoning ability of individuals who have been environmentally disadvantaged. Most of the tasks used in Learning potential assessment procedures are based on common practice in standardised intelligence (Guthke, 1993; Resing, 1993). Since learning potential tests may contribute to improving classroom teaching, tasks were also constructed which provide information about domain-specific knowledge and skills. Examples would be focussing on reading comprehension (Campione & Brown, 1987) and mathematics (Meijer, 1993). Domain-specific tasks have greater relevance for academic performance.

Hamers and Sijtsma (1993) suggest that the following factors be taken into consideration when interpreting the results of training sessions:

- (1) Individuals should preferably not be familiar with the test stimuli otherwise the scores might be confounded. This is to try and minimise the interaction between present learning and prior learning or knowledge.
- (2) Due to differences in prior learning, some individuals will improve their performance more than others.
- (3) Individuals who do not learn with one teaching strategy may learn more efficiently using another strategy. At the same time individuals who perform poorly on some tasks may learn more rapidly on others.

In order to properly interpret test scores, factors such as prior knowledge, familiarity of the test tasks and information on which individuals profit most from specific strategies need to be taken into consideration. The various forms of training have implications for the validity of test scores and a differentiation needs to be made between training effects and the effects of simply repeating the test (Klauer, 1993).

Researchers differ in the cognitive processes they target for training and try to relate to academic performance. Some researchers focus on the training of general metacognitive skills, while others concentrate on developing individuals' task specific strategies (e.g. rehearsal, use of cues, problem identification and reduction to simpler units). The basic format of the learning potential test used by most researchers is the pretest-training-

posttest format. Changes between the pre- and posttest would be more for those individuals who have a lower initial ability as demonstrated by the test score. These individuals have a greater chance of making substantial improvements after the mediated lesson, than those who already possess high problem solving abilities.

A dynamic or learning potential test usually has three sections:

- (1) initial assessment of performance;
- (2) intervention or lesson of some kind which is aimed at teaching some of the core concepts or procedures needed for effective performance; and
- (3) second assessment of competence.

The assessment instruments should be designed in such a way that the pretest and posttest items match. One way of doing this is to use a latent trait model (Embretson, 1987). Another way is to make use of highly structured material such as Kotovsky and Simon's (1973) letter series. A formula can be used to determine the difficulty level of a series. An infinite number of equivalent series can be generated, providing precisely matched items in the pre- and posttests.

Various indices can be used to assess learning potential after the lesson. These include differences between the pre- and posttest performance in the number of errors made, number of responses on each item and number of hints needed to successfully complete an item. The number of methods most commonly used are the number of errors on the test and the number of hints needed. The only viable method to use in large group pencil-and-paper testing is the number of errors. The assistance of computerised testing would make more sophisticated evaluation possible.

Some sort of novel reasoning task is usually used as content domain. Areas which may be more familiar to some testees than others, due to differences in past educational experiences, are usually avoided. During the lessons three kinds of information can be taught: facts, procedures and metaprocesses. The intervention is usually designed with the goal of assessment. In a practical application such as selecting students for a course, it may be better to teach only facts and procedures because it links with the demands of the course. In cases where academic development is involved it would also be desirable to include metacognitive skills in the lesson phase to assess students' modifiability in this regard.

## 6. RELATIONSHIP WITH ACADEMIC PERFORMANCE

Campione and Brown (1987) report on several studies of predictive validity done by them and their colleagues with a dynamic assessment procedure. They obtained measures of initial competence, along with measures of general ability and learning and transfer scores. At some later point the students' abilities are reassessed. The following scores were investigated to see which one would best predict later performance: initial competence, general ability, learning and transfer indices. In these studies the general procedure was to give subjects a pretest, learning and transfer sessions and then a final posttest. The pretest included subscales of an intelligence test and the Raven Coloured Progressive Matrices.

The findings indicated that there were significant relations between the ability scores and the learning and transfer matrices. Children of higher ability tended to require fewer hints to solve the original sets of problems and to deal with the transfer problems. An analysis of the gain scores indicated that the IQ score and the Raven showed a reasonable prediction of the gain score, accounting for about 60% of the variance in that score. The learning and transfer scores, however, still accounted for significant additional portions of the variance in gain scores. Taking the learning and transfer scores into account provided further diagnostic information about individual children. In the matrices task, the learning score accounted for an additional 22% of the variance, and the transfer score for an additional 17%.

The simple correlation scores showed that the learning and transfer tasks were better predictors of gain scores than either of the two static measurements. Within the set of dynamic measures, the tendency is for the transfer measures to be more strongly related to gain scores than the learning index. The best overall description of the differences between successful and unsuccessful students was the ability to apply required skills to the solving of novel problems. Campione and Brown (1987) suggest that any development programme aimed at weaker students would have to focus on meta-cognitive processes to facilitate the transfer of skills to different problem solving situations.

Shochet (1986) adapted Feuerstein's methodology to conduct an investigation into learning potential at a South African university. He made use of the Deductive Reasoning Test (DRT) and the Pattern Relations Test (PRT). Lessons which explained the concepts

underlying the test items in both tests were presented after which the students were again tested on the DRT and PRT. No significant intercorrelations were found between learning potential (represented by the difference scores between the pre- and posttests), initial ability (represented by the pretests) and academic performance.

The sample of students was divided into modifiable (high difference scores) and non-modifiable (low difference scores) groups of students. Shochet found that the correlation between ability (pretest of DRT) and academic performance were significant in the non-modifiable group, but not in the modifiable group. The correlation between scores on the PRT and academic performance was significantly higher in the non-modifiable group than in the modifiable group. The modifiability of the students acted as moderator in the prediction of academic performance. Some difficulties surround the interpretation of this finding because of the low reliability of the difference scores (Boeyens, 1989a).

Kotzé, Van der Merwe and Nel (1996) conducted research with over 5 000 first year students at the Rand Afrikaans University on the predictive validity of the Ability, Processing of Information and Learning Test Battery (APIL) which uses a dynamic assessment approach. The results showed correlations between subtests of the APIL and academic performance varying between 0.043 and 0.45 ( $p < 0.01$ ). Higher correlations were obtained for the faculties of Education and Arts than for the faculties of Engineering, Science or Business.

The conclusions that can be drawn from these studies are that the ZPD can be used to predict the academic performance of those individuals who show low initial ability but have the potential to benefit from a period of mediation as opposed to those who have low ability but do not benefit. Another group would be those individuals who show high initial ability but also benefit from mediation. A further conclusion is that a period of mediation enables effective learners to organise new knowledge into metacognitive structures which can be employed to solve analogous problems. All of the above is an indication that learning potential measures might lead to fairer selection decisions where the candidates are from a socially and educationally disadvantaged background.

## 7. SHORTCOMINGS IN DEVELOPMENT OF DYNAMIC ASSESSMENT PROCEDURES

A very practical criticism against all the Feuerstein and Neo-Vygotskian attempts to measure learning potential is that they are too time consuming and labour intensive to offer a viable alternative or supplement to the traditional psychometric testing approach. A lengthy clinical type approach, where a great deal of time by a skilled assessor is needed, does not seem practical. In a typical assessment session using Feuerstein's Learning Potential Assessment Device (LPAD) one tester could spend anything from 5 to 25 hours on a test.

One of the criticisms against the LPAD is that it does not fulfil a number of methodological requirements, especially with respect to standardisation and reliability. In their discussion of the shortcomings of the LPAD Büchel and Scharnhorst (1993) discuss three aspects of standardisation: task analysis, test administration and interpretation of results. The LPAD does not allow for an empirical or a rational analysis of test tasks because its dimensions are not well defined. Control of test administration requires standardisation of the interaction between examiner and examinee. Feuerstein, in reply, feels that the standardisation of the educational interaction imposes artificial restrictions on the teaching environment and limits the chances of learning for the examinee. Some studies have shown that a standardisation of the examiner-examinee interaction is possible and necessary if the assessment is to be a scientific enterprise (Guthke, 1993; Brown & Ferrara, 1985). Most of the LPAD tests are scored in a rather subjective way and this often leads to a subjective interpretation by the examiner. Although Feuerstein claims that the LPAD assesses process rather than products, it is products which are eventually scored (e.g. Organisation of Dots, Complex Figures, Word Memory) (Büchel & Scharnhorst, 1993).

Feuerstein refuses the concept of reliability for dynamic assessment procedures and argues that learning potential is not a stable characteristic of individuals, but something which is developed with the help of the examiner during the test administration. According to Feuerstein (1979) the peaks in the pattern of the obtained results should be used as an indication of the cognitive potential of the examinee. Although Feuerstein denies the relevance of reliability in the use of dynamic tests, the reliability studies done with tests of the LPAD (e.g. Set Variations 2) show that the correlations are far removed from the

reliability standards set for conventional tests (Buchel & Sharnhorst, 1993). With the LPAD it is often not clear whether the performance on a test is due to the student or to the contribution of the examinee. In a Vygotskian framework the question would be whether such peaks are really indicators of the zone of proximal development.

Some research has been done with the LPAD in group testing to try and reach more testees at a time. Rand and Kaniel (1987) describe group administration with the LPAD as only the first step that has to be followed, more often than not by an application of the more refined individual LPAD testing. Group testing does not have all the characteristic features of the individual administration and acts only as a screening device for the individual testing. With the individual test it is possible to develop a better tester-testee relationship. Group administration of the LPAD differs from conventional group testing in the following ways:

- (1) A pretesting learning phase, where learning processes are activated, is held with the testees. The examiner helps the examinee gain a thorough understanding of the nature of the tasks.
- (2) Intervention takes place during the task itself, whenever the tester considers that some basic prerequisites are still not available to the subjects. In this way instructions are combined with learning to assure that all the subjects have the cognitive prerequisites to tackle all the items of the tests.

The group administration does not allow for a full assessment of the testees' individual performance processes or difficulties with items. In order to try and observe all the students while solving problems Rand and Kaniel (1987) suggested that not more than 20 students be tested at a time.

The basic model of the group testing as described by Rand and Kaniel (1987) is: (1) demonstration, (2) test, (3) learning, and (4) retest. During the demonstration phase the testees are introduced to the tasks and provided with the instructions. During the learning phase the group undergoes a learning process including both the nature of the task and the prerequisites deemed necessary to solve them. The test items themselves are not used in the lesson, but the principles and strategies needed for the problem solving. The retest phase is used to assess the efficiency of the intervention. The difference in performance between test and retest is used as an indicator of the level of modifiability obtained during the intervention. The specific time required for both learning

and testing is not fixed, but varies from test to test and group to group. On the basis of this information the group testing method seems to suffer from the same lack of standardisation as the individual clinical approach.

The LPAD use measuring instruments adapted from conventional IQ tests such as the Ravens Progressive Matrices which are not always the ideal to use in a dynamic assessment. The construction of conventional tests is typically not guided by any formal theory. When investigating learning potential, it is necessary to precisely determine individuals' improvement due to the intervention. When the difficulty level of items is unknown it is impossible to accurately determine the improvement of a test. While it may still be possible to distinguish high learning potential from low potential it is impossible to compare the amount of learning potential of two individuals with a sufficient degree of accuracy (Boeyens, 1989a).

Typical psychometric tests are constructed so that some subjects solve all or almost all items, which makes them unsuitable for the assessment of learning potential. Boeyens (1989a) contends that in order to measure learning potential it is essential that upon a second administration of the test everybody will be able to improve upon their initial scores. If bright subjects do not have sufficient room for improvement (the ceiling effect) their learning potential will be underestimated.

Neo-Vygotskian assessment methods typically use the method where the child is presented with a problem and progressively more explicit clues for solving the problem are provided by the examiner. This approach does not strictly adhere to the Vygotskian model of learning potential where the zone of proximal development is determined by the amount of improvement the test is able to achieve following an intervention. A problem with the hints approach is that the significance or helpfulness of prompts or hints is difficult to grade accurately.

Research on learning potential tests is still in its infancy. Many of the current versions of learning potential tests being used in practice are as unsatisfactory as the conventional intelligence tests as far as their theoretical foundations are concerned. Closely related with this shortcoming is the fact that the existing learning potential tests allow only the recording of learning gains (products) but often not an analysis of the learning (process) as such (Guthke, 1993). The types of items used for learning potential tests tend to draw mainly on conventional tests of intelligence. There is a feeling that learning potential tests

should enable teachers to derive guidelines for enrichment programmes. Tissink, Hamers and Van Luit (1993) feel that particular attention would have to be paid to the construction of curriculum-related potential tests which could be based on error analysis.

Some of the methodological problems associated with dynamic tests will be discussed in the next section.

## **8. METHODOLOGICAL PROBLEMS WITH DYNAMIC TESTS**

The problems in evaluating change are to a large extent problems of scaling and of the regression effect, while problems also exist due to the reliability and validity characteristics of difference scores (Schöttke, Bartram & Wiedl, 1993).

The regression model predicts that the results of a second testing would tend towards the mean of the distribution of test results. This effect is designated the regression effect. On the individual level, following the linear regression model, individuals with low pretest scores are expected to improve and individuals with high pretest scores to decline. Generally the regression effect is stronger for the more extreme pretest performances and occurs irrespective of training effects. The regression effect is stronger the more unreliable the pretest score. The regression effect is likely to occur at group level, as well as when subjects are identified by their pretest scores (low pretest scores) as being in need of training (Sijtsma, 1993).

One of the methodological problems of measuring learning potential is that difference scores tend to be unreliable. Both pretest and posttest should be as reliable as possible to reduce this problem. Using the same test as pretest and posttest will increase the expectancy of low reliability of the difference score.

The intervention in a dynamic test may induce such large changes that they are meaningless. In that case the posttest may be too easy to show real change. As a result of the training many persons might obtain the maximum score on the posttest. This maximum could be a lower indication of their true performance level and as a result the difference score would underestimate the true change. This ceiling effect may cloud real change. For some individuals an intervention programme may have negative effects,

resulting in a decline of test performance. In this case a bottom effect rather than a ceiling effect may occur.

With some dynamic assessment procedures the pre- and posttest may not be truly independent measures. In that case memory of the responses given on the items during the first test session is confounded with the help given during the lesson. The scores on the posttest are thus the result of memory and intervention. The use of parallel or equivalent tests would solve the memory problem. In that case the pre- and posttest would be independent measures and the difference score would reflect real change (Schöttke, Bartram & Wiedl, 1993).

A control group that does not receive the training is needed for the evaluation of a treatment effect. This controls for other sources such as the retest effect (Klauer, 1993) or regression effect that may affect posttest performance. The weakness of change measurement using the same test for each person remains the possible lack of reliability of difference scores. The cause of unreliability seems to lie in the learning potential assessment procedure itself. If pretest and posttest measure the same ability, they may be expected to correlate to a considerable degree and differences will often be unreliable. For individual differences to be significant, the intervention programme needs to be highly effective.

Computerised adaptive testing could be used for learning potential assessment purposes. Tailoring the pretest and posttest to the performance level of each individual leads to shorter tests which should motivate the testee during the rest of the training programme. A large number of items is stored, and the computer selects and presents the items to the individual testee. Each testee receives a test that is neither too easy nor too hard, but constitutes a realistic challenge (Sijtsma, 1993). Modern item response theory (IRT) could be a viable alternative to classical test theory (CTT) and can be used to solve several measurement problems that exist in learning potential research. Both IRT and CCT have limitations and disadvantages. IRT is mathematically more complex and might not be suitable for educationally disadvantaged students who have not had any experience in the use of computers. Another disadvantage of this approach is that each individual receives a different subset of items. The pre- and posttest are usually not perfectly matched (Taylor, 1987).

## 9. CONCLUSION

Dynamic assessment procedures have been developed in opposition to conventional, static techniques. The dissatisfaction with traditional tests of intelligence is mostly based on the following arguments:

- (1) Traditional assessments focus on the products of learning and tend to disregard learning processes.
- (2) Traditional assessments seldom provide information that would assist in developing effective intervention techniques.

Dynamic assessment investigators question the usefulness of products of cognitive performance to predict and classify the ability to learn. The dynamic paradigm underscores the importance of affective and cognitive processes and students' use of learning strategies, such as metacognitive abilities, in predicting academic performance of educationally disadvantaged students. It is argued that the best way to assess disadvantaged students' potential for learning and predict their academic performance would be through the use of dynamic tests.

A major relationship exists between the theories of Vygotsky (1978) and Feuerstein (1980) that helps to inform the development of dynamic assessment procedures. Vygotsky's zone of proximal development describes the area between the level where a learner can go no further without assistance and the level where a learner can go no further, at the present stage, with the assistance of others. Feuerstein's theory of mediated learning experience describes what happens within the zone of proximal development when a learner is assisted in moving through the zone and develops a certain amount of competence.

The use of dynamic assessment procedures is particularly relevant to educationally disadvantaged students. The lack of mediated learning experiences often lead to cognitive deficiencies which could be rectified by a process of mediation. The ability to learn and benefit from the mediation phase would be an indication of learning potential. Cognitive processes, such as metacognition and other learning strategies, seem to play an important role during the mediation phase, as well as students' level of motivation. More research seems to be needed on the relationship between students' response to mediation and the affective and cognitive processes taking place during this period.

In the practical application of dynamic tests to the selection of disadvantaged students for tertiary education the benefits of a clinical use of dynamic assessment procedures have to be weighed up against the benefits of a group and standardised approach. In spite of the methodological problems associated with dynamic tests and other shortcomings, the dynamic assessment approach seems to be the most appropriate to use for the fair and valid selection of educationally disadvantaged students.

The dynamic assessment tests and other measuring instruments used in this study will be discussed in the next chapter (Chapter 6). This will include a section on validity and reliability studies done with these instruments.

## Chapter 6

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# THE MEASURING INSTRUMENTS

### 1. INTRODUCTION

The measuring instruments were selected to operationalise the constructs as described in Chapter 1. The constructs can be divided into two broad areas: cognitive factors and non-cognitive factors.

The cognitive factors include the Conceptual Reasoning Test (CRT) and the Learning Potential Test (LPT) which can be viewed as examples of dynamic assessment procedures. Both the tests have a mediated lesson incorporated in the test. Included in the cognitive factors are examples of the traditional static tests of ability. The Reading Comprehension Test (RCT) measures an individual's ability to read and comprehend English paragraphs. The Mental Alertness Test (MA) evaluates the ability to profit from formal academic work, while the Electrical Aptitude Test (EAT) is a very specific test designed to assess students' aptitude for electrical engineering knowledge and understanding.

The non-cognitive factors include the Study Process Questionnaire (SPQ) and the Motivated Strategies for Learning Questionnaire (MSLQ). The SPQ provides three subscales which indicate to which extent students have a surface, deep and achieving approach to learning. The MSLQ consists of three main scales, each with various subscales. The first scale indicates students' level of motivation, the second scale the level of cognitive strategies used by students and the third scale how well students manage the resources available to them.

Each one of the measuring instruments used in the study is discussed under the following headings:

- (1) Description (scales and subscales)
- (2) Reliability
- (3) Validity.

## 2. STUDY PROCESS QUESTIONNAIRE (SPQ)

### 2.1 DESCRIPTION

The SPQ was developed for use by tertiary students by Biggs (1985, 1987) after 20 years of research. This fairly new approach to the theory of student learning refers to qualitative distinct ways in which students go about learning. The instrument has been designed to measure the extent to which individuals typically endorse common approaches to learning tasks. An increasing shift has taken place towards the view that stable individual differences interact with the perceptions individual students have of the context in which the task is being presented. The final model of student learning emerges in terms of the motives students have for engaging a learning task and the strategies adopted so that the students' interactions are realised. The motive-strategy combinations make up the common approaches to learning.

Three approaches (surface, deep and achieving) and one composite approach, deep-achieving, represent the most important ways in which students consistently approach academic tasks. With the surface approach the surface motives of the student are intrinsic. The student is at the technician to obtain a qualification with minimal effort. This motivational state contains both positive reinforcement (passing the course) and negative (test anxiety) and the resulting strategy is essentially reproductive. Students focus on what appear to be the most important topics and reproduce them fairly exactly. The surface approach is frequently alienating, leaving the student anxious about the outcome.

With the deep approach to learning the deep motive is based on intrinsic motivation and curiosity. The student relates the content to personally meaningful contexts or to existing prior knowledge. Effectively, the deep approach leads to task involvement and to satisfying outcomes.

With the achieving approach, the achieving motive is based on competition and the ego-enhancement that goes with obtaining high grades. The strategies that go with achievement motivation comprise those organisational behaviours that are supposed to indicate the model students, such as keeping clear notes, planning optimal use of time and all those planning activities referred to as study skills. Whereas the deep and surface approaches refer to the kinds of cognitive processes used when engaging the task (meaningful or rote learning) the achieving approach refers to arranging the context for

carrying out the task. An achieving approach linked to a deep approach (deep-achieving) means seeking meaning in an organised way, while surface-achieving would be the approach adopted by students who want to obtain high grades by using rote learning.

The determinants of a student's approaches to learning are both personological and situational. The approach used depends in part upon enduring personality traits, and in part upon the immediate demands of the task and the context in which it is placed.

The 42-item SPQ is scored by summing responses to the 5-point Likert scale for each item comprising each subscale. There are six subscales, three motive and three strategy. The sum of the related motive and strategy subscales yields the approach scale score, as outlined in Table 6.1.

Table 6.1  
Structure of the SPQ Scale and Subscale Scores

LEVEL	SURFACE		DEEP		ACHIEVING	
Subscale	Motive	Strategy	Motive	Strategy	Motive	Strategy
Scale	Approach		Approach		Approach	
Composite			Deep-Achieving Approach			

The wording of some of the items in the SPQ was adapted to fit the South African context. The original version of the SPQ can be found in Appendix A, while the revised version is in Appendix B.

## 2.2 RELIABILITY

The first question that arises in discussing the psychometric properties of a measuring instrument is the reliability of the scales. Reliability may be seen as the stability of the scores obtained, either in the sense of stability over time (test-retest reliability) or of stability over equivalent measurements. A common measure of reliability in this context is internal consistency, measured by the alpha coefficient. This is a measure of the extent to which the items in the scale show that they are measuring the same thing.

Table 6.2 summarises the reliability data for the SPQ scales and subscales. They show the internal consistency (alpha coefficients) obtained from various studies, including investigations done with a sample of students in this study.

Table 6.2  
Reliability Data for SPQ Scale Scores

		(a)	(b)	(c)	(d)	(e)
Surface	- motives	0.61	0.51	0.55	0.60	0.54
	- strategies	0.66	0.62	0.56	0.69	0.57
	- approach	0.73	0.68	0.64	0.75	0.70
Deep	- motives	0.65	0.63	0.64	0.67	0.58
	- strategies	0.75	0.73	0.65	0.72	0.69
	- approach	0.81	0.79	0.76	0.79	0.76
Achieving	- motives	0.72	0.71	0.72	0.70	0.65
	- strategies	0.77	0.75	0.73	0.74	0.76
	- approach	0.78	0.77	0.78	0.77	0.78

(a) Biggs (1987) (University, N=823)

(b) Biggs (1987) (CAE, N=1550)

(c) O'Neil and Child in Biggs (1987) (N=245)

(d) Hattie and Watkins (1981) (N=225)

(e) Present sample (N=385)

The general picture that emerges from the data in Table 6.2 is one of reasonable consistency, both within scales and across populations. The reliability data of the present sample closely resemble that obtained from the original sampling and instrumentation of the SPQ and the other two studies done. The sample used by O'Neil and Child as reported in Biggs (1987) were 245 polytechnic students in the UK and the data obtained from the study by Hattie and Watkins (1981) were from four faculties in an Australian University. The least satisfactory results from all the studies were from the Surface motives.

### 2.3 VALIDITY

The SPQ was developed by utilising a theory of student learning and doing a series of factor analyses of tertiary students' questionnaire responses. The method used was Principal components analysis with varimax rotation utilising three different samples. The results of the analyses suggested a three factor solution. It also became clear that items on each factor grouped themselves into an affective and a cognitive group. A group of items in each factor addressed a motive and another group a cognitive strategy. This led to the learning process complex which refers to students' motives and strategies for

learning. Each motive-strategy combination defines a distinct approach to learning. The surface and deep approaches link up with the qualitative research done by Marton and Saljo (1976) which distinguished surface level and deep level processing of learning material. Students would adopt one or other means of processing academic tasks according to their intentions in approaching the task.

It was noted in Biggs' (1987) study that surface or deep approaches theoretically combine with achieving approaches. Principal component analyses with varimax rotation indicated that the achieving motives loaded equally high on the surface and deep factors. Students see both the surface and deep approaches as related to achieving as possible approaches to learning.

Hattie and Watkins (1981) compared the results obtained from the group of 255 first year Australian students with those obtained from 175 Filipino first years. They applied confirmatory maximum likelihood factor analysis to test the "goodness of fit" of the data and found strong confirmation of the present SPQ model for the Australian data, but not for the Filipino data. In the study that O'Neil and Child did they compared the principal component/varimax procedure and an oblique (oblimin) procedure. The data confirmed the structure of the present scales, while concluding that the surface motive subscale is the weakest.

As regards the construct validity of the SPQ, Biggs (1987) reports highly consistent correlations between self-rated performance and the approaches to learning scales. Surface approach correlates negatively (around -0.15) and deep and achieving positively (around +0.20 and +0.30 respectively). Watkins and Hattie (1980) report surface approach correlations with first year Science results of -0.40 and deep and achieving approach correlations with Arts and Economics performance in first year of +0.30.

The SPQ was administered to 385 first year students at the Peninsula Technikon in the following disciplines: Information Technology (N = 60), Engineering (N = 68), Business (N = 83), Science (N = 74) and Art and Design (N = 38) at a stage when the students were at the technikon for between 2–4 months. Principal components analysis with varimax rotation was applied to the data to try and replicate the three factor results of Biggs. The statistical programme was instructed to extract three factors.

The three-factor solutions yielded very similar results to that obtained by Biggs. The pattern matrix for the solution appears in Table 6.3.

Table 6.3

Three-factor Principal Components Analysis (Varimax Rotation) SPQ

Item	FACTOR PATTERN/STRUCTURE COEFFICIENT		
	F1 Deep (D)	F2 Surface (S)	F3 Achieving (A)
S 1		32	
S 4		59	
S 7		29	35
S 10		45	
S 13			
S 16		33	
S 19		43	
S 22		49	
S 25		53	
S 28		28	34
S 31		53	
S 34		42	
S 37			57
S 40		43	
D 2	36		
D 5	44		
D 8			35
D 11	33		
D 14			33
D 17	41		
D 20	52		
D 23	56		
D 26	32		50
D 29	59		
D 32			30
D 35	69		
D 38	39		
D 41	49		36
A 3			54
A 6			
A 9			52
A 12			
A 15			57
A 18			
A 21			50
A 24	66		
A 27			34
A 30	56		
A 33	42		31
A 36	63		
A 39		35	
A 42	33		33

Note: Zeros and decimal points are omitted. Loadings over 0.30 are shown.

Inspection of the three-factor solution indicated that items loading highly on a factor came from the original subscales. This was more so for the surface and deep approach than the achieving approach. Although the achieving scale showed reasonable results with six items loading on a factor, there were also items that were shared with both surface and deep. The results showed that some of the achieving items shared a common factor with the deep items, which confirms the findings of Biggs that a deep-achieving composite is present in the SPQ.

Generally the analysis supports the structure of the SPQ scales as reported by Biggs (1987) with a particular clear distinction between the surface and deep approaches.

A Principal components analysis was done to establish whether the three scales, achieving, deep and surface, each divides into the two subscales: strategies and motives. Each of the scales were analysed separately and the statistical programme was instructed to extract two factors for each scale.

Table 6.4  
Two-factor Principal Components Analysis (Varimax Rotation)  
of Achieving Approach to Learning

Item	FACTOR PATTERN/STRUCTURE COEFFICIENT	
	F1 Strategies (S)	F2 Motives (M)
M 3		583
M 9	314	555
M 15		624
M 21		466
M 27		522
M 33		562
M 39		551
S 6	647	
S 12	570	304
S 18	668	
S 24	702	
S 30	509	
S 36	676	
S 42	511	

Note: Zeros and decimal points are omitted. Loadings over 0.30 are shown.

Table 6.5

Two-factor Principal Components Analysis (Varimax Rotation)  
of Deep Approach to Learning

Item	FACTOR PATTERN/STRUCTURE COEFFICIENT	
	F1 Strategies (S)	F2 Motives (M)
M 2		481
M 8		543
M 14		544
M 20	467	
M 26		674
M 32		386
M 38	453	
S 5	530	
S 11		392
S 17	303	495
S 23	426	458
S 29	672	
S 35	811	
S 41		614

Note: Zeros and decimal points are omitted. Loadings over 0.30 are shown.

Table 6.6

Two-factor Principal Components Analysis (Varimax Rotation)  
of Surface Approach to Learning

Item	FACTOR PATTERN/STRUCTURE COEFFICIENT	
	F1 Strategies (S)	F2 Motives (M)
M 1		372
M 7		375
M 13		719
M 19	419	
M 25	623	
M 31	440	
M 37		729
S 4	632	
S 10	421	
S 16		307
S 22	648	
S 28		493
S 34	345	346
S 40	350	

Note: Zeros and decimal points are omitted. Loadings over 0.30 are shown.

As can be seen from Tables 6.4, 6.5 and 6.6, with the achieving scale the items loading on each factor completely support the division between the strategies and motives subscales. The results from the deep scale were satisfactory, with 10 of the 14 items loading correctly. The surface scale showed reasonable results with 9 of the 14 items loading correctly.

## **2.4 CONCLUSION**

The results of the reliability and validity studies done with the SPQ using a sample of South African technikon students indicate that the instrument is suitable for use in this study. The internal consistency is adequately high with alpha coefficients ranging from 0.70 to 0.78 for the three scales: surface, deep and achieving. This compares well with the reports of Biggs (1987) where Australian and British samples were used.

Validity studies done with the sample of students in this study indicate that the three factor structure of the SPQ is replicated reasonably well. Especially the deep and surface scales showed distinct structures. Some of the achieving items tended to load on the factor representing the deep scale. The distinction between the strategies and motives subscale were also replicated reasonably well. Especially the achieving scale showed a clear distinction between the strategies and motives subscales.

The three scales, a surface, deep and achieving approach to learning will mainly be used in the study, rather than using the subscales strategies and motives of each scale.

## **3. MOTIVATED STRATEGIES FOR LEARNING QUESTIONNAIRE (MSLQ)**

### **3.1 DESCRIPTION**

The Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia & McKeachie, 1991) is a self-report instrument with a seven point Likert scale designed at the University of Michigan to assess students' motivational orientations and their use of different learning strategies. The self-report instrument was originally developed using a theoretical framework of a general cognitive model of learning and information processing (Pintrich, Smith, Garcia & McKeachie, 1993). The original self-report instrument varied from 50 to 140 items and was used with over 1 000 University of Michigan undergraduates. The instruments were subjected to the usual statistical and psychometric analysis, including internal reliability coefficient computation factor analysis, as well as correlations with academic performance and aptitude measures (e.g. SAT scores). The items were continuously being revised on the basis of these results.

Further development was done with students at a university in the Midwest (N = 326), a small college (N = 687) and a community college (N = 758). After the usual statistical and psychometric analysis, some items were rewritten and the conceptual model underlying the instrument was refined (Pintrich et al., 1993).

There are two sections to the MSLQ, a motivation section, and a learning strategies section. The motivation section consists of 31 items that assess students' goals and value beliefs for a course, their beliefs about their skill to succeed in a course, and their anxiety about tests in a course. The learning strategy section includes 31 items regarding students' use of different cognitive and metacognitive strategies. The learning strategies section also includes 19 items concerning student management of different resources. A process-orientated approach to learning strategies was followed.

The scales and subscales of the MSLQ are shown in the following diagram:

Motivation	• Value Component	- Intrinsic Goal Orientation - Extrinsic Goal Orientation - Task Value
	• Expectancy Component	- Control of Learning Beliefs* - Self-efficacy for Learning
	• Affective Component	- Test Anxiety
Learning Strategies	• Cognitive and Metacognitive Strategies	- Rehearsal - Elaboration - Organisation - Critical Thinking - Self-regulation - Metacognitive
	• Resource Management Strategies	- Time and Study Environment - Effort Regulation - Peer Learning - Help Seeking

\* An earlier version of the MSLQ used in this study included an internal and an external control of learning beliefs. The latter subscale was excluded in a later version.

The first three scales refer to a students' motivation for the course. The value component subscale is a measure of how interested a student is in the material being covered in a course. The expectancy component is an indication of the students' perceptions of their potential success in the course and of their self-confidence for understanding the course content. The test anxiety subscale measures how much students worry about tests and how often they have distracting thoughts when they take examinations.

The remaining scales refer to different kinds of study skills and learning strategies used by students. The cognitive and metacognitive subscales include strategies such as rehearsal (how often students use study strategies), elaboration (summarising and relating material to what has already been learned), organisation (selecting ideas and organising material), critical thinking (making critical evaluations of material), meta-cognition (thinking about what they are studying and monitoring their understanding of the material).

The resource management subscale refers to time and study space (managing time and use of study space), self-effort (willingness to try hard and exert effort), peer learning (using peers as a resource), help seeking (how active the student is in seeking help from others).

The wording of the items was adapted to fit the South African context. Copies of both the original and revised text can be seen in Appendices C and D respectively. Items in which a high score reflects a negative dimension were reverse scored before statistical procedures were performed. An example of this is the test anxiety subscale.

### **3.2 RELIABILITY**

The reliability of a measuring instrument can be established by looking at the internal consistency of scores obtained which is measured by the alpha coefficient. This gives an indication to what extent the items in the scale show that they are measuring the same thing.

Table 6.7 provides a summary of the reliability data for the MSLQ scales and subscales. The data was obtained from a study done by the authors of the questionnaire and an investigation done with a sample of students in this study.

Table 6.7  
Reliability Data for MSLQ Scale Scores

	(a)	(b)
<b>MOTIVATION</b>		
• Value Component	0.81*	0.79
– Intrinsic Goal Orientation	0.74	0.54
– Extrinsic Goal Orientation	0.62	0.43
– Task Value	0.90	0.80
• Expectancy Component	0.80*	0.70
– Internal Control of Learning Beliefs	0.74*	0.42
– External Control of Learning Beliefs	0.68	0.34
– Self-efficacy for Learning	0.93	0.85
• Affective Component	0.80*	0.65
– Test Anxiety	0.80	0.65
<b>LEARNING STRATEGIES</b>		
• Cognitive and Metacognitive	0.74*	0.89
– Rehearsal	0.69	0.56
– Elaboration	0.75	0.78
– Organisation	0.64	0.65
– Critical Thinking	0.80	0.67
– Metacognitive Self-regulation	0.79	0.68
• Resource Management	0.68*	0.71
– Time and Study Environment	0.76	0.56
– Effort Regulation	0.69	0.32
– Peer Learning	0.76	0.60
– Help Seeking	0.52	0.48

\*These figures were not given in the original study and were calculated as means of the subscales' reliability scores.

(a) Pintrich, Smith, Garcia and McKeachie (1993) (N=380)

(b) Sample used in this study (N=388)

The sample used by Pintrich and others (1993) was 380 Midwestern college students. Most of the students (N = 356) attended a public university while the remaining students (N = 24) attended a community college. Five disciplines (natural science, humanities, social science, computer science and languages) were covered. The results indicated that overall the coefficient alphas for the motivational and learning scales are robust, demonstrating good internal consistency.

The Peninsula Technikon sample consisted of 388 first year students from Engineering, Business, Information Technology (Computer Studies), Science and Art and Design. It can be seen from Table 6.7 that the reliability scores of this sample compare reasonably well with the scores obtained by Pintrich and others (1993). Although five of the subscales obtained a reliability score of lower than 0.5, the main scales all showed scores of 0.70 and above. The latter scales will be used in the interpretation of results in this study.

### 3.3 VALIDITY

The development of the MSLQ was based on both theoretical and empirical analyses. Initially a self-report questionnaire with 50 to 140 items was used with students. Scales were constructed and revised on the basis of statistical and psychometric analysis, including internal reliability coefficient computation, factor analysis and correlations with academic performance and aptitude measures. After collecting data with previous versions of the MSLQ, items were rewritten and the conceptual model underlying the instrument refined.

The authors tested the construct validity of the MSLQ scales by running two confirmatory analyses: one for the set of motivation items and another for the set of cognitive and metacognitive strategy items. Lisrel VI was used to estimate parameters and test the models. Parameter estimates for the model specified were generated using maximum likelihood and tests for goodness-of-fit were made. Overall, the models showed sound structures and indicate reasonable construct validity for the MSLQ scales (Pintrich et al., 1993).

The MSLQ was administered to 388 first year students at the Peninsula Technikon. The following disciplines were accommodated: Information Technology (N = 60), Engineering (N = 68), Science (N = 74), Business (N = 83) and Art and Design (N = 38). The students completed the questionnaire when they were between 2 to 4 months into their respective courses. Principal components analysis with varimax rotation was used in all the analyses to replicate the factorial structure of the MSLQ. The first analysis was done on the 85 items of the MSLQ. The statistical programme was instructed to extract 3 factors to replicate the motivation, cognitive and metacognitive strategies and management of resources scales. The results of the analysis is shown in Table 6.8.

Table 6.8

Three-factor Principal Components Analysis (Varimax Rotation) of the MSLQ

Item	FACTOR PATTERN/STRUCTURE COEFFICIENT		
	F1 Motivation (M)	F2 Cognition (C)	F3 Resources (R)
M 25	670		
M 24	657		
M 29	655		
M 20	649		
M 11	646		
M 12	629		
M 23	624		
M 19	611		
M 35	585		
M 32	566		
M 18	564		
M 5	536		
M 6	527		
M 28	534		
M 22	500	326	
M 13	492		
M 7	456		
M 17	440		
M 14	433		
M 2	310		
M 8	347		
M 1	372	396	
M 26		306	
M 9			597
M 3			503
M 16			559
M 21			397
M 31			386
M 34			318
C 85		648	
C 36		558	
C 40		635	
C 68		572	
C 71		595	
C 55		550	
C 76		542	
C 53		538	
C 73	346	526	
C 82		516	
C 83		514	
C 51		508	
C 75		504	
C 59	345	459	
C 63		429	
C 67		453	
C 70		452	
C 66		433	
C 57		416	
C 80	352	383	
C 65		391	
C 60	363	380	
C 58		308	

Table 6.8 (continued)

Item	FACTOR PATTERN/STRUCTURE COEFFICIENT		
	F1 Motivation (M)	F2 Cognition (C)	F3 Resources (R)
C 42	350	388	
C 46		320	
C 45		356	
C 48		364	
C 37			472
C 43			331
C 61			487
C 41			532
R 84	393		446
R 64	345		421
R 81			393
R 56			314
R 44			364
R 54		535	
R 47		514	
R 62		477	
R 72		407	
R 74		522	
R 38		361	
R 77			
R 78			

Note: Zeros and decimal points are omitted. Loadings over 0.30 are shown.

From Table 6.8 it can be seen that for the motivation scale a clear structure emerges and that most of the motivation items loaded on a common factor. The cognition scale also shows indications of a clear structure with the majority of cognition items loading on a common factor. The structure of the resource scale is less clear with 6 items loading on one factor, but 6 factors also loading on another factor. The resource scale thus seems to share items with the cognition scale.

Further factor analysis focused on each of the scales, motivation, cognition and resources separately. A Principal components analysis was done on the motivation scale to try and replicate the three factors reported by the authors of the MSLQ. The statistical programme was instructed to extract three factors. The results of the analysis is shown in Table 6.9.

Table 6.9

Three-factor Principal Components Analysis (Varimax Rotation)  
of the Motivation Scale

Item	FACTOR PATTERN/STRUCTURE COEFFICIENT		
	F1 Value (V)	F2 Expectancy (E)	F3 Affect (A)
V 24	713		
V 25	670		
V 29	681		
V 11	693		
V 12	580	308	
V 19	465	528	
V 18	433	428	
V 5	449	311	
V 8	412		
V 28	415	442	
V 1		465	
V 14		326	
V 34			447
E 22		726	
E 23		683	
E 6		687	
E 32		658	
E 7		622	
E 13		608	
E 17		638	
E 35	363	486	
E 20	704		
E 4			414
E 30			302
E 33			468
A 3			479
A 21			544
A 9			605
A 16			649
A 31			452

Note: Zeros and decimal points are omitted. Coefficients over 0.30 are shown.

Table 6.9 shows that the affect subscale possesses a clear structure with all the affect items loading on a common factor. With the expectancy and value subscales the majority of the items loaded on factors that could be named value and expectancy. Overall the results indicate that the motivation scale can be divided into the three subscales: value, expectancy and affect.

A Principal components analysis was performed on the motivation scale to try and replicate the seven factors as found in the study done by Pintrich and others (1991). The statistical programme was instructed to extract seven factors. The results are shown in Table 6.10.

Table 6.10

Seven-Factor Principal Components Analysis (Varimax Rotation) of Motivation Scale

Item	FACTOR PATTERN/STRUCTURE COEFFICIENT						
	Intrinsic Goal Orientation (IO) F1	Extrinsic Goal Orientation (EO) F2	Task Value (V) F3	Internal Control of Learning Beliefs (IB) F4	External Control of Learning Beliefs (EB) F5	Self-efficacy for Learning (SE) F6	Test Anxiety (A) F7
IO 26	642						
IO 1	453					415	
IO 18			382			423	
IO 24			722				
EO 14		360	330			315	
EO 8			548				
EO 12			633				
V 29			699				
V 11			674				
V 25			666				
V 19		498	437			387	
V 5		497	396				
V 28	606		327				
IB 27				613			
IB 10				663			
IB 2			332				
IB 20			680				
EB 33					597		
EB 4					560		
EB 15					455		
EB 30				473	423		
SE 22						726	
SE 17		331				672	
SE 6						649	
SE 32						664	
SE 23		367				644	
SE 7						640	
SE 13						615	
SE 35			378			520	
A 21							697
A 31							650
A 16					302		582
A 9							579
A 3							534

Note: Zeros and decimal points are omitted. Loadings over 0.30 are shown.

Generally the seven subscales showed clear structures. All five of the test anxiety items loaded on one factor, all eight of the self-efficacy for learning loaded on a common factor, all six of the task value items loaded on one factor and all four of the external control of learning beliefs loaded on one factor. Of the other scales two of the four intrinsic goal orientation items loaded on a factor and two of the four internal control of learning beliefs

loaded on a factor. Only one of the four items of extrinsic goal orientation loaded on a factor.

A Principal components analysis was done on the cognitive strategies and resource management scales to replicate the nine factors found in these scales. The statistical programme was instructed to extract nine factors. The results of the analysis is shown in Table 6.11.

Table 6.11

Nine-factor Principal Components Analysis (Varimax Rotation)  
of the Cognition and Resource Management Scales

Item	STRUCTURE PATTERN / STRUCTURE COEFFICIENT								
	Rehearsal (R) F1	Elaboration (E) F2	Organisation (O) F3	Critical Thinking (C) F4	Meta Cognition (M) F5	Time and Study (T) F6	Effort Regulation (F) F7	Peer Learning (P) F8	Help Seeking (H) F9
R43	664								
R50	625								
R63	389								
R76	300			403					
E57		616							
E85		424		493					
E71		427	472						
E73		406		421					
E68		367	316	547					
E66				621					
O67			642						
O36			620						
O46			459		380				
O53			426					367	
C75		303		708				335	
C70				732					
C42				449				425	
C55			475	398				346	
C51				375					
M45					503				
M65				330	482				
M48					342				
M60			437		328				
M58		576							
M80	311	458							
M40		403	351					507	
M83		388					307		

Table 6.11 (continued)

Item	STRUCTURE PATTERN / STRUCTURE COEFFICIENT								
	Rehearsal (R) F1	Elaboration (E) F2	Organisation (O) F3	Critical Thinking (C) F4	Meta Cognition (M) F5	Time and Study (T) F6	Effort Regulation (F) F7	Peer Learning (P) F8	Help Seeking (H) F9
M82		360				425			
M61							514		
M37							669		
M59			352					332	
T56						588			
T69		303				452			
T47		393				401	370		
T74		424		323		309			
T84						379	397		
T81						307	514		
T77							379		
T39					605				
F41							651		
F64							637		
F78	423								
F52						390			
P38								642	
P54								589	
P49									302
H72									615
H44									685
H79									584
H62		376			362				505
								302	

Note: Zeros and decimal points are omitted. Loadings over 0.30 are shown.

An inspection of Table 6.11 shows mixed results as to the factorial purity of the different subscales. The following subscales show clear structural patterns: rehearsal, organisation, critical thinking, peer learning and help seeking. With these subscales all or the majority of the subscale items loaded on a common factor. The subscales that showed reasonably clear structural patterns were elaboration (four of the five items loaded on one factor, but items were shared with the critical thinking factor), time and study management (six of the eight items loaded on a common factor, but items also loaded on the effort regulation and elaboration factors) and effort regulation (two of the four items loaded strongly on a common factor).

The only subscale that showed a less clear structural pattern was metacognitive strategies. Four of the items of that subscale loaded on a common factor, but items also loaded strongly on the elaboration and effort regulation subscales. The metacognitive strategies subscale seems to incorporate elements of elaboration and effort regulation in this study.

It was possible to replicate the subscales of the MSLQ as found by Pintrich and others (1993), except for metacognitive strategies which did not show a clear structural pattern.

### **3.4 CONCLUSION**

Overall the results of the reliability and validity studies conducted with the MSLQ indicate that the MSLQ can be used in this study with a reasonable degree of confidence. Although the internal consistency of the scales and subscales as indicated by the alpha coefficients range from 0.32 to 0.80 the scales to be used in this study compare well with the findings of Pintrich and others (1993). The alpha coefficients of those scales that will be used in the present study seem to be adequately high.

The validity studies done with the present sample of students showed mixed results. There is sufficient evidence to indicate that the motivation scale has a clear structure indicating three subscales (value, expectancy and affect). Especially the affect subscale showed a clear structure with all the items loading on one factor. For the purpose of this study it was not necessary to look at the subdivisions of the subscales because motivation as a composite score as well as the value, expectancy and affect subscales are used in the interpretation of results. A further analysis of the motivation scale into seven factors shows that four of the factors show structural purity (test anxiety, self-efficacy for learning, task value and external control of learning beliefs), while for two factors (intrinsic goal orientation and internal control of learning beliefs) two of the four items loaded on common factors. Extrinsic goal orientation showed signs of structural impurity with two of the four items loading on the task value factor.

Looking at the cognitive strategies and resource management scales, most of the subscales show reasonably clear structural patterns. The exception is the metacognitive strategies subscale which seem to share items with elaboration and effort regulation. For most of the interpretations done in this study the composite scores of the cognitive

strategies and resource management scales will be used. In the cases where the subscales are used, the interpretation of findings would be done with due consideration of the findings of the validity studies done with the present sample of students.

## **4. CONCEPTUAL REASONING TEST (CRT)**

### **4.1 DESCRIPTION**

The Conceptual Reasoning Test (CRT) (Boeyens, 1990) is a non-verbal test of inductive reasoning ability. Inductive reasoning involves logically deriving general rules from specific examples. Induction problems assess an individual's basic reasoning abilities, the ability to form concepts and the ability to impose structure. Factor analytical studies have shown that tests of inductive reasoning load highly upon a general intelligence or reasoning factor (Pellegrino & Glaser, 1981).

The items in the CRT are non-verbal, which means that testees with low verbal skills are not unnecessarily penalised for having limited vocabularies in the test language. To enable a more equitable assessment of individuals from a disadvantaged background a lesson was included into the first section of the CRT. In this lesson four distinct types of problems are clearly defined. All the items in CRT are representative of one of these types of problems. The four types of problems are explained to the testees making use of examples and a summary of each type of problem. In each of the first eight items in the test hints on the type of problem are provided to the testee. The lesson ensures that the problem solving strategies previously acquired by the testees will be a less important determinant of test performance than would otherwise be the case. The inclusion of a lesson and hints into the test makes the CRT an example of a dynamic assessment procedure.

The four types of problems all occur in 7x7 matrices and superficially resemble each other. Six alternatives appear at the bottom of each item and the testee chooses the correct answer from these alternatives. The test consists of 35 items and the answers are indicated on a separate answersheet. The testee is given thirty five minutes to complete the test.

A short description of each problem type is given in the next sections.

#### **4.1.1 Series Problems**

Series problems provide good indices of general reasoning ability and are frequently included in IQ tests and other cognitive ability tests. Solving of the series problems involves detecting the logical order amongst the elements of the series and extrapolating the next or missing elements in the sequence.

#### **4.1.2 Two-way Classification Problems**

Some features of classification tasks were combined with some features of series problems to create two-way classification problems. Classification tasks are also frequently used to assess inductive reasoning (Sternberg & Gardner, 1983). In this type of problem it is necessary to determine which characteristics are shared by elements in the rows of the matrices and which are shared by the elements in the column.

#### **4.1.3 Transformation Problems**

Transformation problems are representative of analogical reasoning problems which are widely used in intelligence tests (Pellegrino & Glaser, 1981). The testee has to grasp the rules or principles underlying the transformation in order to solve the problem. The transformation problems in the CRT require the testee to infer the rules by which one group of elements is transferred into another. In order to solve the problem the elements of one group must be matched with the elements of the other group and the rules which guide the transformations inferred.

#### **4.1.4 Operations Problems**

The operations problems are logical extensions of the transformation problems. The transformation of one set of elements into another is guided by so-called operators. The operators in operations problems are analogous to operators in mathematics. The operations problems involve reasoning on Piaget's formal operations level and are more complex than the other three types of problems. Solving of an operations problem

involves the transformational rules dictated by the relevant operators and determining how that influences the transformation of the specific element.

The lesson used in the CRT together with examples of test items are shown in Appendix E.

#### 4.2 RELIABILITY

A common measure of reliability is internal consistency, measured by the alpha coefficient. Table 6.12 shows the reliability index obtained for a number of different samples which includes the sample in this study.

Table 6.12  
Reliability Data for CRT

	Alpha	N
(a)	0.82	98
(b)	0.82	104
(c)	0.62	136
(d)	0.77	130
(e)	0.78	385

- (a) White Male matriculation group (Boeyens, 1990)
- (b) White Vocational guidance sample (Boeyens, 1990)
- (c) Black Promat College group (Boeyens, 1990)
- (d) Black Sultan College sample (Boeyens, 1990)
- (e) Present sample

The reliability index obtained in the present study compares favourably with the indices obtained with other samples.

#### 4.3 VALIDITY

Various studies were done to determine the predictive validity of the CRT (Boeyens, 1990).

### 4.3.1 White Male Matriculation Group

This group was tested with the CRT, the High Level Mental Alertness (MA), High Level Arithmetical Reasoning (AR), High Level Reading Comprehension (RCT), High Level Vocabulary (VOC) and the Progressive Matrices (A15) (an adaptation of Raven's progressive matrices). End of the year standard nine results were available for these students. Table 6.13 is an intercorrelation matrix of all the tests and the standard nine results.

Table 6.13

Intercorrelation Matrix of All the Test Scores and End of Year Standard Nine Results

	MA	AR	RCT	VOC	A15	CRT	Eng	Maths	Science	Average
MA		0.64**	0.43**	0.49**	0.52**	0.68**	0.55**	0.61**	0.61**	0.67**
AR			0.35**	0.45**	0.42**	0.45**	0.42**	0.59**	0.57**	0.60**
RCT				0.56**	0.21*	0.30**	0.63**	0.46**	0.52**	0.59**
VOC					0.21*	0.35**	0.64**	0.50**	0.55**	0.63**
A15						0.54**	0.29**	0.26*	0.34**	0.38**
CRT							0.36**	0.49**	0.55**	0.54**

\*p<0.05

\*\*p<0.01

It can be seen from Table 6.13 that the predictive validity of the CRT compares favourably with that of the other tests.

### 4.3.2 Black Promat College Students

The CRT and the Academic Aptitude Test (AAT) battery were administered to 74 Black matriculation students. The tests included in the AAT battery are: Non-verbal reasoning (NV), Verbal reasoning (VR), English reading comprehension (RCT), Afrikaanse leesbegrip (LB) and Number comprehension (NC). The intercorrelations between the above tests are presented in Table 6.14.

Table 6.14

Intercorrelation between Test Scores

	NV	VR	RCT	LB	NC	CRT
NV		0.52**	0.32**	0.33**	0.37**	0.57**
VR			0.41**	0.39**	0.34**	0.57**
RCT				0.42**	0.12	0.24*
LB					0.14	0.32**
NC						0.47**

\*p<0.05

\*\*p<0.01

It can be seen from Table 6.14 that the CRT correlated more highly with the other tests of reasoning (non-verbal reasoning, verbal reasoning and number comprehension tests) than they correlated with each other. The CRT gave a good overall measure of reasoning ability (Boeyens, 1990).

4.3.3 Peninsula Technikon Students (Present Sample)

The CRT, the High Level Reading Comprehension Test (RCT) and the High Level Mental Alertness (MA) were administered to 33 Business Management students at the Peninsula Technikon. Table 6.15 shows the intercorrelation matrix of these tests and the academic performance (year mark, examination mark, final mark and credits obtained).

Table 6.15

Intercorrelation Matrix of the Tests and Academic Performance

	MA	RCT	CRT	Year	Exam	Final	Credits
MA		0.39*	0.68*	0.37*	0.28	0.29	0.34
RCT			0.28	0.27	0.09	0.12	0.19
CRT				0.37*	0.30	0.32	0.35*

p<0.05

The results with the Peninsula Technikon students compare favourably with that obtained by Boeyens (1990) and the predictive validity of the CRT is marginally better than that obtained by the High Level Mental Alertness.

#### 4.3.4 Wits Psychology Students

The CRT was administered to 133 first year students who registered for Psychology 1 at the University of the Witwatersrand (Nunns & Ortlepp, 1994). The sample was divided into a non-disadvantaged (white students) and disadvantaged (black students) group. The CRT yielded a significant correlation with the Psychology 1 mark for both the non-disadvantaged group ( $N = 107$ ,  $r = 0.44$ ,  $p < 0.0001$ ) and the disadvantaged students ( $N = 26$ ,  $r = 0.48$ ,  $p < 0.01$ ).

Nunns and Ortlepp (1994) found the CRT to be the best predictor of Psychology 1 results for educationally disadvantaged students ( $r = 0.48$ ,  $p < 0.01$ ,  $N = 26$ ). The other tests used were the Mental Alertness and Reading Comprehension of the Intermediate Battery.

#### 4.4 CONCLUSION

The results of the reliability studies done with the CRT in South Africa show that it has adequately high reliability. The internal consistency as measured by the alpha coefficient obtained by the sample in this study compare well with those obtained by Boeyens (1990).

The validity studies show that the CRT has adequate predictive validity. The results obtained with the sample in this study compared well with that obtained by Boeyens (1990) and Nunns and Ortlepp (1994).

Overall the studies show that the CRT has adequate reliability and predictive validity for it to be used in this study.

## 5. LEARNING POTENTIAL TEST (LPT)

### 5.1 DESCRIPTION

The LPT was developed as a way of operationalising the concept of learning potential. Learning potential is also known as modifiability. Learning potential measures usually have three sections:

- (1) an initial assessment of performance in the content area
- (2) an intervention or lesson of some kind which is intended to teach the core concepts or principles required for success
- (3) a second assessment of competence in the content area.

The most common practice is to use a novel reasoning task as the content domain and to avoid areas which may be more familiar to some subjects than to others. This tries to eliminate differences in past education or other life experiences (Hamers & Sijtsma, 1993).

In the development of the LPT Boeyens (1989a) opted to use a letter series for the items in the pre-test and the post-test. It was possible to determine the difficulty level of these series and to generate equivalent series for the pre- and post-test. This made it possible to have precisely matched items for the pre- and post-test.

Each test contains 30 series of letters and the testee is required to supply the next three letters in each series. A time limit of thirty minutes was allowed on both the pre-test and the post-test. A lesson is given to the testees before the second test is attempted. During the lesson rules and methods for solving the series problems are discussed and the testees have the opportunity to attempt some examples. The difference score between Test 1 and Test 2 is seen as the learning potential score.

The mediated lesson of the LPT is shown in Appendix F which provides examples of the items in the test.

## 5.2 RELIABILITY

The scalability of the items of the LPT was investigated empirically by Boeyens (1989b), using the 202 students enrolled at Promat Colleges. The coefficients of reproducibility and of scale reliability and the probability of misclassification for the pre- and the post-tests are presented in Table 6.16.

Table 6.16

Results of the Guttman Procedure Program of SAS performed on the Pre- and the Posttests: Promat Sample

<u>Pre-test</u>	
Coefficient of reproducibility	0.969
Probability of misclassification	0.021
Scale reliability	0.976
<u>Post-test</u>	
Coefficient of reproducibility	0.966
Probability of misclassification	0.023
Scale reliability	0.981

Boeyens (1989b) concluded that the results suggested the tests are highly scalable and the theoretical difficulty values of the items were confirmed.

Kuder Richardson (formula 20) reliability coefficients on both the pre-test and the post-test responses of the 202 Promat students were calculated by Boeyens (1989b). The test scores were out of 90 (30 problems with three items in each). The alpha coefficients were calculated for the 206 Peninsula Technikon students on their pre- and post-test results. In this case the score was out of 30 (an item was scored correctly if a student had all three sections correct). The reliability indices are shown in Table 6.17.

Table 6.17

Reliability Data for the Learning Potential Measures

	ALPHA		N
	Pre-test	Post-test	
Promat	0.96	0.97	202
Peninsula Technikon	0.85	0.84	206

The Promat sample shows a high reliability score. The Peninsula Technikon sample's reliability scores compare favourably with the Promat sample and confirm that both the pre-test and the post-test of the LPT are acceptably reliable.

Table 6.18 shows the means and standard deviations of the pre- and post-test and difference scores of the Promat and Peninsula Technikon samples.

Table 6.18

Means and Standard Deviations of the Pre- and Posttests and Difference Scores of the Promat and Peninsula Technikon Samples

	PROMAT		PENINSULA TECHNIKON	
	Mean	Std Dev.	Mean	Std Dev.
Pre-test score	30.59	15.55	16.75	4.64
Post-test score	41.00	18.53	20.16	4.22
Difference score	10.40	9.32	3.62	3.10

The errors of measurement and the reliability of the difference score were calculated as follows:

Standard error of measurement:  $S = \delta\sqrt{1-r}$ , where  $\delta$  is the standard deviation of the test and  $r$  is the reliability of the test.

After the standard error of measurement for each test has been calculated the reliability of the difference score is calculated as follows (Boeyens, 1989b):

$$r_{dd} = \frac{1 - Se1^2 + Se2^2}{\delta_{dd}^2}$$

Where  $r_{dd}$  is the reliability of the difference score

$Se1$  is the standard error of measurement of the pre-test

$Se2$  is the standard error of measurement of the post-test

$\delta_{dd}^2$  is the standard deviation of the difference score

The reliability of the difference score for the Promat sample was 0.76, while for the Peninsula Technikon sample it was 0.40. The adequately high reliability of the difference score for the Promat sample could not be repeated with the Peninsula Technikon sample. The reason for this could be that for the Promat sample the scores of the pre- and post-tests were calculated out of 90 while for the Peninsula Technikon sample the scores were calculated out of 30. If 60 items had been added then the reliability of LPT1 and LPT2 would have increased to 0.96 and 0.95 respectively.

In summary it can be said that the pre- and post-tests are acceptably reliable, but that the reliability of the difference score could not be replicated for the Peninsula Technikon sample.

### 5.3 VALIDITY

Boeyens (1989b) administered the LPT and the Mathematical Achievement Test (MAT) to 40 students of the Promat College at the beginning of the year. The MAT was repeated at the end of the year and an index of improvement in academic competence was calculated. The correlation between this index and the difference score of the LPT proved to be highly significant ( $r = 0.47, p < 0.01$ ). This is an indication of the predictive validity of the difference score of the LPT.

The LPT, the CRT, the High Level Reading Comprehension Test (RCT) and the Electrical Engineering Aptitude Test (EAT) were administered to 41 Electrical Engineering 1 students at the Peninsula Technikon. Table 6.19 shows the intercorrelation matrix of the above tests and the students' academic performance (year and final marks and credits obtained).

Table 6.19

Intercorrelational Matrix of Tests and Academic Performance  
of Electrical Engineering 1 Students

	LPT1	LPT2	CRT	RCT	EAT	Year	Final	Cred.
LPT1		0.78*	0.57*	0.16	0.32*	0.23	0.20	0.21
LPT2			0.43*	0.26	0.31*	0.19	0.17	0.30
CRT				0.14	0.37*	0.05	0.05	0.03
RCT					0.08	0.23	0.22	0.29
EAT						0.09	0.07	0.05

\* $p < 0.05$

From Table 6.19 it can be seen that the LPT1 and LPT2 have a moderate correlation with the CRT and the EAT. The predictive validity of the LPT1 and LPT2 also compares favourably with the other tests.

## **5.4 CONCLUSION**

The reliability and validity studies done with the LPT show that it can be used with a reasonable level of confidence. The internal consistency of both the LPT1 and LPT2 is high as measured by the alpha coefficients. The adequately high reliability of the difference score as obtained by Boeyens (1989b) could not be replicated with the sample in this study. The posttest score of the LPT (LPT2) will be used in this study.

Validity studies done with the LPT show that the predictive validity of the LPT1, LPT2 and difference score compares well with the predictive validity of other tests. The difference score seems to have good predictive validity when an index of improvement is used as criterion variable.

## **6. READING COMPREHENSION TEST (RCT)**

### **6.1 DESCRIPTION**

The Reading Comprehension Test (RCT) is one of the six tests in the High Level Battery. The RCT contains four short paragraphs, each followed by five questions based on its content. It assesses the ability to understand written English material. The testees are given 20 minutes to read the paragraphs and answer the questions. The test is suitable for matriculants and higher, and is aimed at English first language users (Lombard, 1975). The test was developed in South Africa by the National Institute for Personnel Research. It could be seen as a representation of a traditional static test as opposed to a dynamic test. The RCT is closely linked to an assessment of formal academic work.

Examples of test items in the RCT are shown in Appendix G.

### **6.2 RELIABILITY**

Reliability indices were calculated for various samples (Lombard, 1975), using Kuder Richardson's formula 21 with Tucker's correction. The results are indicated in Table 6.20 together with the Cronbach alphas obtained with the sample in this study.

Table 6.20

Reliability Data for the Reading Comprehension Test

Sample	Alpha
(a)	0.775
(b)	0.612
(c)	0.668
(d)	0.473
(e)	0.487

- (a) This sample consisted of white matriculants English first language speakers.
- (b) The sample consisted of first year Science students at an English speaking university.
- (c) The sample consisted of African matriculants.
- (d) This sample consisted of first year Indian university students.
- (e) The sample in the study.

An inspection of Table 6.20 indicates that although some of the samples provided adequate reliability, the sample of the first year Indian students and the sample in this study provided unsatisfactory reliability.

### 6.3 VALIDITY

The RCT assesses the ability to read and understand written English material. The written paragraphs are of a general nature and do not reflect a particular discipline's content.

Two validation studies were done with samples of students in this study.

#### 6.3.1 Business Management

The RCT, the MA and the CRT were administered to 33 Business Management students. Table 6.21 shows the intercorrelation matrix of these tests.

Table 6.21

Intercorrelation Matrix of the Tests: RCT, MA and CRT

	RCT	MA	CRT
RCT	1.00	0.39*	0.28
MA		1.00	0.68*
CRT			1.00

\*p<0.05

A significant correlation between the RCT and MA was found, but not between the RCT and CRT. The MA contains strong elements of written material and verbal reasoning whereas the CRT is primarily non-verbal in nature. This strengthens the case that the RCT is a measure of students' understanding of written material.

### 6.3.2 Electrical Engineering

The RCT, LPT, CRT and EAT was administered to 41 Electrical Engineering students at the technikon and their scores correlated with the students' year mark, final mark and credits obtained. The results are shown in Table 6.22.

Table 6.22  
Correlations between RCT, LPT, CRT, EAT and Academic Performance  
Of Electrical Engineering Students

	CRT	LPT1	LPT2	RCT	EAT
Year	0.05	0.23	0.19	0.23	0.09
Final	0.05	0.20	0.17	0.22	0.07
Credits	0.03	0.21	0.30	0.29	0.05

An inspection of Table 6.22 indicates that the RCT compares favourably to the other tests in predicting students' academic performance.

## 6.4 CONCLUSION

The reliability studies done with the RCT in a South African context shows mixed results. The alpha coefficients range from 0.78 to 0.47. The alpha coefficients calculated for this sample fitted into the lower regions of this range. A possible explanation of the relatively low reliability index is the fact that many of the students in the sample are English second language speakers. It is felt that the RCT can be used in this study with certain considerations in the interpretation of results.

## 7. MENTAL ALERTNESS TEST (MA)

### 7.1 DESCRIPTION

The Mental Alertness Test (MA) is one of six tests that make up the High Level Battery. The High Level Battery was developed by the Human Science Research Council (HSRC) and is suitable for persons with matric and higher qualifications (Lombard, 1975). The Mental Alertness Test is often used for selection purposes in the South African context (Boeyens, 1989b). It evaluates the ability to profit from formal academic work, and provides a measure of general intellectual functioning. In this regard it can be seen to represent the traditional, static view of assessment as opposed to dynamic assessment.

The test consists of 42 items which include numerical and letter series, verbal analogies, common elements and other problems requiring reasoning ability. The testees have 45 minutes to complete the test and mark their answers on a separate answersheet. Each item is a question followed by five possible answers, only one of which is correct. The test has a fairly high verbal content.

Examples of test items are provided in Appendix H.

### 7.2 RELIABILITY

Reliability indices were calculated for various samples making use of Kuder Richardson's formula 21 with Tucker's correction. The results are reflected in Table 6.23 (Lombard, 1975).

Table 6.23

Reliability Data for the Mental Alertness Test

	Alpha
(a)	0.833
(b)	0.771
(c)	0.856
(d)	0.738

- (a) White English first language speakers in matric
- (b) First year Science students at an English-speaking university
- (c) African students in matric
- (d) Indian first year university students

From Table 6.23 it can be seen that the MA has adequate high reliability for all the samples.

### 7.3 VALIDITY

The Mental Alertness Test (MA), the CRT and the RCT were administered to 33 Business Management students. Table 6.24 shows an intercorrelational matrix of the above-mentioned tests and the students academic results (year mark, exam mark, final mark and credits obtained).

Table 6.24  
Intercorrelation Matrix of the Tests and Academic Performance

	MA	RCT	CRT	Year	Exam	Final	Credits
MA		0.39*	0.68*	0.37*	0.28	0.29	0.34
RCT			0.28	0.27	0.09	0.12	0.19
CRT				0.27*	0.30	0.32	0.35*

\*p<0.05

The MA correlated significantly with the year mark, the CRT and the RCT. It can be seen from Table 6.24 that the predictive validity of the MA compared favourably with those of the other tests.

### 7.4 CONCLUSION

Reliability studies done with the MA in South Africa indicate that it has adequately high reliability indices. Unfortunately, it was not possible to calculate a reliability index for the sample in this study. Only the total scores of the MA were used and the answersheets were not available for calculating scores of each item. Validity studies show that the MA has adequate predictive validity.

## **8. ELECTRICAL ENGINEERING APTITUDE TEST (EAT)**

### **8.1 DESCRIPTION**

The Electrical Engineering Aptitude Test (EAT) was developed in the School of Electrical Engineering at the University of Sydney and was designed to measure high school students' aptitude for electrical and electronic engineering. Particular emphasis was placed on circuit theory. The test consists of 32 problems grouped in five sections in which different aspects of the thought process used during solution of the given electrical problems can be measured. The items are multiple choice and the testee selects one fragment from the six given options to complete the missing part of an electrical circuit. The first two sections of the test do not require a pre-existing knowledge of electrical engineering. The last two sections depend on a fundamental knowledge of high school physics (Pudlowski & Rados, 1987). Testees are given 60 minutes for the test.

Examples of some test items are shown in Appendix I.

### **8.2 RELIABILITY**

The EAT was administered to 218 first year students in Electrical Engineering at the University of New South Wales. The Kuder Richardson formula was used to calculate a reliability index of 0.62. The authors conclude that the test can be used to make reasonable judgements about individual student aptitude.

### **8.3 VALIDITY**

The EAT scores of 194 first year students at the University of New South Wales were correlated with their Electrical Engineering 1 end of year results. A correlation coefficient of 0.34 was obtained. When the results were divided into marks obtained for the written paper and the laboratory work a correlation coefficient of 0.61 was obtained between the EAT and the marks in laboratory work.

Another sample of 247 first year students who completed the EAT at the University of New South Wales obtained a correlation coefficient of 0.52 between the EAT score and

the examination results. The conclusion of the authors was that this was a reasonable indication of the predictive validity of the EAT.

#### **8.4 CONCLUSION**

Studies done with an Australian sample showed adequate reliability and predictive validity. Unfortunately it was not possible to do any predictive or validity studies with a South African sample. The total scores of the EAT were used and the answersheets were not available to calculate the scores for each item.

### **9. CONCLUSION**

Overall the reliability and validity studies done with the measuring instruments indicate that they can be used with a South African sample with a fair degree of confidence.

The reliability scores of the SPQ, CRT and MSLQ are adequately high and compare well with the findings of other studies done with these instruments. Adequately high indices were obtained for the reliability of the pretest and posttest of the LPT, but this could not be duplicated for the difference score of the LPT. This is partly compensated for by the fact that the posttest scores are used for prediction purposes, rather than the difference score. The RCT did not produce an adequately high reliability score and the results linked to the RCT have to be interpreted with due caution.

The factorial studies done with the SPQ and MSLQ generally indicate that the factorial structure of the questionnaires are sound. In the case of the MSLQ where some of the subscales show signs of factorial impurity the composite score of the scales are used in the interpretation of the results. Studies done with the CRT, LPT, RCT and MA seem to indicate adequate predictive validity and the indications are that they can be used in this study.

## Chapter 7

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# RESULTS OF PRELIMINARY STUDIES

## 1. INTRODUCTION

The purpose of the investigation is to identify those disadvantaged students who have the learning potential to benefit from tertiary education and be academically successful. The question that needs to be answered is whether this can be facilitated through the implementation of the zone of proximal development (ZPD) and dynamic assessment as opposed to the static assessment of students' cognitive ability. Those individuals who benefit from the mediated lesson can be described as more modifiable. Dynamic assessment may also provide information on students' learning and thinking and how current levels of functioning can be improved.

The statistical analysis of the studies was done by using the SPSS and Statistica for Windows packages.

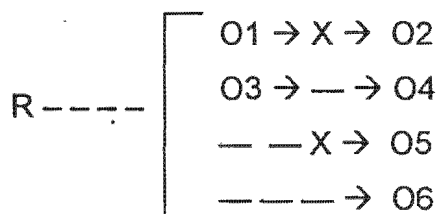
In the first study the effectiveness of the mediated lessons used in the two dynamic assessment instruments were assessed, while in the second study the correlation patterns of static tests as opposed to dynamic assessment are investigated. The third study focuses on finding predictors of academic performance.

## 2. EFFECTIVENESS OF THE MEDIATED LESSONS

The two dynamic assessment instruments used in the study both have a mediated lesson incorporated into the test. The Learning Potential Test (LPT) has a pretest (LPT1), a lesson and a posttest (LPT2), while the Conceptual Reasoning Test (CRT) has a lesson preceding the test. Both the LPT and CRT were described in detail in Chapter 6.

## 2.1 LEARNING POTENTIAL TEST (LPT)

The Solomons Four Group Design (Christensen, 1997; Leedy, 1989) was chosen as the most appropriate experimental design for testing the effectiveness of the mediated lesson in the LPT. The design can be depicted in the following way:



Two studies were done with the LPT.

### 2.1.1 Study 1

The LPT was designed as a way of integrating the mediated and psychometric approaches. The lesson forms part of the test and focuses on metacognitive input as well as developing specific problem-solving strategies. The researcher conducted the test and the standardised lesson with the group as a whole. The students were provided with the standardised lesson in printed form and were able to study it while the researcher was verbally interacting with them. Students were encouraged to ask questions during the lesson. The lesson included providing feedback on students' efforts in problem solving and highlighting the underlying principles involved (Appendix F).

The subjects were black students (classified as either African or Coloured according to the old Population Registration Act) who were in a six months bridging programme prior to entering a Technikon course. Most of the students had not completed their Matric (last year of secondary education) and they were in the course to upgrade their science and mathematics skills. The four groups used in the study were the four classes in the programme and consisted of the following:

- Group 1 ..... 19 students (Engineering)
- Group 2 ..... 13 students (Science)
- Group 3 ..... 16 students (Business)
- Group 4 ..... 14 students (Business and Building).

The experimental group was given Test 1 on the first day. They received the mediated lesson the following day and immediately afterwards completed Test 2. The Control group went through the same process except that they did not receive the lesson, but a placebo. The placebo was used to control the effect of contact with the researcher. It consisted of a short discussion providing general hints on problem solving (Appendix J). The other two groups received no pretesting but completed Test 2. The one group received the mediated lesson, while the other one received the problem solving hints.

The means and standard deviations of the test scores and difference scores were calculated for the four groups.

Table 7.1

Means and Standard Deviations of the Test Scores and Difference Scores

	Group		N	Mean	Std dev.
Lesson	1	Pretest	19	12.15	3.84
		Posttest		14.57	4.76
		Difference score		2.47	3.84
No lesson	2	Pretest	13	11.31	3.98
		Posttest		14.53	6.09
		Difference score		3.25	2.65
Lesson	3	Posttest	16	10.50	3.24
No lesson	4	Posttest	14	8.21	4.75

A one way Analysis of Variance was used to compare the two pretested groups (those that completed LPT1). The observed differences in the two groups were not statistically significant (F-ratio = 0.32,  $p > 0.05$ ,  $df = 1;30$ ).

As can be seen from Table 7.1 both groups 1 and 2 improved their scores from the pretest to the posttest. The mean scores of groups 1 and 3 who received the mediated lesson tended to be higher than the mean scores of groups 2 and 4 respectively, who did not receive the lesson. These differences were not statistically significant.

The most appropriate statistical analysis for evaluating the effect of the lesson on LPT2 scores is a two-way analysis of variance. This enables the researcher to test the following simultaneously:

- (1) The effect of the lesson, i.e. did those who were exposed to the lesson differ from those who were not exposed to the lesson.

- (2) The effect of pretesting or sensitisation effect. In other words did the mere fact that they were pretested increase performance on the posttest.
- (3) The interaction effect between the lesson and pretesting.

The results in Table 7.1 indicate that the mediated lesson had no effect ( $F = 0.88$ ,  $p > 0.05$ ,  $df = 2;58$ ). The group who received the lesson did not differ significantly from the group who did not receive the lesson in terms of LPT2 scores. There was no interaction between treatment and pretesting ( $F = 0.85$ ,  $p > 0.05$ ,  $df = 2;58$ ).

The means and standard deviations of the total group with a pretest and the total group without a pretest were calculated for the total sample.

Table 7.2  
Means of Groups with Pretest and without Pretest

Group	N	Mean	Std. dev.
Group with pretest	32	14.56	5.248
Group without pretest	30	9.43	4.116
Total group	62	12.08	5.36

An examination of the means of the groups who did not receive a lesson in Table 7.2 shows that the group who was pretested had a mean of 14.56 while the other group which received no pretest had a mean of 9.43. The pretest sensitised the one group so that they performed significantly better than the other group ( $F = 17.54$ ,  $p < 0.05$ ,  $df = 2;58$ ). The mere fact of being pretested affected the performance of the group that was pretested.

In the case of this particular study providing the problem solving hints to students had the effect of improving their scores on the posttest. This is seen as a possible explanation that no significant differences were found between the two posttest groups in the first Solomons Four Group study. The problem solving hints were of a general nature and could be seen as being more conducive to transfer than the specific problem solving lesson included in the mediation phase.

An inspection of the answersheets of the students in the experimental group indicated that some students attempted less items in the posttest than the pretest in the allocated time. A closer analysis of the problem solving methods utilised, showed these students were more methodical and cautious in their approach to the problems and tended to

rigidly apply the methods taught in the mediated lesson, even to the more simple problems at the beginning of the test. This confirms Boeyens' (1989b) finding in his use of the LPT with disadvantaged students. A difference of two or more number of attempts between the pretest and posttest, with the number of attempts in the posttest always being less, was used to distinguish the group of students who showed a rigid approach.

The means and standard deviations of the test scores and difference scores were calculated for the experimental group when the scores of students with a rigid approach were omitted. The results are shown in Table 7.3.

Table 7.3

Means and Standard Deviations of the Experimental Group  
when Students with a Rigid Approach were omitted

Group	N	Mean	Std. dev.
Pretest	14	12.21	4.14
Posttest		16.36	3.73
Difference		4.14	2.93

An inspection of Table 7.3 shows a significant difference ( $t = -2.78$ ,  $p = 0.001$ ,  $df = 26$ ) between the pretest and posttest scores when the students who rigidly applied the lesson were omitted.

The above finding has to be interpreted in the light of the lack of randomisation that took place to establish the four groups of the design. The first two groups who received a pretest were groups of Engineering and Science students, while the other two groups who did not receive a pretest were Business students. It can be assumed that the Engineering and Science students would have more well developed skills in the area of problem solving than the Business students and this could have had an influence on their scores. The fact that the control groups received general hints on problem solving might also have influenced their subsequent performance on the test.

### 2.1.2 Study 2

The same experimental design (the Solomons Four Group Design) as the previous study was used with another sample of students.

The subjects were black (African and Coloured) students in their first year of the Education in Commerce course. The students were all in the same class and randomly assigned to the four groups using an alphabetical class list. The first person on the list was allocated to group 1, the second person on the list to group 2 and so on. The number of students in each group were the following:

- Group 1 ..... 15 students
- Group 2 ..... 16 students
- Group 3 ..... 17 students
- Group 4 ..... 15 students

The experimental group was given LPT1 on the first day. The next day they were given the mediated lesson and immediately afterwards given LPT2. The control group went through the same process, except that they did not receive the mediated lesson. The other two groups received no pre-test but were evaluated at the end with LPT2. The one group received the mediated lesson, while the other did not.

The means and standard deviations for the tests and difference scores for the four groups were calculated and are reflected in Table 7.4.

Table 7.4  
Means and Standard Deviation for Tests and Difference Scores

	Group	N	Mean	Std dev.
Lesson	1	15	Pretest	5.53
			Posttest	8.73
			Difference score	3.2
No lesson	2	16	Pretest	4.25
			Posttest	5.08
			Difference score	0.94
Lesson	3	17	Posttest	3.65
No lesson	4	15	Posttest	6.39

The two groups which were pretested were compared by using a one way Analysis of Variance. The differences between them were not significant (F-ratio = 1.43,  $p > 0.05$ ,  $df = 1;29$ ).

A two-way Analysis of Variance was used to evaluate the effect of the mediated lesson on the LPT2 scores. The results show that the lesson had a significant effect ( $F = 4.51$ ,  $p < 0.05$ ,  $df = 1;59$ ) on the LPT2 score of the group who received the lesson. There was

no interaction between the lesson and pretesting ( $F = 1.19, p > 0.05, df = 1;59$ ) and pretesting did not have a significant effect ( $F = 0.03, p > 0.05, df = 1;59$ ). This means that the group who repeated another form of the LPT during the posttest did not show a significant increase in the difference score. The indication is that practice in taking an equivalent form of the test did not have a significant influence on the scores in the subsequent test.

Table 7.4 shows that the difference score of group 1 who received the lesson was significantly higher than the difference score of group 2 who did not receive the lesson ( $t = 2.44, p = 0.02, df = 29$ ). As the use of the Solomons Four Group Design controls for the practice effect the indications are that the gains were due to the mediated lesson.

A comparison between the mean scores of the groups in study 2 with those of the previous experiment in study 1, indicates some differences between the scores of the groups in the different studies. Large differences exist between the pretest scores of groups 1 (12.15 and 5.53 for studies 1 and 2 respectively) and the pretest scores of groups 2 (11.31 and 3.5 for studies 1 and 2 respectively). The differences between groups 3 (10.52 and 7.52 for studies 1 and 2 respectively) and groups 4 (8.21 and 6.13 for studies 1 and 2 respectively) were less marked.

A closer inspection of the students' scores in the second study revealed that 7 of the 15 students in group 1 and 10 of the 16 students in group 2 obtained scores of less than 4 in the pretest. This resulted in the low mean for both these groups. In the posttest 3 of the 15 students in group 1 and 9 of the 16 students in group 2 obtained scores of less than 4. Four students in group 1 (who received the mediated lesson) were able to improve their scores as opposed to the students in group 2 (who did not receive the lesson) where only 1 student improved to push the score above the cutoff point of 4.

From an investigation of the students' posttest scores in group 3 (who did not receive the lesson) it can be seen that 7 of the 15 students obtained scores of less than 4, whereas 2 of the 17 students in group 4 (who received the lesson) obtained scores of less than 4.

This seems to indicate that some unknown dynamic was present in the second study which resulted in some students getting lower scores in both the pre- and posttests. It should be noted that although the mean pre- and posttest scores of the first study are higher than the scores in the second study, the difference scores are very close to each other (2.5 and 3.2 for the first and second studies respectively).

A possible explanation for the differences between the scores of the studies could be that in the first study groups 1 and 2 consisted of Engineering and Science students respectively who can be considered as better problem solvers than the Education students used in study 2. This argument is supported by the fact that the differences between the two studies were not that great with groups 3 and 4. In the first study groups 3 and 4 consisted of students in Business Studies, while in the second study the students were in Education. The problem solving abilities of these two groups of students (Business and Education) can be seen to be more or less equal.

According to Klauer (1993) it is possible to use a standardised mean change between posttest and pretest for measuring retest effects, where  $x$  and  $y$  present the means of the pretest and posttest respectively, and where  $S_x$  is the standard deviation of the pretest.

$$z(g) = \frac{y - x}{S_x}$$

It can be interpreted in a similar way as the effect size measure  $d$  used by Cohen (1977).

Use of the formula with the control group receiving the pre- and posttest, but not the mediated lesson, provides the opportunity to calculate the amount of gains which are due to the retest effect only.

The retest effect of the first group was calculated as being 0.81, while the retest effect of the second group was 0.22. It can be concluded that the retest effect of the first group was considerable and that a large proportion of the gain could be attributed to the retest effect. The retest effect of the second group was relatively low and less of the gains made were due to the retest effect.

In conclusion it seems reasonable to suggest that in the case where the experimental design was more rigorously set up regarding randomisation and with the absence of the placebo the mediated lesson had an appreciable effect on subsequent performance in the posttest. The low retest effect for this group indicated that most of the gains were due to the mediated lesson.

From these results it can be assumed that the LPT is suitable for use in further studies, but that there might be differences between students in the way they respond to the

mediated lesson. An investigation of students' response to the mediated lesson is done in Chapter 8.

## **2.2 CONCEPTUAL REASONING TEST (CRT)**

The experimental design used for the CRT is the Posttest-only Control Group Design (Leedy, 1989) which can be depicted in the following way:

R X → O1

R — → O2

This design is an adaptation of the last two groups in the Solomons Four Group Design and is usually used to evaluate a situation that cannot be pretested.

Two studies were done to evaluate the effectiveness of the mediated lesson incorporated into the CRT.

### **2.2.1 Study 1**

The subjects were black (African and Coloured) first year students in Electrical Engineering. The course is run on a semester basis and has two intakes during the year. The January intake of students served as the experimental group (N = 79), while the July intake of the same year served as the control group (N = 23).

The experimental group received the mediated lesson and immediately afterwards completed the test. The control group did not receive the mediated lesson, but only completed the test part of the CRT.

With the CRT the lesson forms part of the test and focuses on metacognitive inputs as well as specific problem solving strategies. The researcher conducted the test and the standardised lesson. Students had the opportunity to study the printed lesson which provided feedback on how the different problems were solved. Students were encouraged to ask questions during the verbally presented lesson and their understanding of the principles involved in solving the problems were highlighted during this phase.

The means and standard deviations for the two groups were calculated and are shown in Table 7.5.

Table 7.5  
Means and Standard Deviations of CRT Scores

Group	N	Mean	Std dev.	df
Experimental group	79	18.26	5.06	100
Control group	23	13.47	3.64	

If one considers the means in Table 7.5 it is clear that the experimental group scored higher in the test. A t-test indicated that the difference in means was significant ( $t = 4.22$ ,  $p < 0.001$ ,  $df = 100$ ).

These results indicate that the mediated lesson had a positive effect on the scores of the CRT. The students who received the lesson scored significantly higher than the students who did not receive the lesson.

### 2.2.2 Study 2

The subjects were black (African and Coloured) first year students in Information Technology. Students in this course were randomly allocated to the two classes at the beginning of the year. One of the classes served as the experimental group ( $N = 34$ ), while the other served as the control group ( $N = 35$ ).

The experimental group was given the mediated lesson and immediately afterwards completed the test section of the CRT. The control group completed the test without receiving the mediated lesson.

The means and standard deviations for the two groups were calculated.

Table 7.6  
Means and Standard Deviations of CRT Scores

Group	N	Mean	Std dev.	df
Experimental group	34	18.38	6.61	68
Control group	35	15.91	5.24	

As can be seen from Table 7.6 the experimental group scored higher on the CRT than the control group. A t-test of significance of the difference between the means of the scores indicated that the difference was not significant ( $t = 1.4, p = 0.09, df = 68$ ).

It was decided to separate the DET and non-DET students in the total group. The experimental and control groups were divided into groups of DET and non-DET students and the means and standard deviations calculated.

Table 7.7

Means and Standard Deviations of CRT Test for Non-DET and DET Students separately

Group		N	Mean	Std dev.	df
Non-DET students	Experimental group	24	20.83	6.01	54
	Control group	32	16.56	4.96	
DET students	Experimental group	10	12.5	3.68	11
	Control group	3	9.0	2.64	

Table 7.7 indicates that the mean CRT scores of the non-DET students in the experimental group is significantly higher than the scores in the control group ( $t = 2.91, p < 0.01, df = 54$ ). Although the mean CRT scores of the experimental group of the DET students were higher than those of the control group, the difference was not significant ( $t = 15.1, p > 0.05, df = 11$ ).

The reason why the students receiving the mediated lesson did not have significantly higher scores than those students who did not receive the lesson was because the DET and non-DET students formed two distinct groups. The DET students were not able to benefit from the mediated lesson to the same extent as the non-DET group were able to.

Seen in its totality and taking both studies into consideration the mediated lesson did have an effect on the students' subsequent performance in the CRT. It would thus be useful to investigate how the CRT, as an example of dynamic assessment, would compare with static tests in predicting students' academic performance.

### 3. A COMPARISON BETWEEN PAST ACHIEVEMENT, STATIC TESTS AND DYNAMIC ASSESSMENT AS PREDICTORS

The Mental Alertness Test (MA) and Reading Comprehension Test (RCT) of the High Level Battery and the Electrical Aptitude Test (EAT) were used as examples of traditional, static assessment instruments, while the Conceptual Reasoning Test (CRT) and the Learning Potential Test (LPT) were seen as examples of dynamic assessment procedures.

The students' high school results (matriculation marks) were used as an example of past academic achievement. The Swedish rating system was used to calculate a composite score using the various subjects of each student. The points were allocated in the following way and is referred to as the SR score:

Table 7.8  
Swedish Rating Scores for Matriculation Symbols

SWEDISH RATING			
Symbol	Higher Grade	Standard Grade	Lower Grade
A	8	6	4
B	7	5	3
C	6	4	2
D	5	3	1
E	4	2	0
F	3	1	0

A small number of students were identified as rigidly applying the lesson to problem solving in the posttest of the LPT. These students had a difference of two or more between the number of items attempted in LPT1 and those attempted in LPT2, with the number of attempts always being less in LPT2. These students were seen as a different group and were not included in the main group of Electrical Engineering and Information Technology students. Separate studies are done with them in Chapter 8.

Two studies were done – the first with Business students and the second with Electrical Engineering students.

### 3.1 STUDY 1: BUSINESS MANAGEMENT

The subjects for the first study were 33 first year Business Management students at the technikon and the assessments were done at the beginning of 1994 as part of the selection process.

Pearson product moment correlation coefficients were computed to measure the relationship between each of the predictor variables and the students' academic performance at the end of their first year. Academic performance as the criterion variable was broken down into the students' average year marks, examination marks, final marks (a product of 60% of the year and 40% of the examination mark) and credits obtained. Students would be allocated one credit for each subject that they passed at the end of the year. A minimum of 50% for a subject is needed to pass.

Correlations were calculated between the MA, RCT, CRT, SR score as the independent variables and the students' academic performance (year, examination and final marks and credits obtained) as the dependent variables. The results are reflected in Table 7.9.

Table 7.9  
Correlations between the MA, RCT, SR Score, CRT  
and Academic Performance for Business Management

Variable	MA	CRT	SR	RCT
YEAR	0.368* N=33* p=0.035*	0.372* N=33* p=0.033*	0.202 N=33 p=0.260	0.272 N=33 p=0.125
EXAM	0.279 N=33 p=0.116	0.303 N=33 p=0.086	0.288 N=33 p=0.104	0.090 N=33 p=0.617
FINAL	0.287 N=33 p=0.106	0.324 N=33 p=0.066	0.260 N=33 p=0.144	0.117 N=33 p=0.514
CREDIT	0.339 N=33 p=0.054	0.349* N=33* p=0.046*	0.388* N=33* p=0.026*	0.192 N=33 p=0.286

\*p<0.05

From Table 7.9 it can be seen that the only significant correlation with the MA was obtained with the year mark ( $r = 0.368$ ,  $p = 0.035$ ) while the CRT obtained significant correlations with both the year mark ( $r = 0.372$ ,  $p = 0.033$ ) and credits obtained ( $r = 0.349$ ,  $p = 0.046$ ). The RCT did not have a significant relationship with any of the predictor

variables. The SR obtained a significant relationship with credits obtained ( $r = 0.388$ ,  $p = 0.026$ ) but not with the other indicators of academic performance. Overall it seems as if the CRT, together with the SR proved to be the better predictors of the students' academic performance at the end of the first year. The CRT obtained the highest correlation for the year, examination and final marks, while the SR obtained the highest correlation for credits obtained.

The MA and RCT are examples of the kind of traditional and static assessment instruments that have been used for selection purposes in the past. The MA evaluates an individual's ability to profit from formal academic work and provides a measure of general verbal intellectual functioning. The RCT assesses the ability to understand written English material. The academic nature of the MA is borne out by the significant correlation with the SR ( $r = 0.463$ ,  $p = 0.007$ ). In contrast to this the correlation between the CRT, which is an example of a dynamic assessment procedure, and the SR was not significant ( $r = 0.174$ ,  $p = 0.334$ ).

A stepwise multiple regression analysis (Kerlinger & Pedhazur, 1973) was done to identify the weighting of the different predictor variables in the Business Management course and to try and build a model of prediction. The variables entered into the analysis were the MA, CRT, SR and the RCT. The results in Table 7.10 show that only the SR score and the CRT were selected as significant predictors.

Table 7.10

Summary of the Results of the Stepwise Multiple Regression Analysis  
for Business Management

For Year Mark

R = 0.371  
R<sup>2</sup> = 0.138  
R<sup>2</sup>a = 0.110  
F = 4.976  
p = 0.033  
N = 33

Variable selected	Beta	Std Error of Beta	t	p
CRT	0.371	0.166	2.23	0.033

F to enter 3

Table 7.10 (continued)

For Credits Obtained

R = 0.387  
 R<sup>2</sup> = 0.151  
 R<sup>2</sup>a = 0.123  
 F = 5.493  
 p = 0.025  
 N = 33

Variable selected	Beta	Std Error of Beta	t	p
SR	0.387	0.165	2.343	0.025

F to enter 3

From Table 7.10 it can be inferred that in the case of the year mark the stepwise regression analysis identified the CRT as the "best" predictor of academic performance. In the case of the credits obtained the "best" predictor selected was the SR score. When the CRT is added to the regression analysis the value of R<sup>2</sup> is increased to 0.232 (R = 0.482, R<sup>2</sup>a = 0.181, F = 4.541, p < 0.019). This represents an addition to R<sup>2</sup> of 0.08 which could be seen as a useful contribution. A method of establishing whether a contribution is large enough to have practical value, is to calculate Cohen's (1977) effect size (f<sup>2</sup>). Using the formula:

$$f^2 = \frac{\text{Contribution of variable to } R^2}{(1 - R^2)}$$

The effect size calculated was 0.10. This value has a low to medium practical value (Kotzé, 1994).

From the above results it can be deduced that the RCT was not a good predictor of academic performance. Although the MA fared better, it was not identified in the stepwise multiple regression as adding to a prediction model for academic performance. The two variables who contributed the most to predicting the students' academic performance were the CRT and the SR score. The CRT, as an example of a dynamic assessment procedure, fared better than the two traditional, static assessment instruments (MA and RCT) in predicting academic performance. It must be noted that the variance explained by both the CRT (14%) and the SR score (15%) is low and leaves a large percentage of unexplained variance.

### 3.2 STUDY 2: ELECTRICAL ENGINEERING

The second study was done with Electrical Engineering students. The Electrical Engineering course is an example of a semester course. Their first "year" lasts six months, after which they are promoted to the next "year" of the course according to a final mark or credits obtained.

A group of 41 first year Electrical Engineering students completed the CRT and the RCT. In place of the MA, the Electrical Aptitude Test (EAT) was used as an example of a static test that assess students' previously acquired electrical knowledge and insight. The students also completed the Learning Potential Test (LPT) as another example of a dynamic assessment procedure. In contrast to the CRT that consists of one test preceded by a mediated lesson, the LPT consists of the LPT1 which is followed by a mediated lesson and finally the students would complete LPT2. The gains made between LPT1 and LPT2 would be an indication of the learning potential of the students. The SR score was used to reflect the students' overall matriculation marks. These factors were used as independent variables. The dependent variable academic performance was divided into a year mark, a final mark and credits obtained (number of subjects passed). The Electrical Engineering students do not have an examination mark as they make use of continuous evaluation.

Pearson product moment correlations were calculated between the SR score, CRT, LPT, RCT, EAT and academic performance. The results can be found in Table 7.11.

Table 7.11

Correlations between the LPT1, LPT2, CRT, RCT, SR Score, EAT and Academic Performance for Electrical Engineering

Variable	SR	CRT	LPT1	LPT2	RCT	EAT
YEAR	0.424* N=41* p=0.006*	0.050 N=41 p=0.757	0.234 N=41 p=0.140	0.189 N=41 p=0.238	0.234 N=41 p=0.142	0.091 N=41 p=0.573
FINAL	0.421* N=41* p=0.006*	0.047 N=41 p=0.771	0.201 N=41 p=0.207	0.172 N=41 p=0.282	0.224 N=41 p=0.160	0.074 N=41 p=0.647
CREDIT	0.311* N=41* p=0.047*	0.030 N=41 p=0.854	0.210 N=41 p=0.189	0.299 N=41 p=0.058	0.291 N=41 p=0.065	0.048 N=41 p=0.767

\*p<0.05

It can be seen from Table 7.11 that the SR score was the only variable that had a moderately strong correlation with the year mark ( $r = 0.424$ ,  $p = 0.006$ ), final mark ( $r = 0.421$ ,  $p = 0.006$ ) and credit ( $r = 0.311$ ,  $p = 0.047$ ). The only other relationship of note was the correlation between LPT2 and credits obtained ( $r = 0.299$ ,  $p = 0.058$ ). The EAT and CRT showed weak relationships with academic performance.

A stepwise regression analysis was done using the variables SR score, CRT, LPT1, RCT and EAT. The SR score was the only significant variable to be selected for all three criteria variables (year mark, final mark and credits obtained). The variance explained varied from 18% for the year and final marks to 10% for the credits obtained. A summary of the results of the analysis for credits obtained is shown in Table 7.12.

Table 7.12

Summary of the Results of the Stepwise Multiple Regression Analysis  
for Electrical Engineering

For Credits Obtained

R = 0.311  
 $R^2$  = 0.096  
 $R^2a$  = 0.074  
 F = 4.188  
 P = 0.47  
 N = 41

Variable selected	Beta	Std Error of Beta	t	p
SR	0.311	0.152	2.046	0.047

F to enter 2

When LPT2 is included in the regression analysis the value of  $R^2$  is increased from 0.096 to 0.166 ( $F = 3.807$ ,  $p = 0.031$ ). This shows an addition to  $R^2$  of 0.07 which could be seen as a useful contribution. A calculation of Cohen's effect size ( $f^2 = 0.08$ ) shows it to have low to medium practical value. The variance explained varied from 10% to 18%, which still leaves a large proportion unexplained.

In conclusion, it can be reported that in general the dynamic assessment instruments did marginally better in predicting academic performance than the traditional, static tests. The SR score of the matriculation marks proved to be a better predictor than both the static tests and the dynamic assessment procedures in the case of Electrical Engineering, and to a lesser extent with Business Management. It also seems clear that there are differences in the correlation and prediction patterns of the different disciplines. With the

Business Management students the CRT together with the SR score proved to be the better predictors, while with the Electrical Engineering students the posttest of the LPT proved to be the next best predictor after the SR score. The predictor variables used were all examples of cognitive factors which accounted for the small proportion of the variance explained. Research has indicated that non-cognitive factors make a strong contribution as predictors of academic performance for Black students in the USA (Shochet, 1986). In the next chapter both cognitive and non-cognitive variables are investigated as predictors of academic performance.

#### **4. PREDICTORS OF ACADEMIC PERFORMANCE**

This section investigates the relationship between past academic achievement (school results), manifest ability, learning potential, various non-cognitive factors and future academic performance. The disciplines included in the investigation were first year students in Information Technology and Electrical Engineering. The data for Electrical Engineering and Information Technology was obtained during 1993. The cognitive factors were assessed at the beginning of the year as part of the selection process, while the non-cognitive factors were obtained after the students had been at the technikon between one to three months.

Pearson product moment correlation coefficients were computed to measure the relationship between each of the predictor variables and the performance in the criterion variables (year, examination and final marks and credits obtained). Where appropriate, multiple regression analysis was done in order to obtain information regarding the relative weighting of the different significant predictors of academic performance. The predictor variables included cognitive factors, non-cognitive factors and past academic achievement. Each discipline was investigated in turn, starting with Electrical Engineering.

##### **4.1 NON-COGNITIVE FACTORS**

The following non-cognitive factors were added to the cognitive factors and SR score that were used in the previous studies:

- (1) The Motivation (Mot): subscale of the MSLQ
- (2) Metacognitive strategies (Meta): subscale of the MSLQ
- (3) Management of Resources (Res): subscale of the MSLQ
- (4) Affect: test anxiety (Anx): subscale of the MSLQ
- (5) Surface approach to learning (Surf): subscale of the SPQ
- (6) Deep approach to learning (Deep): subscale of the SPQ
- (7) Achieving approach to learning (Ach): subscale of the SPQ.

The scales and subscales of the MSLQ and SPQ were discussed in detail in Chapter 6.

#### 4.1.1 Electrical Engineering

Correlations were computed between the cognitive factors, non-cognitive factors, SR score and academic performance (year and final marks and credits obtained). The results are shown in Table 7.13.

Table 7.13

Correlations between Cognitive Factors, Non-cognitive Factors, SR Score and Academic Performance for Electrical Engineering

Variable	CRT	LPT1	LPT2	RCT	EAT	SR	MOT
YEAR	0.049 N=41 p=0.757	0.234 N=41 p=0.140	0.188 N=41 p=0.238	0.233 N=41 p=0.142	0.090 N=41 p=0.573	0.423* N=41* p=0.006*	0.032 N=41 p=0.840
FINAL	0.046 N=41 p=0.771	0.201 N=41 p=0.207	0.172 N=41 p=0.282	0.223 N=41 p=0.160	0.073 N=41 p=0.647	0.421* N=41* p=0.006*	0.019 N=41 p=0.905
CREDIT	0.029 N=41 p=0.854	0.209 N=41 p=0.189	0.299 N=41 p=0.058	0.290 N=41 p=0.065	0.047 N=41 p=0.767	0.311* N=41* p=0.047*	0.061 N=41 p=0.702

Variable	META	COG	RES	ANX	SURF	DEEP	ACH
YEAR	0.268 N=41 p=0.090	0.155 N=41 p=0.332	-0.089 N=41 p=0.578	0.121 N=41 p=0.450	-0.044 N=37 p=0.793	0.316 N=37 p=0.056	0.293 N=37 p=0.077
FINAL	0.248 N=41 p=0.117	0.129 N=41 p=0.419	-0.115 N=41 p=0.473	0.127 N=41 p=0.428	-0.038 N=37 p=0.823	0.312 N=37 p=0.060	0.289 N=7 p=0.083
CREDIT	0.268 N=41 p=0.090	0.097 N=41 p=0.543	-0.167 N=41 p=0.296	0.098 N=41 p=0.539	-0.102 N=37 p=0.546	0.203 N=37 p=0.227	0.219 N=37 p=0.191

\*p<0.05

An inspection of Table 7.13 shows that the SR score was the only variable to have a significant relationship with academic performance. There were indications that the LPT2 and some of the non-cognitive factors, such as metacognitive strategies and the deep and achieving approaches to learning might make a contribution to the prediction of academic performance in addition to the role that previous academic achievement plays. The most appropriate method chosen to enable a model of prediction to be built and to establish the contribution that non-cognitive factors make in predicting academic performance was regression analysis. After an inspection of the correlation matrix the following variables were chosen to enter into the stepwise multiple regression analysis: LPT1, LPT2, RCT, SR score, metacognition, deep and achieving approaches to learning. A summary of the results appear in Table 7.14.

Table 7.14

Summary of the Results of the Stepwise Multiple Regression Analysis  
for Electrical Engineering

For Year Mark

R = 0.534  
 R<sup>2</sup> = 0.285  
 R<sup>2</sup>a = 0.243  
 F = 6.806  
 P = 0.003  
 N = 37

Variables selected	Beta	Std Error of Beta	t	p
SR	0.391	0.144	2.698	0.011
Meta	0.373	0.144	2.575	0.014

F to enter 4

For Final Mark

R = 0.516  
 R<sup>2</sup> = 0.267  
 R<sup>2</sup>a = 0.224  
 F = 6.186  
 P = 0.005  
 N = 37

Variables selected	Beta	Std Error of Beta	t	p
SR	0.385	0.147	2.620	0.013
Meta	0.353	0.147	2.404	0.022

F to enter 4

Table 7.14 (continued)

For Credits Obtained

R = 0.328  
 R<sup>2</sup> = 0.107  
 R<sup>2a</sup> = 0.082  
 F = 4.209  
 P = 0.048  
 N = 37

Variables selected	Beta	Std Error of Beta	t	p
LPT2	0.328	0.160	2.051	0.048
Meta	0.373	0.144	2.575	0.014

F to enter 4

An inspection of Table 7.14 shows that the inclusion of non-cognitive factors had increased the value of R<sup>2</sup> from 0.18 to 0.29 in the case of the year mark and from 0.18 to 0.27 in the case of the final mark. This represents an addition of 0.11 and 0.09 respectively, which could be seen as a useful contribution. Calculations of Cohen's f<sup>2</sup> produced values of 0.155 and 0.123 for the year and final marks respectively. The value for the year mark has medium practical value, while the value for the final mark has low to medium practical value. The addition in value to R<sup>2</sup> for the year mark is statistically significant (F = 4.35, p < 0.05) using the following formula to calculate F:

$$F = f^2 \times (n - k - 1)$$

where k = number of variables in regression.

For credits obtained, the LPT2 and metacognition were the only significant variable selected and it explained 11% of the variance.

In conclusion it can be reported that although the SR score was the only variable with a significant relationship with academic performance, there was some evidence that the posttest of the LPT and certain non-cognitive factors could make an important contribution. In the case of the Electrical Engineering students their metacognition strategies score made a significant contribution to the increase of R<sup>2</sup> with the year marks. Metacognitive strategies as a representative of non-cognitive factors shows strong relationships with deep (r = 0.455, p = 0.005) and achieving approaches (r = 0.483, p = 0.002) to learning. These three variables achieved moderately high correlations with academic performance,

while the surface approach to learning, which is the opposite of the deep and achieving approaches, showed negative correlations with academic performance.

#### 4.1.2 Information Technology

The same variables used with the Electrical Engineering students were used with the Information Technology students. The cognitive factors, non-cognitive factors and the SR score as independent variables were correlated with academic performance (year mark, examination marks, final mark and credits obtained) as dependent variables. The year mark and examination mark contributed to the final mark in the ratio 60:40. The students had to obtain 50% or more for the final mark to pass a particular subject. Credits obtained is a reflection of the number of subjects passed. Table 7.15 shows the results of the correlation matrix.

Table 7.15

Correlations between Cognitive Factors, Non-cognitive Factors, SR Score and Academic Performance for Information Technology

Variable	CRT	LPT1	LPT2	RCT	SR	MOT	META
YEAR	0.115 N=55 p=0.399	0.033 N=55 p=0.807	0.122 N=55 p=0.374	0.093 N=55 p=0.498	0.510* N=51* p=0.004*	0.012 N=55 p=0.926	0.291* N=55* p=0.031*
EXAM	0.057 N=55 p=0.679	0.019 N=55 p=0.888	0.148 N=55 p=0.279	0.066 N=55 p=0.632	0.493* N=51* p=0.004*	0.115 N=55 p=0.400	0.362* N=55* p=0.007*
FINAL	0.057 N=55 p=0.675	0.024 N=55 p=0.861	0.145 N=55 p=0.288	0.075 N=55 p=0.585	0.514* N=51* p=0.004*	0.098 N=55 p=0.469	0.342* N=55* p=0.010*
CRED	-0.059 N=55 p=0.665	0.014 N=55 p=0.918	0.057 N=55 p=0.675	0.114 N=55 p=0.404	0.500* N=51* p=0.004*	0.254 N=55 p=0.060	0.373* N=55* p=0.005*

Variable	COG	RES	ANX	SURF	DEEP	ACH
YEAR	0.284* N=55* p=0.035*	0.170 N=55 p=0.213	0.167 N=55 p=0.223	-0.031 N=55 p=0.817	0.260 N=55 p=0.054	0.385* N=55* p=0.004*
EXAM	0.325* N=55* p=0.015*	0.130 N=55 p=0.344	0.116 N=55 p=0.398	0.029 N=55 p=0.832	0.353* N=55* p=0.008*	0.411* N=55* p=0.002*
FINAL	0.323 N=55* p=0.016*	0.151 N=55 p=0.268	0.130 N=55 p=0.342	0.011 N=55 p=0.931	0.335* N=55* p=0.012*	0.415* N=55* p=0.002*
CRED	0.422* N=55* p=0.001*	0.197 N=55 p=0.149	-0.007 N=55 p=0.958	0.122 N=55 p=0.373	0.346* N=55* p=0.010*	0.409* N=55* p=0.002*

\*p<0.05

Table 7.15 shows that the SR score obtained moderately high correlations with academic performance. All the cognitive factors showed low correlations. This included the dynamic assessment procedures (CRT and LPT2). In contrast to the cognitive factors, some of the non-cognitive factors showed moderately strong relationships with academic performance (cognitive and metacognitive strategies and deep and achieving approaches to learning). This result tends to confirm the trend, found with the Electrical Engineering students, that non-cognitive factors play an important role in predicting disadvantaged students' academic performance.

In order to build a model of prediction for the Information Technology students and to assess the contribution of non-cognitive factors to the prediction, a stepwise multiple regression analysis was performed. After an inspection of the correlation matrix the following variables were entered into the regression analysis: LPT1, LPT2, RCT, SR score and metacognition, cognition, deep and achieving approaches to learning. A summary of the results is shown in Table 7.16.

Table 7.16

Summary of the Results of the Stepwise Multiple Regression Analysis  
for Information Technology

For Year Mark

R = 0.607  
 R<sup>2</sup> = 0.368  
 R<sup>2</sup>a = 0.328  
 F = 9.145  
 P = 0.0001  
 N = 51

Variables selected	Beta	Std Error of Beta	t	p
SR	0.415	0.122	3.413	0.001
ACH	0.306	0.125	2.448	0.018
RCT	0.242	0.119	2.018	0.049

F to enter 3.75

For Examination Mark

R = 0.567  
 R<sup>2</sup> = 0.321  
 R<sup>2</sup>a = 0.293  
 F = 11.369  
 P = 0.0001  
 N = 51

Variables selected	Beta	Std Error of Beta	t	p
SR	0.411	0.124	3.310	0.002
ACH	0.291	0.124	2.343	0.023

F to enter 3.75

Table 7.16 (continued)

For Final Mark

R = 0.584  
 R<sup>2</sup> = 0.341  
 R<sup>2a</sup> = 0.313  
 F = 12.397  
 P = 0.0001  
 N = 51

Variables selected	Beta	Std Error of Beta	t	p
SR	0.432	0.122	3.533	0.001
ACH	0.288	0.122	2.352	0.023

F to enter 3.75

For Credits Obtained

R = 0.586  
 R<sup>2</sup> = 0.343  
 R<sup>2a</sup> = 0.316  
 F = 12.540  
 P = 0.00004  
 N = 51

Variables selected	Beta	Std Error of Beta	t	p
SR	0.409	0.122	3.353	0.002
ACH	0.318	0.122	2.606	0.012

F to enter 3.75

An inspection of Table 7.16 indicates that the SR score and the achieving approach to learning were the two variables consistently selected in the analysis. The SR score and achieving approach explain 32% and 34% of the variance in predicting the examination mark, final mark and credits obtained. The presence of the RCT together with the SR score and the achieving approach to learning explain 37% of the variance for the year mark.

The value of R<sup>2</sup> is increased from 0.24 to 0.32 and from 0.25 to 0.34 for the examination marks and credits respectively when the achieving approach is added to the SR score in the regression analysis. This represents an addition of 0.08 and 0.09 which could be seen as useful with low to medium practical value ( $r^2 = 0.14$  for both). The increase in the value of R<sup>2</sup> was significant at the 5% level (F = 6.72) for both the examination marks and credits. This indicates the value of non-cognitive factors in the prediction of disadvantaged students' academic performance.

A comparison between the Electrical Engineering and Information Technology students' correlation patterns shows different profiles. The Electrical Engineering department makes use of continuous assessment while the Information Technology department makes

use of an examinations based evaluation system. In the case of continuous assessment a final mark is calculated from tests, assignments and projects done during the year, while in the case of Information Technology a final mark is calculated using 60% of the year mark and 40% of the examination mark.

Looking at the correlations between the cognitive factors and academic performance one of the differences is in the LPT and SR scores. For the Electrical Engineering students the LPT2 had a moderate correlation with credits obtained ( $r = 0.29$ ) which was very similar to the correlation obtained by the SR score. In contrast to this, for the Information Technology students the LPT2 showed a low correlation with credits obtained ( $r = 0.06$ ) which was in sharp contrast to the moderately high correlation obtained by the SR score ( $r = 0.50$ ). This seems to suggest that the LPT2 which is an example of a dynamic assessment procedure, might be a better predictor of academic performance in the case of continuous assessment, whereas the SR score, which represents previous academic achievement seems to be more suitable in predicting academic performance where the evaluation is examinations based.

Looking at the non-cognitive factors the pattern seems to be that the non-cognitive factors play a more important role in predicting academic performance for the Information Technology students than for the Electrical Engineering students. For the Electrical Engineering students a negative correlation was found between a surface approach to learning and credits obtained ( $r = -0.10$ ), while this correlation was positive, although small ( $r = 0.12$ ), for the Information Technology students. The same pattern was repeated with the subscale resource management. For the Electrical Engineering students the correlation with credits obtained was negative ( $r = -0.17$ ), while for the Information Technology students it was positive ( $r = 0.20$ ). Both the surface approach to learning and resource management could be linked to academic performance that is based on writing examinations. For the Electrical Engineering students who did not write examinations they were not that important in predicting academic performance, which explains the negative correlations obtained.

In conclusion, it is clear that the SR score plays an important role in the prediction of academic performance for both the Electrical Engineering and Information Technology groups. The LPT2 score seems to play a more important role in the case of a course with continuous assessment as opposed to a course that uses an examinations based assessment system. There are indications that non-cognitive factors such as meta-

cognitive strategies and an achieving approach to learning play a valuable supporting role in the prediction of disadvantaged students' academic performance. Although the non-cognitive factors substantially improved the prediction of academic performance, there still remains a fairly large proportion of variance that needs to be explained.

Previous academic achievement as represented by individual high school subjects and the Swedish rating (SR) score will subsequently be examined in more detail.

## 4.2 PREVIOUS ACADEMIC ACHIEVEMENT

### 4.2.1 Swedish Rating System

The matriculation marks have traditionally been used as an indication of students' previous academic performance. The Swedish Rating System (SR) was used to represent the students' school marks. The allocation of points for symbols obtained for subjects was discussed in a previous section and reflected in Table 7.8.

Research conducted with matriculation marks as predictors of academic performance has shown that the higher the marks, the better the prediction, but that the lower marks tend to be poor predictors (Miller, 1992; Shochet, 1986; Entwistle, Percy & Nisbet, 1977). In an effort to investigate this phenomenon it was decided to divide the SR score according to the median into lower and higher SR groups. This was done for the Electrical Engineering and Information Technology groups. The results of the correlations between various cognitive, non-cognitive factors and academic performance for the lower SR score in Electrical Engineering is shown in Table 7.17.

Table 7.17

Correlations between Various Cognitive Factors, Non-cognitive Factors, SR Score and Academic Performance for the Group with Lower SR Score in Electrical Engineering (SR < 36)

Variable	SR	CRT	LPT1	LPT2	RCT	EAT	MOT
YEAR	-0.315 N=18 p=0.202	0.440 N=18 p=0.067	0.543* N=18* p=0.020*	0.552* N=18* p=0.017*	0.290 N=18 p=0.243	0.396 N=18 p=0.103	0.193 N=18 p=0.443
FINAL	-0.327 N=18 p=0.185	0.424 N=18 p=0.079	0.498* N=18* p=0.035*	0.530* N=18* p=0.023*	0.241 N=18 p=0.335	0.371 N=18 p=0.129	0.219 N=18 p=0.383
CREDIT	-0.141 N=18 p=0.576	0.300 N=18 p=0.226	0.435 N=18 p=0.071	0.515* N=18* p=0.028*	0.215 N=18 p=0.391	0.187 N=18 p=0.456	0.144 N=18 p=0.568

Table 7.17 (continued)

Variable	META	COG	RES	ANX	SURF	DEEP	ACH
YEAR	0.387 N=18 p=0.112	0.306 N=18 p=0.216	0.264 N=18 p=0.289	0.353 N=18 p=0.150	-0.293 N=17 p=0.253	0.409 N=17 p=0.102	0.265 N=17 p=0.303
FINAL	0.388 N=18 p=0.111	0.309 N=18 p=0.212	0.254 N=18 p=0.308	0.385 N=18 p=0.114	-0.303 N=17 p=0.237	0.445 N=17 p=0.073	0.291 N=17 p=0.256
CREDIT	0.354 N=18 p=0.149	0.187 N=18 p=0.457	0.115 N=18 p=0.648	0.325 N=18 p=0.187	-0.425 N=17 p=0.089	0.293 N=17 p=0.252	0.305 N=17 p=0.234

\*p<0.05

Correlations between cognitive factors, non-cognitive factors and SR score as independent variables and academic performance as dependent variable was subsequently computed for the group with higher SR scores in Electrical Engineering. The results are shown in Table 7.18.

Table 7.18

Correlations between Various Cognitive Factors, Non-cognitive Factors, SR Score and Academic Performance for the Group with Higher SR Score in Electrical Engineering (SR > 36)

Variable	SR	CRT	LPT1	LPT2	RCT	EAT	MOT
YEAR	0.318 N=9 p=0.183	-0.541* N=19* p=0.017*	-0.175 N=19 p=0.472	-0.152 N=19 p=0.532	0.036 N=19 p=0.883	-0.074 N=19 p=0.762	-0.307 N=19 p=0.201
FINAL	0.293 N=19 p=0.222	-0.534* N=19* p=0.018*	-0.223 N=19 p=0.358	-0.183 N=19 p=0.451	0.030 N=19 p=0.900	-0.088 N=19 p=0.720	-0.345 N=19 p=0.147
CREDIT	0.286 N=9 p=0.235	-0.498* N=19* p=0.030*	-0.252 N=19 p=0.296	-0.091 N=19 p=0.710	0.107 N=19 p=0.661	-0.041 N=19 p=0.866	-0.147 N=19 p=0.546

Variable	META	COG	RES	ANX	SURF	DEEP	ACH
YEAR	0.220 N=19 p=0.366	0.111 N=19 p=0.650	-0.174 N=19 p=0.475	-0.423 N=19 p=0.071	0.169 N=17 p=0.515	0.344 N=17 p=0.176	0.149 N=17 p=0.566
FINAL	0.167 N=19 p=0.492	0.057 N=19 p=0.815	-0.208 N=19 p=0.391	-0.441 N=19 p=0.058	0.193 N=17 p=0.457	0.319 N=17 p=0.211	0.119 N=17 p=0.648
CREDIT	0.269 N=19 p=0.265	0.073 N=19 p=0.764	-0.321 N=19 p=0.180	-0.552* N=19* p=0.014*	0.332 N=17 p=0.192	0.268 N=17 p=0.298	0.093 N=17 p=0.721

\*p<0.05

In comparing the results obtained in Tables 7.17 and 7.18 it is noteworthy that for the group with a lower SR score the LPT1 and LPT2 show significant positive correlations

with academic performance, whereas the SR score has a low and negative correlation with academic performance. In contrast, for the group with a higher SR score the CRT, LPT1, LPT2 and EAT show a negative and in the case of CRT significant negative correlation with academic performance, whereas the SR score shows a positive correlation.

Using Fishers Z transformation for differences between correlations (Ferguson, 1981) the following variables showed significant differences between the lower and higher SR score groups for the final marks: CRT ( $p = 0.007$ ); LPT1 ( $p = 0.040$ ); LPT2 ( $p = 0.039$ ). For credits obtained the differences in correlations were significant for test anxiety ( $p = 0.011$ ) and for a surface approach to learning ( $p = 0.042$ ).

The differences in correlation patterns on various cognitive and non-cognitive factors seem to indicate that different sets of criteria act as predictors of academic performance for the two groups. The following variables seemed to be distinctive predictors for the group of students with lower matriculation marks: higher scores on the posttest of the LPT and the CRT, with lower scores on test anxiety. For the group with higher matriculation marks the most distinctive predictors seem to be the SR score of the matriculation marks and a surface approach to learning.

The correlations between cognitive factors, non-cognitive factors, SR score and academic performance was computed for the Information Technology students with a lower SR score. The results are shown in Table 7.19.

Table 7.19

Correlations between Various Cognitive Factors, Non-cognitive Factors, SR Score and Academic Performance for the Group with Lower SR Score in Information Technology (SR < 27)

Variable	SR	CRT	LPT1	LPT2	RCT	MOT	META
YEAR	0.357 N=21 p=0.111	-0.033 N=25 p=0.873	-0.304 N=25 p=0.139	-0.181 N=25 p=0.385	0.223 N=25 p=0.283	0.147 N=25 p=0.481	0.357 N=25 p=0.079
EXAM	0.357 N=25 p=0.079	-0.186 N=25 p=0.371	-0.182 N=25 p=0.384	-0.074 N=25 p=0.725	0.166 N=25 p=0.426	0.205 N=25 p=0.324	0.429* N=25* p=0.032*
FINAL	0.415 N=21 p=0.061	-0.189 N=25 p=0.365	-0.215 N=25 p=0.301	-0.102 N=25 p=0.626	0.174 N=25 p=0.404	0.235 N=25 p=0.257	0.406* N=25* p=0.043*
CRED	0.333 N=21 p=0.139	-0.362 N=25 p=0.075	-0.198 N=25 p=0.342	-0.183 N=25 p=0.380	0.313 N=25 p=0.127	0.277 N=25 p=0.180	0.280 N=25 p=0.174

Table 7.19 (continued)

Variable	COG	RES	ANX	SURF	DEEP	ACH
YEAR	0.383 N=25 p=0.059	0.373 N=25 p=0.066	0.117 N=25 p=0.577	-0.094 N=25 p=0.655	0.422* N=25* p=0.035*	0.388 N=25 p=0.055
EXAM	0.351 N=25 p=0.085	0.321 N=25 p=0.117	0.144 N=25 p=0.491	-0.172 N=25 p=0.410	0.398* N=25* p=0.049*	0.261 N=25 p=0.207
FINAL	0.369 N=25 p=0.069	0.359 N=25 p=0.078	0.142 N=25 p=0.496	-0.148 N=25 p=0.480	0.420* N=25* p=0.036*	0.316 N=25 p=0.124
CRED	0.374 N=25 p=0.065	0.273 N=25 p=0.186	-0.143 N=25 p=0.495	-0.015 N=25 p=0.943	0.322 N=25 p=0.116	0.300 N=25 p=0.144

\*p<0.05

Correlations were computed between cognitive factors, non-cognitive factors, SR score and academic performance for the group of Information Technology students with higher SR scores. The results are shown in Table 7.20.

Table 7.20

Correlations between Various Cognitive Factors, Non-cognitive Factors, SR Score and Academic Performance for the Group with Higher SR Score in Information Technology (SR > 27)

Variable	SR	CRT	LPT1	LPT2	RCT	MOT	META
YEAR	0.605* N=25* p=0.001*	0.045 N=25 p=0.829	0.108 N=25 p=0.607	0.258 N=25 p=0.213	-0.056 N=25 p=0.790	-0.077 N=25 p=0.713	0.219 N=25 p=0.292
EXAM	0.560* N=25* p=0.004*	0.101 N=25 p=0.629	0.089 N=25 p=0.671	0.298 N=25 p=0.147	-0.009 N=25 p=0.965	0.038 N=25 p=0.855	0.258 N=25 p=0.213
FINAL	0.580* N=25* p=0.002*	0.075 N=25 p=0.721	0.086 N=25 p=0.681	0.291 N=25 p=0.157	-0.027 N=25 p=0.897	-0.002 N=25 p=0.990	0.245 N=25 p=0.236
CRED	0.542* N=25* p=0.005*	0.001 N=25 p=0.995	0.120 N=25 p=0.566	0.267 N=25 p=0.196	-0.103 N=25 p=0.621	0.235 N=25 p=0.257	0.415* N=25* p=0.039*

Variable	COG	RES	ANX	SURF	DEEP	ACH
YEAR	0.189 N=25 p=0.365	0.025 N=25 p=0.905	0.098 N=25 p=0.641	0.040 N=25 p=0.848	0.152 N=25 p=0.467	0.372 N=25 p=0.067
EXAM	0.248 N=25 p=0.230	-0.056 N=25 p=0.788	0.026 N=25 p=0.901	0.161 N=25 p=0.439	0.297 N=25 p=0.148	0.458* N=25* p=0.021*
FINAL	0.238 N=25 p=0.250	-0.034 N=25 p=0.869	0.033 N=25 p=0.873	0.129 N=25 p=0.539	0.258 N=25 p=0.212	0.442* N=25* p=0.027*
CRED	0.409* N=25* p=0.042*	0.065 N=25 p=0.757	-0.004 N=25 p=0.982	0.272 N=25 p=0.187	0.353 N=25 p=0.083	0.466* N=25* p=0.019*

\*p<0.05

An inspection of Tables 7.19 and 7.20 indicate that for the group with the higher SR score a strong significant correlation between academic performance and the matriculation marks was obtained, while for the group with the lower SR score the correlation between SR score and academic performance, although moderate was not significant.

If one looks at the non-cognitive factors, the group with the higher SR score had significant correlations between academic performance and the achieving approach to learning while for the group with the lower SR score a significant correlation was found between the deep approach to learning and academic performance. With both the groups, metacognition also showed significant correlations with academic performance. The differences in correlation patterns between the two groups suggest that different selection criteria be used for Information Technology students who have lower matriculation marks as opposed to those who have higher marks, although the differences were not as substantial as those found with the Electrical Engineering students.

#### **4.2.2 Individual Matriculation Subjects**

Marks obtained for individual school subjects are often used to select students for a particular course. A Stepwise Multiple Regression Analysis was performed in the case of each of the following courses: Information Technology, Electrical Engineering and Business Management in order to establish the predicative value of matriculation subjects. The marks obtained in each individual technikon subject was used as dependent variable and various cognitive factors, non-cognitive factors and individual matriculation subjects as independent variables. This was done to establish the contribution that matriculation subjects as independent variables make in explaining the variance in the academic performance as dependent variable of students in different courses at the technikon. The following matriculation subjects were seen as important for courses in technology and entered into the regression analysis: Mathematics, Physical Science, Accounting, English and another language (in the case of English second language users this would often be their first language).

Table 7.21

Summary of the Results of Stepwise Regression Analysis  
using Technikon Subjects as DV for Information Technology

**Technikon Subject: Development Software**

R = 0.276  
 R<sup>2</sup> = 0.076  
 R<sup>2</sup>a = 0.057  
 Std Err. = 19.500  
 F = 4.064  
 p = 0.049  
 N = 50

Selected Variable	Beta	T	Sig T
Mathematics	0.276	2.016	0.049

**Technikon Subject: Financial Accounting**

R = 0.756  
 R<sup>2</sup> = 0.572  
 R<sup>2</sup>a = 0.523  
 Std Err. = 13.701  
 F = 11.527  
 p = 0.00004  
 N = 48

Selected Variables	Beta	T	Sig T
Accounting	0.433	4.029	0.004
Mathematics	0.279	2.454	0.018
LPT2	0.317	2.867	0.006
Second Language	0.262	2.544	0.014
COG	0.212	2.078	0.043

**Technikon Subject: Information Systems**

R = 0.51977  
 R<sup>2</sup> = 0.27037  
 R<sup>2</sup>a = 0.23997  
 Std Err. = 21.19243  
 F = 8.893  
 p = 0.004  
 N = 50

Selected Variables	Beta	T	Sig T
Achieving	0.389	3.144	0.002
Mathematics	0.313	2.536	0.014

**Technikon Subject: Programming**

R = 0.480  
 R<sup>2</sup> = 0.230  
 R<sup>2</sup>a = 0.197  
 Std Err. = 19.542  
 F = 7.040  
 P = 0.002  
 N = 49

Table 7.21 (continued)

Selected Variables	Beta	T	Sig T
Metacognition	0.405	3.169	0.002
Second Language	0.267	2.088	0.042

Table 7.22

Summary of the Results of Stepwise Regression Analysis  
using Technikon Subjects as DV for Electrical Engineering

**Technikon Subject: Communication Skills**

R = 0.661  
 R<sup>2</sup> = 0.437  
 R<sup>2</sup>a = 0.405  
 Std Err. = 6.903  
 F = 13.632  
 p = 0.001  
 N = 37

Selected Variables	Beta	T	Sig T
RCT	0.630	4.945	0.001
Deep Strategies	0.279	2.195	0.034

**Technikon Subject: Digital Systems**

R = 0.537  
 R<sup>2</sup> = 0.288  
 R<sup>2</sup>a = 0.247  
 Std Err. = 9.951  
 F = 7.097  
 p = 0.002  
 N = 37

Selected Variables	Beta	T	Sig T
Deep	0.486	3.290	0.002
LPT2	0.392	2.651	0.012

**Technikon Subject: Electrical Engineering**

R = 0.49758  
 R<sup>2</sup> = 0.24759  
 R<sup>2</sup>a = 0.20460  
 Std Err. = 9.66888  
 F = 5.758  
 p = 0.006  
 N = 37

Selected Variables	Beta	T	Sig T
Physical Science	-0.4460	-0.294	0.005
RCT	0.3634	2.395	0.022

Table 7.22 (continued)

**Technikon Subject: Electronics**

R = 0.60095  
 R<sup>2</sup> = 0.36114  
 R<sup>2</sup>a = 0.30477  
 Std Err. = 11.60784  
 F = 6.406  
 p = 0.001  
 N = 37

Selected Variables	Beta	T	Sig T
Test Anxiety	0.236	1.578	0.123
Deep Strategies	0.325	2.291	0.028
English	-0.299	-2.053	0.047

**Technikon Subject: Mathematics**

R = 0.505  
 R<sup>2</sup> = 0.255  
 R<sup>2</sup>a = 0.213  
 Std Err. = 16.058  
 F = 6.014  
 p = 0.005  
 N = 37

Selected Variables	Beta	T	Sig T
Achieving Motives	0.454	3.000	0.005
LPT1	0.378	2.495	0.017

**Technikon Subject: Project**

R = 0.790  
 R<sup>2</sup> = 0.624  
 R<sup>2</sup>a = 0.578  
 Std Err. = 5.218  
 F = 13.699  
 p = 0.0004  
 N = 37

Selected Variables	Beta	T	Sig T
CRT	0.583	5.333	0.0004
Deep Strategies	0.534	4.753	0.0004
Mathematics	-0.390	-3.597	0.001
Physical Science	0.339	2.992	0.005

Table 7.23

Summary of the Results of Stepwise Regression Analysis  
using Technikon Subjects as DV for Business Management

**Technikon Subject: Economics 1**

R = 0.702  
R<sup>2</sup> = 0.494  
R<sup>2a</sup> = 0.440  
Std Err. = 14.043  
F = 9.276  
p = 0.001  
N = 21

Selected Variables	Beta	T	Sig T
Second Language	-0.472	-2.797	0.011
Expectancy	0.410	2.431	0.025

**Technikon Subject: Financial Accounting**

R = 0.811  
R<sup>2</sup> = 0.659  
R<sup>2a</sup> = 0.602  
Std Err. = 13.079  
F = 11.600  
p = 0.002  
N = 21

Selected Variables	Beta	T	Sig T
English	-0.586	-4.062	0.001
Achieving Motives	0.558	3.654	0.001
Deep Strategies	-0.383	-2.419	0.026

**Technikon Subject: Management Principles and Practice**

R = 0.69454  
R<sup>2</sup> = 0.48238  
R<sup>2a</sup> = 0.42790  
Std Err. = 15.28788  
F = 8.853  
p = 0.001  
N = 21

Selected Variables	Beta	T	Sig T
English	-0.510	-3.096	0.005
Second Language	-0.471	-2.857	0.010

**Technikon Subject: Mercantile Law**

R = 0.53044  
R<sup>2</sup> = 0.28136  
R<sup>2a</sup> = 0.24543  
Std Err. = 21.37575  
F = 7.831  
p = 0.01  
N = 21

Table 7.23 (continued)

Selected Variable	Beta	T	Sig T
Expectancy	0.530	2.798	0.011

**Technikon Subject: Statistical Methods and Calculations**

R = 0.67768  
 R<sup>2</sup> = 0.45924  
 R<sup>2</sup>a = 0.40232  
 Std Err. = 16.30305  
 F = 8.068  
 p = 0.002  
 N = 21

Selected Variables	Beta	T	Sig T
English	-0.516	-3.060	0.006
Second Language	-0.440	-2.610	0.017

**Technikon Subject: Economics 2**

R = 0.52112  
 R<sup>2</sup> = 0.27157  
 R<sup>2</sup>a = 0.23515  
 Std Err. = 19.75383  
 F = 7.456  
 p = 0.012  
 N = 21

Selected Variable	Beta	T	Sig T
English	-0.521	-2.731	0.012

An inspection of Tables 7.21 to 7.23 shows that for some individual technikon subjects fairly strong prediction models could be built. Overall the matriculation subjects played an inconsistent role in the prediction of academic performance in individual technikon subjects for the different courses. The results of each course will be reported on separately.

**4.2.2.1 Information Technology**

From Table 7.21 it can be seen that the matriculation subjects mathematics, accounting and a second language was identified as playing a role in building a prediction model. In the case of the technikon subject financial accounting the proportion variance explained in predicting performance was a fairly high 57%. Accounting, mathematics, a second language, the posttest of the LPT and cognitive strategies combined to achieve this. With the technikon subjects that have less in common with high school subjects, the proportion

variance explained ranged from 8% to 27%. The matriculation subject mathematics was present in three of the four prediction models and seems to have played an important role in the academic success in an individual technikon subject. Non-cognitive variables such as metacognitive strategies and an achieving approach to learning were prominent in two of the models.

#### 4.2.2.2 Electrical Engineering

For the Electrical Engineering students the RCT and a deep approach to learning seemed to play an important role. The RCT and the use of deep strategies explained 44% of the variance in predicting the performance in Communication Skills. For Digital Systems a deep approach to learning and the posttest of the LPT explained 29% of the variance. Physical Science and mathematics had an inverse relationship to academic success in the technikon subjects Electrical Engineering and Projects respectively. The English mark had an inverse relationship to academic success in Electronics, but did not seem to play a role in any of the other models.

For the technikon subject Mathematics achieving motives and the pretest of LPT explained 26% of the variance, but mathematics as a matriculation subject was not selected into the model. For the technikon subject Project 62% of the variance was explained by a combination of the CRT, deep strategies and the matriculation mathematics and physical science. Mathematics had an inverse relationship with academic success in the subject Projects.

#### 4.2.2.3 Business Management

For the Business Management students the matriculation subjects English and marks in a second language had an inverse relationship with academic performance at the technikon. The non-cognitive factors selected into the prediction models were the expectancy subscale of motivation and the achieving motives subscale of the achieving approach to learning. The non-cognitive factors seemed to play a more important role in predicting academic performance in individual technikon subjects for Business Management than individual matriculation subjects.

## 5. CONCLUSION

In conclusion it can be reported that the weight of evidence suggests that the mediated lesson is effective in substantially increasing students' scores on the subsequent test in both the LPT and the CRT.

In looking at predictors of academic performance, the SR score of the matriculation marks seem to be the best single predictor. The LPT2 and CRT, as examples of dynamic assessment procedures, are marginally better predictors of academic performance than examples of traditional static tests and make useful contributions in the prediction model. The variance in academic performance explained can be significantly improved by the use of certain non-cognitive factors such as metacognitive strategies and an achieving approach to learning.

The SR score is a better predictor of academic performance for those students who obtained higher symbols in the matriculation examinations. For the Electrical Engineering students who obtained lower symbols in the matriculation examinations the LPT2 and CRT proved to be better predictors of academic performance. Individual matriculation subjects did not play an important role in building prediction models for technikon subjects except for mathematics in Information Technology.

In the next chapter (Chapter 8) the results of studies looking at students' response to mediation, and the differences between different groups of students' cognitive and learning profiles will be shown.

## Chapter 8

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# RESULTS OF FURTHER STUDIES

## 1. INTRODUCTION

In Chapter 7 the role that different variables play in predicting academic performance was investigated. The results indicated that although previous academic achievement, in the form of the SR score, was the best single predictor of academic performance at the technikon for the total group of students, the prediction patterns changed when the group was divided into a lower and higher SR score group. The SR score was still a good predictor for the higher SR score group, but less so for the lower SR score group. In the latter group the dynamic assessment procedure in the form of the CRT and LPT played a more important role in predicting academic performance.

Further investigations into different prediction patterns for different groups of students include the students' response to the mediation provided in the LPT. Some students benefited more from the mediated lesson than others. Students can also be differentiated along the lines of secondary school attendance, gender, language and socio-economic status (SES). Each of these groups are investigated for differences in cognitive and learning profiles.

## 2. RESPONSE TO MEDIATION

In this section the students' response to the mediated lesson incorporated in the LPT is explored. The means and standard deviations of the LPT1, LPT2 and difference scores were calculated for the groups of Information Technology and Electrical Engineering students. The results are shown in Table 8.1.

Table 8.1

Means and Standard Deviations of LPT1, LPT2 and Difference Scores for Information Technology and Electrical Engineering

	LPT1		LPT2		Diff. Score	
	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
Info Tech (N=55)	16.56	4.84	20.98	4.15	4.42	2.97
Elect. Eng. (N=41)	17.54	4.60	21.41	4.13	3.88	2.92

A t-test for independent samples was performed to find out whether significant gains were made on the LPT as a result of the mediated lesson. Significant gains were found for both the Information Technology group ( $t = -5.14$ ,  $df = 108$ ,  $p < 0.0001$ ) and the Electrical Engineering group ( $t = -4.02$ ,  $df = 80$ ,  $p < 0.0001$ ). Generally the students from both groups benefited from the mediated lesson and showed significant improvements in their posttest scores.

An investigation of the minimum and maximum scores of the difference score indicates that there are differences in the way that individual students benefited from the lesson.

There were those students who obtained a high score on the first test of the LPT and these students could be described as higher achieving. They seemed to have developed the necessary problem solving skills during past learning experiences necessary to do well in the LPT. Another group of students obtained low scores on the LPT1 and they could be described as lower achieving. The latter group could be further divided into two groups. The first group attained high scores in the second test of the LPT after having received the mediated lesson and could be described as more modifiable. The second group who did not show much difference between the LPT1 and LPT2 scores could be described as less modifiable. For this group the mediated lesson did not lead to a much higher score on the LPT2.

There are various ways in which dynamic assessment measures may be used to predict academic performance (Hamers & Sijtsma, 1993). The one way is using the difference score between the LPT1 and LPT2. Boeyens (1989b) found that the difference score correlated significantly with a change in mathematics ability. A baseline measure was done at the beginning of the year with a mathematical ability test and then followed up with another measure after a period of time. The difference between the two measures correlated significantly with the difference score between LPT1 and LPT2. The use of the

difference score in predicting academic performance is beset with problems, with the reliability index being a special problem (Embretson, 1987).

Another way to use dynamic assessment measures would be to use the posttest (LPT2) score. This seems to be a more reliable method. For the group of students who started off with a high LPT1, there is less opportunity to obtain a high difference score. In using the LPT2 for predicting academic performance this group has the same opportunity as the group who starts off with a low LPT1 and is able to substantially improve their LPT2 score. The latter group could be seen as more modifiable. The use of LPT2 in predicting academic performance would also identify the group of students who start off with a low LPT1, but are unable to improve on their LPT2 score. These students could be seen as less modifiable. Using the LPT2 scores would also minimise the problematic reliability of the difference scores (Hamers & Sijtsma, 1993).

The samples of Information Technology and Electrical Engineering students were divided into more modifiable and less modifiable groups according to the median of the difference scores. By dichotomising the samples on the basis of the difference score it is hoped to find significant differences between the correlation patterns for the two groups on a number of cognitive and non-cognitive factors. Fisher's Z Transformations was used to test for significant differences between two correlations.

## **2.1 MORE MODIFIABLE VERSUS LESS MODIFIABLE**

A t-test for independent samples indicated that for the total group of students (Electrical Engineering and Information Technology 1993 and 1994 students) the achieving approach to learning ( $t = -2.6$ ,  $p = 0.01$ ,  $df = 144$ ) and achieving strategies ( $t = 2.83$ ,  $p = 0.005$ ,  $df = 144$ ) significantly differentiated between more modifiable and less modifiable students. The differences of the deep approach to learning ( $t = -1.92$ ,  $p = 0.056$ ,  $df = 144$ ) also seems worthwhile to mention when viewed together with the achieving approach to learning differences. In each case the more modifiable students showed higher scores on an achieving and deep approach to learning. A further analysis of the achieving approach to learning shows that it was the achieving strategies rather than the motives that made for the differences. The more modifiable students showed that they had more appropriate and flexible learning strategies which they implemented to increase their cognitive performance.

### 2.1.1 Information Technology

A high and low difference score divided according to the median indicates more modifiable and less modifiable groups of students. Correlations between the SR score, cognitive factors, non-cognitive factors as independent variables and academic performance as dependent variable were calculated for both groups.

**Table 8.2**

**Correlations between SR Score, Cognitive, Non-cognitive Factors and Academic Performance of the More Modifiable Information Technology Students (Diff > 4)**

Variable	CRT	LPT1	LPT2	SR	RCT	MOT
YEAR	0.167 N=23 p=0.446	0.151 N=23 p=0.491	0.157 N=23 p=0.473	0.473* N=22* p=0.026*	0.213 N=23 p=0.328	-0.067 N=23 p=0.761
EXAM	0.091 N=23 p=0.667	0.105 N=23 p=0.631	0.172 N=23 p=0.432	0.430* N=22* p=0.045*	0.223 N=23 p=0.305	0.007 N=23 p=0.974
FINAL	0.110 N=23 p=0.617	0.123 N=23 p=0.573	0.173 N=23 p=0.428	0.458* N=22* p=0.032*	0.228 N=23 p=0.295	-0.018 N=23 p=0.934
CRED	-0.110 N=23 p=0.615	-0.034 N=23 p=0.876	0.010 N=23 p=0.961	0.507* N=22* p=0.016*	0.159 N=23 p=0.466	0.083 N=23 p=0.706

Variable	META	COG	RES	ANX	SURF	DEEP	ACH
YEAR	0.148 N=23 p=0.499	0.202 N=23 p=0.355	0.071 N=23 p=0.745	0.148 N=23 p=0.498	-0.157 N=23 p=0.472	0.211 N=23 p=0.332	0.297 N=23 p=0.169
EXAM	0.113 N=23 p=0.606	0.111 N=23 p=0.614	0.035 N=23 p=0.873	0.096 N=23 p=0.662	-0.201 N=23 p=0.356	0.271 N=23 p=0.210	0.267 N=23 p=0.216
FINAL	0.119 N=23 p=0.586	0.144 N=23 p=0.512	0.049 N=23 p=0.822	0.118 N=23 p=0.591	-0.188 N=23 p=0.388	0.256 N=23 p=0.238	0.288 N=23 p=0.182
CRED	0.110 N=23 p=0.617	0.163 N=23 p=0.455	0.064 N=23 p=0.769	-0.020 N=23 p=0.925	0.027 N=23 p=0.902	0.231 N=23 p=0.289	0.268 N=23 p=0.215

\*p<0.05

Table 8.3

Correlations between SR Score, Cognitive, Non-cognitive Factors and Academic Performance of the Less Modifiable Information Technology Students (Diff < 4)

Variable	CRT	LPT1	LPT2	SR	RCT	MOT
YEAR	0.190 N=27 p=0.341	0.136 N=27 p=0.497	0.106 N=27 p=0.596	0.529* N=24* p=0.008*	-0.062 N=27 p=0.758	0.041 N=27 p=0.837
EXAM	0.087 N=27 p=0.666	0.124 N=27 p=0.536	0.126 N=27 p=0.529	0.505* N=24* p=0.012*	-0.078 N=27 p=0.696	0.151 N=27 p=0.452
FINAL	0.096 N=27 p=0.634	0.137 N=27 p=0.494	0.130 N=27 p=0.516	0.534* N=24* p=0.007*	-0.072 N=27 p=0.720	0.155 N=27 p=0.439
CRED	0.011 N=27 p=0.955	0.147 N=27 p=0.464	0.145 N=27 p=0.468	0.461* N=24* p=0.023*	0.077 N=27 p=0.701	0.295 N=27 p=0.135

Variable	META	COG	RES	ANX	SURF	DEEP	ACH
YEAR	0.334 N=27 p=0.088	0.282 N=27 p=0.153	0.180 N=27 p=0.367	0.252 N=27 p=0.203	0.252 N=27 p=0.204	0.164 N=27 p=0.411	0.401* N=27* p=0.038*
EXAM	0.427* N=27* p=0.026*	0.342 N=27 p=0.081	0.081 N=27 p=0.685	0.193 N=27 p=0.334	0.396* N=27* p=0.040*	0.256 N=27 p=0.197	0.451* N=27* p=0.018*
FINAL	0.403* N=27* p=0.037*	0.336 N=27 p=0.086	0.128 N=27 p=0.523	0.207 N=27 p=0.299	0.367 N=27 p=0.060	0.239 N=27 p=0.229	0.452* N=27* p=0.018*
CRED	0.307 N=27 p=0.119	0.323 N=27 p=0.100	0.119 N=27 p=0.554	0.119 N=27 p=0.553	0.315 N=27 p=0.109	0.213 N=27 p=0.286	0.436* N=27* p=0.023*

\*p<0.05

An inspection of Tables 8.2 and 8.3 shows some differences in correlation patterns for the two groups. For the less modifiable group moderate and significant correlations were found between an achieving approach to learning and academic performance as well as metacognitive strategies and academic performance. In the case of the more modifiable group correlations between these two variables and academic performance was low and not significant. Another significant correlation was found between a surface approach to learning and examinations for the less modifiable group, while for the more modifiable group a negative correlation was found between a surface approach to learning and examinations. The differences between the correlations for the two groups regarding a surface approach to learning proved to be significant (p = 0.04). Both groups showed moderately high and significant correlations between the SR score and academic performance.

In conclusion it seems that the SR score, metacognitive strategies and a combination of a surface and achieving approach to learning are predictors of academic performance in the case of the less modifiable group of students. This finding supports the argument that students with a surface-achieving approach to learning tend to focus on obtaining high marks in the examinations. For the group of students who showed more modifiability a surface approach to learning had an inverse relationship with the examinations mark.

### 2.1.2 Electrical Engineering

The Electrical Engineering students were divided into a more and less modifiable group according to the median of the difference score between LPT1 and LPT2. Correlations between the SR score, cognitive factors, non-cognitive factors as independent variables and academic performance as dependent variable were computed for both groups. The results are shown in Tables 8.4 and 8.5.

Table 8.4

Correlations between SR Score, Cognitive, Non-cognitive Factors and Academic Performance of the More Modifiable Electrical Engineering Students (Diff > 4)

Variable	SR	CRT	LPT1	LPT2	RCT	EAT	MOT
YEAR	0.360 N=16 p=0.170	0.590* N=16* p=0.016*	0.646* N=16* p=0.007*	0.492 N=16 p=0.053	0.228 N=16 p=0.395	0.019 N=16 p=0.943	0.428 N=16 p=0.098
FINAL	0.356 N=16 p=0.175	0.590* N=16* p=0.016*	0.638* N=16* p=0.008*	0.481 N=16 p=0.059	0.204 N=16 p=0.447	-0.013 N=16 p=0.959	0.414 N=16 p=0.111
CRED	0.312 N=16 p=0.239	0.569* N=16* p=0.021*	0.768* N=16* p=0.001*	0.625* N=16* p=0.010*	0.195 N=16 p=0.467	-0.080 N=16 p=0.766	0.367 N=16 p=0.161

Variable	META	COG	RES	ANX	SURF	DEEP	ACH
YEAR	0.246 N=16 p=0.357	0.257 N=16 p=0.336	-0.011 N=16 p=0.966	0.475 N=16 p=0.063	-0.000 N=16 p=0.997	0.311 N=16 p=0.241	0.434 N=16 p=0.093
FINAL	0.236 N=16 p=0.377	0.250 N=16 p=0.350	-0.020 N=16 p=0.939	0.469 N=16 p=0.066	0.002 N=16 p=0.993	0.305 N=16 p=0.250	0.442 N=16 p=0.086
CRED	0.176 N=16 p=0.513	0.177 N=16 p=0.512	-0.097 N=16 p=0.721	0.389 N=16 p=0.136	0.032 N=16 p=0.906	0.137 N=16 p=0.611	0.322 N=16 p=0.224

\*p<0.05

Table 8.5

Correlations between SR Score, Cognitive, Non-cognitive Factors and Academic Performance of the Less Modifiable Electrical Engineering Students (Diff < 4)

Variable	SR	CRT	LPT1	LPT2	RCT	EAT	MOT
YEAR	0.530* N=20* p=0.016*	-0.260 N=20 p=0.267	0.136 N=20 p=0.566	0.101 N=20 p=0.669	0.200 N=20 p=0.396	0.186 N=20 p=0.431	-0.143 N=20 p=0.547
FINAL	0.549* N=20* p=0.012*	-0.268 N=20 p=0.252	0.110 N=20 p=0.643	0.078 N=20 p=0.741	0.184 N=20 p=0.435	0.182 N=20 p=0.441	-0.147 N=20 p=0.536
CRED	0.386 N=20 p=0.093	-0.106 N=20 p=0.656	0.275 N=20 p=0.240	0.238 N=20 p=0.311	0.242 N=20 p=0.304	0.276 N=20 p=0.237	-0.014 N=20 p=0.951

Variable	META	COG	RES	ANX	SURF	DEEP	ACH
YEAR	0.317 N=20 p=0.173	0.133 N=20 p=0.574	-0.105 N=20 p=0.658	0.017 N=20 p=0.941	-0.057 N=17 p=0.828	0.371 N=17 p=0.142	0.219 N=17 p=0.397
FINAL	0.287 N=20 p=0.219	0.109 N=20 p=0.645	-0.124 N=20 p=0.602	0.033 N=20 p=0.889	-0.048 N=17 p=0.854	0.360 N=17 p=0.156	0.204 N=17 p=0.431
CRED	0.381 N=20 p=0.097	0.157 N=20 p=0.506	-0.034 N=20 p=0.887	0.041 N=20 p=0.863	-0.140 N=17 p=0.590	0.277 N=17 p=0.281	0.144 N=17 p=0.581

\*p<0.05

From Tables 8.4 and 8.5 it can be seen that there are differences in the correlation patterns of the two groups. For the more modifiable group a moderately high and significant correlation was found between the CRT and academic performance. In contrast to this, for the less modifiable group the correlation between the CRT and academic performance was found to be negative. The differences in correlations between the two groups were significant ( $p = 0.02$  for final marks and  $p = 0.045$  for credits obtained). The CRT is an example of a dynamic assessment procedure. Negative correlations were found between the EAT (an example of a static test) and academic performance for the more modifiable group.

Another measure of learning potential, the LPT2, also produced a significant correlation with academic performance (credit) for the more modifiable group, while moderately low correlations were obtained between LPT2 and academic performance for the less modifiable group. At the same time significant correlations were found between the SR score and academic performance (final) for the less modifiable group, but not for the more modifiable group. Other differences were for motivation and test anxiety. In both cases the more modifiable group showed moderate correlations, while for the less

modifiable group negative correlations (motivation) and low correlations (test anxiety) were found with academic performance.

In conclusion, it can be reported that different correlation patterns are found for the more modifiable and less modifiable groups of students. For the more modifiable group the CRT, LPT2 (examples of dynamic assessment), motivation and management of test anxiety seemed to be better predictors of academic performance. For the less modifiable group the SR score and metacognitive strategies seemed to be the better predictors of academic performance. Whereas the dynamic assessment procedures (CRT and LPT2) obtained moderately high and significant correlations with academic performance an example of a static aptitude test (EAT) showed negative correlations with academic performance for this group.

In comparing the Information Technology and Electrical Engineering groups certain commonalities and differences emerge. Both disciplines showed that the SR score and metacognitive strategies obtained higher correlations with academic performance for the less modifiable group than for the more modifiable group. The significant correlations obtained between the CRT, LPT2 and academic performance for Electrical Engineering (more modifiable group) was not repeated for the Information Technology students. These differences might be explained by the fact that Electrical Engineering makes use of continuous assessment whereas Information Technology uses an examinations based system.

## **2.2 LOWER ACHIEVING / MORE MODIFIABLE**

Besides taking modifiability into consideration when comparing correlation patterns, it is also necessary to look at students' level of initial achievement as reflected in their LPT1 score. This indicates their level of performance before being exposed to the mediated lesson. The students who obtained a high LPT1 score could be described as higher achieving. This group can be seen as already possessing the problem solving skills needed to perform well in the LPT. The group of students who did not perform well on the LPT1 could be described as lower achieving. Some of these students did not benefit from the mediated lesson and can be described as less modifiable as opposed to the group who did benefit and who can be described as more modifiable. The group of students who did benefit from the mediated lesson is the group that will be focused on in this

section. This group could be described as lower achieving/more modifiable and would represent those students who had an initial low score on the LPT1, but then showed themselves to be more modifiable by scoring substantially higher on the LPT2 after receiving the mediated lesson.

## 2.2.1 Information Technology

A lower achieving/more modifiable group was formed from the Information Technology students using the LPT1 and difference score medians (LPT1 < 17, difference > 4). Correlations were computed between the SR score, cognitive factors, non-cognitive factors as independent variables and academic performance as dependent variable and the results are shown in Table 8.6.

Table 8.6

Correlations between SR Score, Cognitive, Non-cognitive Factors  
and Academic Performance  
of the Lower Achieving/More Modifiable Information Technology Students  
(LPT1 < 17, Diff > 4)

Variable	CRT	LPT1	LPT2	SR	RCT	MOT
YEAR	0.099 N=16 p=0.714	0.221 N=16 p=0.410	0.247 N=16 p=0.356	0.204 N=15 p=0.465	0.056 N=16 p=0.834	0.058 N=16 p=0.828
EXAM	0.024 N=16 p=0.929	0.234 N=16 p=0.382	0.363 N=16 p=0.166	0.121 N=15 p=0.666	0.051 N=16 p=0.851	0.219 N=16 p=0.414
FINAL	0.050 N=16 p=0.854	0.252 N=16 p=0.345	0.349 N=16 p=0.184	0.160 N=15 p=0.569	0.059 N=16 p=0.827	0.176 N=16 p=0.514
CRED	-0.024 N=16 p=0.929	0.375 N=16 p=0.152	0.418 N=16 p=0.107	0.141 N=15 p=0.614	0.034 N=16 p=0.898	0.387 N=16 p=0.139

Variable	META	COG	RES	ANX	SURF	DEEP	ACH
YEAR	0.427 N=16 p=0.098	0.403 N=16 p=0.121	0.281 N=16 p=0.291	0.122 N=16 p=0.650	-0.180 N=16 p=0.505	0.603* N=16* p=0.013*	0.544* N=16* p=0.029*
EXAM	0.404 N=16 p=0.120	0.317 N=16 p=0.230	0.254 N=16 p=0.342	0.119 N=16 p=0.660	-0.184 N=16 p=0.493	0.642* N=16* p=0.007*	0.482 N=16 p=0.059
FINAL	0.415 N=16 p=0.109	0.358 N=16 p=0.173	0.272 N=16 p=0.308	0.133 N=16 p=0.621	-0.184 N=16 p=0.494	0.643* N=16* p=0.007*	0.524* N=16* p=0.037*
CRED	0.374 N=16 p=0.153	0.356 N=16 p=0.176	0.210 N=16 p=0.434	0.061 N=16 p=0.823	-0.014 N=16 p=0.958	0.460 N=16 p=0.072	0.427 N=16 p=0.099

\*p<0.05

An inspection of Table 8.6 shows that a different correlation pattern emerges for the lower achieving/more modifiable group in comparison to the total group of Information Technology students. For the total group the SR score showed moderate and significant correlations with academic performance, while the LPT2 showed low correlations. With the lower achieving/more modifiable group of students the SR score does not seem to be a good predictor of academic performance, while the LPT2 showed higher correlations with academic performance. Significant correlations between a deep and achieving approach to learning and academic performance was present in both groups.

### 2.2.2 Electrical Engineering

A lower achieving/more modifiable group of students was selected from the total group using the medians of the LPT1 and difference score (LPT < 18, difference score > 4). Correlations were computed for this group between SR score, cognitive factors, non-cognitive factors as independent variables and academic performance as dependent variable. The results are shown in Table 8.7.

Table 8.7  
Correlations between SR Score, Cognitive, Non-cognitive Factors  
and Academic Performance  
of the Lower Achieving/More Modifiable Electrical Engineering Students  
(LPT1 < 18, Diff > 4)

Variable	SR	CRT	LPT1	LPT2	RCT	EAT	MOT
YEAR	0.253 N=11 p=0.452	0.568 N=11 p=0.068	0.561 N=11 p=0.072	0.325 N=11 p=0.329	0.236 N=11 p=0.483	0.032 N=11 p=0.925	0.315 N=11 p=0.344
FINAL	0.259 N=11 p=0.441	0.587 N=11 p=0.057	0.588 N=11 p=0.057	0.348 N=11 p=0.294	0.226 N=11 p=0.503	0.004 N=11 p=0.990	0.311 N=11 p=0.351
CREDIT	0.280 N=11 p=0.404	0.610* N=11* p=0.046*	0.851* N=11* p=0.001*	0.639* N=11* p=0.034*	0.175 N=11 p=0.605	-0.176 N=11 p=0.603	0.293 N=11 p=0.382

Variable	META	COG	RES	ANX	SURF	DEEP	ACH
YEAR	0.222 N=11 p=0.510	0.109 N=11 p=0.748	-0.152 N=11 p=0.655	0.536 N=11 p=0.089	-0.075 N=11 p=0.825	0.220 N=11 p=0.515	0.443 N=11 p=0.172
FINAL	0.216 N=11 p=0.523	0.115 N=11 p=0.734	-0.147 N=11 p=0.665	0.526 N=11 p=0.096	-0.058 N=11 p=0.864	0.209 N=11 p=0.536	0.454 N=11 p=0.160
CREDIT	0.122 N=11 p=0.720	0.066 N=11 p=0.846	-0.219 N=11 p=0.518	0.403 N=11 p=0.219	-0.127 N=11 p=0.935	0.098 N=11 p=0.773	0.291 N=11 p=0.385

\*p<0.05

Table 8.7 shows that high and significant correlations were obtained between the variables CRT, LPT1, LPT2 and academic performance (credits obtained) for the lower achieving/more modifiable group. In contrast to this, for the total group of Electrical Engineering students the SR score was the only variable that obtained a moderate and significant correlation with academic performance. The differences between the correlations of the two groups were significant for the LPT1 ( $p = 0.01$ ).

In conclusion, a pattern can be seen to emerge for both the Information Technology and Electrical Engineering students regarding predictors of academic performance. For the total groups the SR score is a significant predictor of academic performance, but for the lower achieving/more modifiable groups not the SR score, but the LPT2 and LPT1 and the CRT (in the case of Electrical Engineering), showed higher correlations with academic performance. This indicates different predictors for different groups of disadvantaged students. The matriculation marks (which is represented by the SR score) does not seem to be a good predictor for the group of students who are lower achieving, but who are able to benefit from a mediated lesson. A better predictor for this group seems to be the dynamic assessment procedures.

### **2.3 ATTEMPTS AT PROBLEM SOLVING**

An inspection of students' LPT answersheets showed that some students made a large number of attempts at solving the problems, while other students made fewer attempts at solving the problems. In an effort to investigate the implications of students' number of attempts at problem solving on both the pretest and posttest of the LPT, the combined group of Electrical Engineering and Information Technology students were divided into a less modifiable and more modifiable group using the lower and upper quartile of the difference score between LPT1 and LPT2. The means and standard deviations for the number of attempts on LPT1 and LPT2 in the less modifiable and more modifiable groups are shown in Table 8.8.

Table 8.8

Means and Standard Deviations of Problem Solving Attempts for Less and More Modifiable Groups

	Attempts on LPT1		Attempts on LPT2		Valid N
	Mean	Std Dev.	Mean	Std Dev.	
Less modifiable	22.43	3.27	23.75	3.60	28
More modifiable	21.88	3.26	24.81	2.31	32

A t-test for independent samples showed that for the more modifiable group the number of attempts on the LPT2 were significantly higher than the attempts on the LPT1 ( $t = -4.16$ ,  $df = 62$ ,  $p = 0.0001$ ), but that no significant differences existed for the less modifiable group. The trend seemed to be that the more modifiable group of students started off with a lower number of attempts on the LPT1, but were then able to increase the number of attempts significantly on the LPT2 so that in the end there was a trend for them to have more attempts on the LPT2 than the less modifiable group.

Each of the less modifiable and more modifiable groups were further divided into a low and high number of attempts on the pretest and posttest of the LPT. In this way it was possible for the speed and accuracy factors to be controlled to a certain extent.

Correlations were calculated between the students' academic performance as dependent variable and a number of cognitive and non-cognitive factors as independent variables for the groups of less and more modifiable students with a lower number of attempts at problem solving on the pretest of the LPT. Tables 8.9 and 8.10 show the results of the correlation matrix.

Table 8.9

Correlations between Academic Performance and Cognitive and Non-cognitive Factors for Less Modifiable Students with a Low Number of Attempts on LPT1 (< 23)

Variable	LPT1	LPT2	RCT	CRT	SR	MOT	META
YEAR	0.379 N=13 p=0.201	0.396 N=13 p=0.180	0.587* N=13* p=0.035*	0.139 N=13 p=0.649	0.858* N=12* p=0.004*	-0.686* N=13* p=0.010*	-0.159 N=13 p=0.604
FINAL	0.297 N=13 p=0.323	0.306 N=13 p=0.308	0.465 N=13 p=0.109	0.068 N=13 p=0.825	0.890* N=12* p=0.004*	-0.666* N=13* p=0.013*	0.019 N=13 p=0.949
CRED	0.431 N=13 p=0.141	0.378 N=13 p=0.202	0.399 N=13 p=0.177	0.039 N=13 p=0.897	0.600* N=12* p=0.039*	-0.290 N=13 p=0.336	0.044 N=13 p=0.885

Table 8.9 (continued)

Variable	COG	RES	ANX	SURF	DEEP	ACH
YEAR	-0.415 N=13 p=0.158	-0.192 N=13 p=0.529	0.472 N=13 p=0.103	-0.312 N=12 p=0.323	-0.212 N=12 p=0.507	-0.288 N=12 p=0.362
FINAL	-0.291 N=13 p=0.334	-0.174 N=13 p=0.569	0.501 N=13 p=0.081	-0.128 N=12 p=0.691	-0.036 N=12 p=0.911	-0.295 N=12 p=0.351
CRED	-0.188 N=13 p=0.537	-0.031 N=13 p=0.920	0.379 N=13 p=0.202	-0.385 N=12 p=0.216	0.019 N=12 p=0.951	-0.164 N=12 p=0.610

\*p<0.05

Table 8.10

Correlations between Academic Performance and Cognitive and Non-cognitive Factors for More Modifiable Students with a Low Number of Attempts on LPT1 (< 22)

Variable	LPT1	LPT2	RCT	CRT	SR	MOT	META
YEAR	0.810* N=16* p=0.004*	0.744* N=16* p=0.001*	0.218 N=16 p=0.416	0.509* N=16* p=0.044*	0.409 N=16 p=0.116	0.623* N=16* p=0.010*	-0.008 N=16 p=0.975
FINAL	0.842* N=16* p=0.004*	0.826* N=16* p=0.004*	0.292 N=16 p=0.271	0.444 N=16 p=0.084	0.313 N=16 p=0.237	0.677* N=16* p=0.004*	-0.041 N=16 p=0.880
CRED	0.831* N=16* p=0.004*	0.833* N=16* p=0.004*	0.261 N=16 p=0.329	0.440 N=16 p=0.088	0.353 N=16 p=0.179	0.716* N=16* p=0.002*	0.071 N=16 p=0.792

Variable	COG	RES	ANX	SURF	DEEP	ACH
YEAR	0.105 N=16 p=0.699	-0.012 N=16 p=0.962	0.440 N=16 p=0.088	-0.055 N=16 p=0.837	0.324 N=16 p=0.220	0.359 N=16 p=0.171
FINAL	0.081 N=16 p=0.765	0.024 N=16 p=0.929	0.452 N=16 p=0.101	-0.185 N=16 p=0.493	0.314 N=16 p=0.235	0.376 N=16 p=0.151
CRED	0.128 N=16 p=0.635	0.010 N=16 p=0.968	0.317 N=16 p=0.231	-0.042 N=16 p=0.877	0.253 N=16 p=0.344	0.408 N=16 p=0.116

\*p<0.05

An inspection of Tables 8.9 and 8.10 shows a clear pattern emerging. For the less modifiable group, positive and significant correlations are found between academic performance and the Swedish Rating of the matriculation marks, while for the more modifiable group LPT2 shows a positive and significant correlation with academic performance. Motivation, LPT1 and the CRT (year mark) also show positive and significant correlations.

These differences in patterns between the less and more modifiable groups continue for a low number of attempts on the LPT2. The less modifiable group shows a positive and significant relationship between LPT1 and credits obtained ( $r = 0.63$ ,  $p = 0.05$ ) and a positive and significant correlation between academic performance and the Swedish Rating score of the matriculation marks (year mark:  $r = 0.9$ ,  $p = 0.001$ ; final mark:  $r = 0.93$ ,  $p = 0.0004$ ). On the other hand the more modifiable group shows a positive and significant correlation between LPT2 and CRT and academic performance (credits obtained:  $r = 0.79$ ,  $p = 0.0004$  and  $r = 0.59$ ,  $p = 0.15$ ) while showing a low correlation with the Swedish Rating score ( $r = 0.13$ ,  $p = 0.62$ ). Significant differences in correlations were found between the two groups on motivation ( $p = 0.01$ ) for credits obtained.

This pattern replicates the pattern found with the less achieving/more modifiable group. The results indicate that although the matriculation marks are better predictors of academic performance for some students, for other students who are more modifiable a dynamic assessment instrument might be a more appropriate predictor of academic performance.

## 2.4 RIGID APPLICATIONS

An inspection of the students' LPT answersheets showed that a small group of students attempted less items on the posttest than the pretest. A closer look at their problem solving methods on the answersheets indicated that they applied the methods shown in the mediated lesson in such a rigid way that this led to the lesser attempts on the LPT2 in the time allocated to them. This group of students which consisted of five Electrical Engineering and five Information Technology students were seen as a different group and compared to the combined group of Electrical Engineering and Information Technology students for differences in cognitive and learning profiles. Students were allocated to the rigid group where the difference between the number of attempts of items on the LPT1 and LPT2 was two or more, with the number of attempts on the LPT2 always being less than that of the LPT1. The results of a t-test for independent samples are shown in Table 8.11.

Table 8.11

Comparison between the Rigid Group and the Combined Group of Information Technology and Electrical Engineering Students

Variable	Mean		t-value	df	p
	Combined	Rigid			
LPT1	16.979	18.700	-1.133	104	0.2595
LPT2	21.166*	17.300*	2.885*	104*	0.0047*
DIFF	4.187*	-1.400*	5.719*	104*	0.0004*
RCT	6.729	6.400	0.331	104	0.7412
CRT	19.177	21.500	-1.363	104	0.1755
MOT	188.062	194.111	-1.076	103	0.2841
META	59.260	61.777	-0.706	103	0.4814
COG	155.864	169.333	-1.546	103	0.1251
RES	92.010*	103.000*	-2.273*	103*	0.0250*
ANX	17.916	19.777	-0.834	103	0.4057
SURF	49.684	50.444	-0.293	99	0.7697
DEEP	48.837	47.666	0.413	99	0.6798
ACH	50.467	50.000	0.164	99	0.8698
YEAR	52.371	53.530	-0.286	104	0.7752
FINAL	51.654	48.870	0.598	104	0.5506
CRED	16.229	15.200	0.365	104	0.7151
SR	31.978	32.500	-0.198	98	0.8430

Variable	Std dev.		Valid N	
	Combined	Rigid	Combined	Rigid
LPT1	4.739	2.002	96	10
LPT2	4.123*	2.907*	96*	10*
DIFF	2.946*	2.875*	96*	10*
RCT	3.031	2.547	96	10
CRT	5.115	5.233	96	10
MOT	16.220	14.793	96	9
META	10.522	5.472	96	9
COG	25.747	12.951	96	9
RES	14.258*	7.858*	96*	9*
ANX	6.501	4.969	96	9
SURF	7.513	6.125	92	9
DEEP	8.355	4.153	92	9
ACH	8.334	5.545	92	9
YEAR	12.090	13.019	96	10
FINAL	13.570	17.853	96	10
CRED	8.374	9.342	96	10
SR	7.066	7.910	92	8

\*p<0.05

An inspection of Table 8.11 shows that although there are no significant differences between the two groups on the LPT1 score, the LPT2 and difference score do show significant differences. The rigid group actually shows a lower score for the LPT2 than the LPT1. Instead of assisting the rigid group of students to improve their LPT2, as happened with the other group, the mediated lesson seemed to make them aware of the complexity of the problems and seemed to make them more methodical and subsequently slower in their applications of the lesson to the problems in LPT2.

Although there was a trend that the rigid group showed slightly better SR scores, their final mark and credits obtained were slightly lower than the other group's marks. These differences were not statistically significant. The only significant difference regarding the non-cognitive factors was on the resource management scores, where the rigid group obtained the higher score.

Correlations were computed for the rigid group of students between the SR score, cognitive factors, non-cognitive factors as independent variables and academic performance as dependent variable. The results are shown in Table 8.12.

Table 8.12

Correlations between SR Score, Cognitive, Non-cognitive Factors and Academic Performance of the Rigid Group of Students

Variable	LPT1	LPT2	RCT	CRT	SR	MOT	META
YEAR	0.093 N=10 p=0.798	-0.470 N=10 p=0.170	0.274 N=10 p=0.443	0.022 N=10 p=0.951	0.844* N=8* p=0.008*	0.797* N=9* p=0.010*	0.064 N=9 p=0.869
FINAL	-0.145 N=10 p=0.689	-0.582 N=10 p=0.077	-0.304 N=10 p=0.393	-0.359 N=10 p=0.307	0.402 N=8 p=0.322	0.761* N=9* p=0.017*	-0.045 N=9 p=0.907
CRED	-0.014 N=10 p=0.969	-0.636* N=10* p=0.048*	-0.386 N=10 p=0.270	-0.268 N=10 p=0.454	0.061 N=8 p=0.886	0.666* N=9* p=0.050*	-0.405 N=9 p=0.279

Variable	COG	RES	ANX	SURF	DEEP	ACH
YEAR	0.307 N=9 p=0.422	0.479 N=9 p=0.192	0.631 N=9 p=0.068	0.030 N=9 pP=0.938	0.257 N=9 p=0.503	0.407 N=9 p=0.277
FINAL	0.202 N=9 p=0.602	0.362 N=9 p=0.338	0.503 N=9 p=0.167	0.087 N=9 p=0.824	0.210 N=9 p=0.588	0.385 N=9 p=0.305
CRED	-0.133 N=9 p=0.732	-0.000 N=9 p=1.000	0.240 N=9 p=0.533	-0.234 N=9 p=0.543	0.446 N=9 p=0.228	0.449 N=9 p=0.225

\*p<0.05

Correlations between the SR score, cognitive factors, non-cognitive factors and academic performance were calculated for the combined group of students. The results are shown in Table 8.13.

Table 8.13

Correlations between SR Score, Cognitive, Non-cognitive Factors and Academic Performance for the Combined Group

Variable	LPT1	LPT2	RCT	CRT	SR	MOT
YEAR	0.147 M=96 p=0.152	0.128 N=96 p=0.213	0.111 N=96 p=0.281	0.045 N=96 p=0.662	0.498* N=92* p=0.000*	0.022 N=96 p=0.827
FINAL	0.115 N=96 p=0.261	0.163 N=96 p=0.111	0.051 N=96 p=0.619	0.022 N=96 p=0.828	0.522* N=92* p=0.000*	0.120 N=96 p=0.242
CRED	0.114 N=96 p=0.268	0.159 N=96 p=0.120	0.101 N=96 p=0.327	-0.052 N=96 p=0.611	0.482* N=92* p=0.000*	0.218* N=96* p=0.033*

Variable	META	RES	ANX	SURF	DEEP	ACH
YEAR	0.233* N=96* p=0.022*	0.000 N=96 p=0.997	0.153 N=96 p=0.135	0.074 N=92 p=0.481	0.279* N=92* p=0.007*	0.283* N=92* p=0.006*
FINAL	0.302* N=96* p=0.003*	0.043 N=96 p=0.675	0.170 N=96 p=0.098	0.037 N=92 p=0.726	0.323* N=92* p=0.002*	0.373* N=92* p=0.000*
CRED	0.327* N=96* p=0.001*	0.045 N=96 p=0.663	0.077 N=96 p=0.452	0.088 N=92 p=0.402	0.291* N=92* p=0.005*	0.344* N=92* p=0.001*

\*p<0.05

A comparison of Tables 8.12 and 8.13 shows different correlation patterns for the two groups. For the rigid group the LPT2 score attained a significant negative correlation with academic performance, while for the combined group a positive correlation was found. The differences in correlation was significant ( $p = 0.02$ ). Although the SR score obtained high significant relationship with the year mark for both groups, for the rigid group the SR relationship with credits obtained was low, while for the combined group high and significant correlation was found between the SR score and academic performance.

For the combined group metacognitive strategies obtained moderate and significant correlations with academic performance, while for the rigid group high negative correlations were found between metacognitive strategies and credits obtained. The difference in correlation was not significant ( $p = 0.07$ ). Motivation showed a high and significant relationship with the year mark for the rigid group, but for the combined group a low correlation was found between motivation and year mark. The difference in correlations was significant ( $p = 0.02$ ).

It is evident that the LPT scores are not a good indication of the rigid group of students' academic performance. The SR score could seemingly be used to predict the year mark,

but this does not follow through as far as the credits obtained is concerned. Motivation was found to be the most consistent indicator of academic performance for this group. It must be noted that these interpretations have to be viewed with some caution, because of the small size of the rigid group.

### **3. GROUP COMPARISONS**

One of the aims of the study is to differentiate between various groups of students according to a number of cognitive and non-cognitive factors. The different groupings that were identified for analysis are the following:

- (1) Students from schools of the Department of Education and Training (DET) versus students from non-DET schools
- (2) Students with a higher Socio-economic background versus students from a lower Socio-economic status (SES)
- (3) Students who have English as a first language (Eng 1) versus students who have English as a second language (Eng 2)
- (4) Male versus Female students
- (5) Engineering versus Business Management students
- (6) More successful versus less successful students (pass/fail)
- (7) First year students versus third year students (longitudinal study).

The comparisons were done firstly with the combined group of Information Technology and Electrical Engineering students. The comparisons are repeated in certain instances with the total group of students, which consists of the above-mentioned two academic departments plus Business Management, Art and Design, Information Technology, Food Science and Horticulture. With the total group a larger sample of students made the comparisons more meaningful.

A t-test for independent samples was done to establish significant differences between the groups. The level of significance is set at 0.05 (two-tailed). In the case of a type 1 error this would mean that 5% of the sample means could lead to an erroneous conclusion.

### 3.1 DET STUDENTS VERSUS NON-DET STUDENTS

The subjects were the combined group of Information Technology and Electrical Engineering students. Students from DET schools were compared to students from non-DET schools using the SR score, academic performance and a number of cognitive and non-cognitive factors. The results of a t-test to establish significant differences are shown in Table 8.14.

Table 8.14

Comparison between DET and Non-DET Groups for the Combined Group of Information Technology and Electrical Engineering Students

Variable	Mean		t-value	df	p
	DET	Non-DET			
LPT1	14.50	17.14	-1.328	94	0.187
LPT2	18.16	21.36	-1.864	94	0.065
DIFF	3.66	4.22	-0.445	94	0.657
RCT	2.83*	6.98*	-3.430*	94*	0.001*
CRT	14.50*	19.48*	-2.368*	94*	0.019*
MOT	191.16	187.85	0.482	94	0.630
META	64.00	58.94	1.141	94	0.256
RES	99.33	91.52	1.304	94	0.195
ANX	16.66	18.00	-0.484	94	0.629
SURF	50.50	49.62	0.273	90	0.785
DEEP	54.00	48.47	1.578	90	0.117
ACH	55.33	50.12	1.489	90	0.139
YEAR	45.00	52.86	-1.553	94	0.123
FINAL	53.53	51.52	0.348	94	0.728
CRED	17.66	16.13	0.432	94	0.666
SR	30.40	32.06	-0.511	90	0.610

Variable	Std dev.		Valid N	
	DET	Non-DET	DET	Non-DET
LPT1	6.83	4.57	6	90
LPT2	7.52	3.78	6	90
DIFF	2.94	2.95	6	90
RCT	1.32*	2.93*	6*	90*
CRT	3.14*	5.07*	6*	90*
MOT	17.85	16.19	6	90
META	6.63	10.68	6	90
RES	10.21	14.39	6	90
ANX	8.21	6.41	6	90
SURF	7.42	7.56	6	90
DEEP	9.18	8.23	6	90
ACH	7.91	8.29	6	90
YEAR	20.99	11.29	6	90
FINAL	9.28	13.83	6	90
CRED	9.33	8.35	6	90
SR	3.84	7.21	5	87

\*p<0.05

Table 8.14 shows that the DET students had lower scores on the cognitive variables (LPT1, LPT2, Difference score, RCT, CRT) although only the differences on the RCT ( $t = 3.43, p = 0.0008, df = 94$ ) and the CRT ( $t = 2.368, p = 0.019, df = 94$ ) proved to be significant. There was a trend for the non-DET students to benefit more from the mediated lesson, although the differences between the difference score of the two groups were not significant. The DET students generally had higher scores on all the non-cognitive variables, except for the management of test anxiety measure where the DET students' scores (a low score indicates higher anxiety) showed that they are more anxious in a test situation. The trend was that DET students obtained lower scores on the SR score of the matriculation marks and also for the technikon year mark, but then did better as a group in the final mark and with credits obtained.

The differences between the groups of scores obtained in the cognitive and non-cognitive variables and the SR score and academic marks indicated that there might be differences in the correlation patterns for the two groups. Correlations were computed between the SR score, cognitive factors, non-cognitive factors as independent variables and academic performance as dependent variable. The results are shown in Tables 8.15 and 8.16.

Table 8.15

Correlations between SR Score, Cognitive, Non-cognitive Factors and Academic Performance for Combined Group of DET Students

Variable	LPT1	LPT2	RCT	CRT	SR	RES
YEAR	0.156 N=6 p=0.767	0.003 N=6 p=0.994	0.264 N=6 p=0.612	-0.421 N=6 p=0.405	-0.396 N=5 p=0.509	-0.323 N=6 p=0.532
FINAL	0.564 N=6 p=0.244	0.714 N=6 p=0.111	0.674 N=6 p=0.142	0.722 N=6 p=0.105	-0.405 N=5 p=0.499	0.081 N=6 p=0.877
CRED	0.824* N=6* p=0.043*	0.855* N=6* p=0.030*	0.768 N=6 p=0.074	0.810 N=6 p=0.050	-0.019 N=5 p=0.975	-0.296 N=6 p=0.568

Variable	ANX	SURF	DEEP	ACH	MOT	META
YEAR	0.099 N=6 p=0.851	0.556 N=6 p=0.252	0.645 N=6 p=0.166	-0.368 N=6 p=0.473	-0.378 N=6 p=0.459	-0.013 N=6 p=0.980
FINAL	0.972* N=6* p=0.001*	-0.344 N=6 p=0.504	0.455 N=6 p=0.364	-0.573 N=6 p=0.234	0.314 N=6 p=0.544	0.556 N=6 p=0.251
CRED	0.796 N=6 p=0.058	-0.759 N=6 p=0.080	0.037 N=6 p=0.944	-0.750 N=6 p=0.085	0.235 N=6 p=0.653	0.181 N=6 p=0.732

\*p<0.05

Table 8.16

Correlations between SR Score, Cognitive, Non-cognitive Factors and Academic Performance for Combined Group of Non-DET Students

Variable	LPT1	LPT2	RCT	CRT	SR	RES
YEAR	0.124 N=90 p=0.767	0.121 N=90 p=0.253	0.056 N=90 p=0.597	0.036 N=90 p=0.736	0.566* N=87* p=0.004*	0.048 N=90 p=0.651
FINAL	0.099 N=90 p=0.352	0.140 N=90 p=0.186	0.057 N=90 p=0.594	0.015 N=90 p=0.883	0.538* N=87* p=0.004*	0.037 N=90 p=0.724
CRED	0.056 N=90 p=0.600	0.089 N=90 p=0.402	0.106 N=90 p=0.319	-0.076 N=90 p=0.472	0.507* N=87* p=0.004*	0.054 N=90 p=0.609

Variable	ANX	SURF	DEEP	ACH	MOT	META
YEAR	0.155 N=90 p=0.143	0.029 N=86 p=0.787	0.276* N=86* p=0.101*	0.394* N=86* p=0.000*	0.078 N=90 p=0.462	0.284* N=90* p=0.006*
FINAL	0.132 N=90 p=0.204	0.050 N=86 p=0.643	0.316* N=86* p=0.003*	0.408* N=86* p=0.000*	0.111 N=90 p=0.295	0.294* N=90* p=0.005*
CRED	0.022 N=90 p=0.832	0.141 N=86 p=0.195	0.305* N=86* p=0.004*	0.408* N=86* p=0.000*	0.215* N=90* p=0.042*	0.332* N=90* p=0.001*

\*p<0.05

An inspection of Tables 8.15 and 8.16 shows different correlation patterns for the two groups. For the DET students significant correlations were obtained between academic performance (credits), CRT ( $r = 0.810$ ,  $p = 0.05$ ) and LPT2 ( $r = 0.856$ ,  $p = 0.03$ ), while the management of test anxiety correlated significantly with final marks ( $r = 0.977$ ,  $p = 0.001$ ). For the non-DET group, significant correlations were found with metacognition, deep and achieving approach to learning and the SR score of matriculation marks. While the SR score correlated significantly with academic performance for the non-DET group, for the DET group a negative correlation was found between the SR score and academic performance. These findings have to be treated with caution because of the small sample of DET students.

The above results seem to suggest the trend that dynamic assessment procedures are better predictors of academic performance for DET students than the SR score. In order to obtain a larger sample the total group of students was used to make comparisons between the DET and non-DET groups. This sample consists of students of both the 1993 and 1994 intake of students and includes Information Technology, Electrical Engineering, Business Management, Art and Design, Food Technology and Horticulture.

Unfortunately it was not possible to calculate the SR score for this sample of students, but in the place of the SR score, individual matriculation subjects Mathematics (Maths), Physical Science (Science), Accounting (Acc), English (Eng), a second language (Lang 2) and an extra subject (Ext Subj.) was used. The results of a t-test for independent samples are shown in Table 8.17.

**Table 8.17**  
Comparison between DET and Non-DET Groups  
for the Total Group of Students of 1993 and 1994 Intakes

Variable	Mean		t-value	df	p
	DET	Non-DET			
LPT1	13.78	16.99	-2.52	203	0.013*
LPT2	15.50	20.53	-4.52	201	0.004*
DIFF	2.71	3.71	-1.15	201	0.250
RCT	4.81	6.47	-2.81	293	0.005*
CRT	13.93	18.54	-4.89	350	0.0004*
MOT	199.43	191.75	2.63	361	0.009*
META	62.10	58.69	2.34	351	0.020*
COG	167.41	155.76	2.22	360	0.002*
RES	94.87	90.15	3.12	361	0.027*
ANX	21.12	21.03	0.09	361	0.931
SURF	51.64	50.93	0.59	357	0.554
DEEP	53.95	48.78	4.34	357	0.0004*
ACH	55.68	50.65	4.11	357	0.0004*
MATHS	2.67	2.44	0.82	315	0.412
SCIENCE	2.65	2.59	0.07	253	0.945
ACC	2.28	2.05	0.51	189	0.612
ENG	3.97	5.03	-0.70	352	0.487
LANG 2	4.08	3.92	0.27	351	0.788
EXT SUBJ.	3.26	3.35	-0.31	350	0.754

Variable	Std dev.		Valid N	
	DET	Non-DET	DET	Non-DET
LPT1	5.45	4.54	14	191
LPT2	6.06	3.84	14	189
DIFF	3.25	3.10	14	189
RCT	2.40	2.67	22	273
CRT	3.75	5.19	32	320
MOT	16.33	19.24	48	315
META	10.61	9.22	48	315
COG	23.78	24.14	48	314
RES	15.92	13.37	48	315
ANX	7.21	6.85	48	315
SURF	7.73	7.68	48	311
DEEP	7.08	7.77	48	311
ACH	6.96	8.03	48	311
MATHS	1.07	1.54	31	286
SCIENCE	1.29	4.42	26	229
ACC	1.63	1.66	14	177
ENG	1.20	8.94	35	319
LANG 2	1.50	3.57	35	318
EXT SUBJ.	1.16	1.64	34	318

\*p<0.05

Table 8.17 shows that the DET students tend to have significantly higher scores on the non-cognitive learning factors (motivation metacognition, management of resources and a deep and achieving approach to learning). In contrast to this the DET students scored significantly lower on the cognitive measurements (LPT1, LPT2, RCT, CRT), while their difference score was also lower. No significant differences between Matriculation subject symbols could be found. There was a trend for the DET group to have marginally higher scores in Mathematics, Science, Accounting and a second language, while they scored lower in English and the extra subject.

An inspection of Tables 8.14 and 8.17 indicates that there is a similar pattern in the combined group of Information Technology and Electrical Engineering students and the total group of students. The DET students tend to have higher scores on the non-cognitive factors and lower scores on the cognitive factors. The difference scores of the DET group is also lower which means that they did not benefit to the same degree from the mediated lesson as the non-DET students. This result supports the findings of Shochet (1986) that educationally advantaged students benefitted more from the mediated lesson than the disadvantaged students.

In conclusion there seem to be clear differences between the DET and non-DET groups. The DET students who represent an even more academically disadvantaged group than the non-DET students consistently scored higher on the non-cognitive measures while scoring consistently lower on the cognitive measures. The findings also suggest that for the DET students the dynamic assessment procedures tend to be better predictors of academic performance than the SR score of the matriculation marks. The schooling background of the students tended to have a moderator effect in the prediction of academic performance (Shochet, 1994).

### **3.2 HIGHER SES VERSUS LOWER SES**

A rough socio-economic status (SES) index was devised using a combination of parents' academic qualifications and occupational status. Although the traditional, static ability tests or intellectual tests are sensitive to high or low SES, dynamic assessment techniques should be impervious to the influence of the socio-economic status of students. The two groups were split by using the lower quartile and upper quartile of the SES index (lower SES < 6, higher SES > 14).

Table 8.18

Comparison between the Lower SES and Higher SES Groups for the Combined Group of Information Technology and Electrical Engineering Students

Variable	Mean		t-value	df	p
	Lower SES	Higher SES			
RCT	6.36	7.36	-0.940	36	0.353
CRT	16.78	18.05	-0.729	36	0.470
MOT	190.94	188.00	0.522	36	0.604
META	59.73	62.15	-0.726	36	0.472
COG	160.89	161.78	-0.124	36	0.901
RES	90.31	91.42	-0.217	36	0.828
ANX	17.94	17.89	0.022	36	0.982
SURF	49.66	47.38	0.818	34	0.418
DEEP	52.88	50.83	0.730	34	0.470
ACH	54.16	50.11	1.596	34	0.119
LPT1	14.31*	18.05*	-2.158*	36*	0.037*
LPT2	19.47	22.47	-1.841	36	0.073
DIFF	5.15	4.42	0.692	36	0.493
YEAR	49.94	54.35	-1.097	36	0.279
FINAL	49.03	53.20	-0.861	36	0.394
CRED	14.73	17.05	-0.825	36	0.414
SR	31.94	33.05	-0.516	34	0.608

Variable	Std dev.		Valid N	
	Lower SES	Higher SES	Lower SES	Higher SES
RCT	3.654	2.852	19	19
CRT	5.170	5.502	19	19
MOT	17.812	16.954	19	19
META	8.312	11.922	19	19
COG	22.160	22.237	19	19
RES	14.753	16.466	19	19
ANX	8.051	6.154	19	19
SURF	8.029	8.657	18	18
DEEP	8.532	8.354	18	18
ACH	7.390	7.843	18	18
LPT1	5.706*	4.938*	19*	19*
LPT2	5.253	4.776	19	19
DIFF	3.655	2.854	19	19
YEAR	12.079	12.679	19	19
FINAL	14.652	15.181	19	19
CRED	8.490	8.803	19	19
SR	6.347	6.548	18	18

\*p<0.05

Table 8.18 shows that the only significant differences between the higher and lower SES groups were on the pretest of the Learning Potential Test (LPT1). The LPT1 could be seen as an example of a traditional, static ability test and the lower SES group scored significantly lower on the LPT1 ( $t = -2.16$ ,  $p = 0.037$ ,  $df = 36$ ) than the group with a higher SES. The scores on the CRT (which is an example of a dynamic test) were almost the same for the two groups.

The group with the lower SES showed a higher difference score than the group with the higher SES which means that they were able to improve their scores considerably after receiving the mediated lesson. This lends some support to the argument that although static measurement scores tend to reflect differences in SES, this is less so with dynamic assessment procedures.

### 3.3 ENGLISH FIRST LANGUAGE SPEAKERS VERSUS ENGLISH SECOND LANGUAGE SPEAKERS (AFRIKAANS)

The combined group of Information Technology and Electrical Engineering students were divided into two groups according to their language of instruction at secondary school level. The first group of students were the English first language speakers, while the second group of students were Afrikaans language speakers. The language of instruction at the Technikon is English, and the second group can be seen as having English as a second language. The students who have an African language as a first language were omitted, because they were included in the DET group. Comparisons were made between the two groups on the SR score, cognitive factors, non-cognitive factors and academic performance using the t-test for independent samples. The results are shown in Table 8.19.

Table 8.19

Comparisons between English First Language and English Second Language (Afrikaans) Speakers for the Combined Group of Students

Variable	Mean		t-value	df	p
	Eng (1)	Eng (2)			
LPT1	18.82*	15.89*	3.127*	86*	0.002*
LPT2	22.70*	20.50*	2.891*	86*	0.004*
DIFF	3.87	4.60	-1.153	86	0.251
RCT	8.57*	5.77*	5.033*	86*	0.0004*
CRT	20.50	18.87	1.511	86	0.134
MOT	186.35	188.72	-0.679	86	0.498
META	58.37	59.45	-0.470	86	0.639
RES	90.05	93.29	-1.051	86	0.295
ANX	17.45	18.70	-0.913	86	0.363
SURF	47.67*	51.33*	-2.268*	83*	0.025*
DEEP	46.92	49.80	-1.613	83	0.110
ACH	49.32	50.82	-0.823	83	0.412
YEAR	53.95	52.10	0.761	86	0.448
FINAL	53.20	50.32	0.969	86	0.335
CRED	18.05*	14.45*	2.033*	86*	0.450*
SR	31.70	32.41	-0.454	83	0.650

Table 8.19 (continued)

Variable	Std dev.		Valid N	
	Eng (1)	Eng (2)	Eng (1)	Eng (2)
LPT1	3.802*	4.799*	40*	48*
LPT2	3.516*	3.584*	40*	48*
DIFF	2.573	3.233	40	48
RCT	2.753*	2.468*	40*	48*
CRT	5.467	4.620	40	48
MOT	12.256	19.081	40	48
META	11.378	10.227	40	48
RES	14.656	14.184	40	48
ANX	6.234	6.594	40	48
SURF	8.163*	6.698*	40*	45*
DEEP	8.175	8.217	40	45
ACH	7.707	8.906	40	45
YEAR	9.484	12.694	40	48
FINAL	11.823	15.413	40	48
CRED	7.337*	8.937*	40*	48*
SR	7.351	7.040	37	48

\*p&lt;0.05

Table 8.19 shows significant differences between English first language (Eng 1) and English second language (Eng 2) speakers on a few variables. The most obvious differences is on the Reading Comprehension Test (RCT) scores, which consisted of English paragraphs that had to be read. The Eng 1 group had significantly higher scores on the RCT ( $t = 5.033$ ,  $p = 0.00004$ ,  $df = 86$ ) than the Eng 2 group.

While the Eng 2 group scored significantly lower on the LPT1 ( $t = 3.127$ ,  $p = 0.002$ ,  $df = 86$ ) and LPT2 ( $t = 2.891$ ,  $p = 0.004$ ,  $df = 86$ ), they had a slightly higher difference score than the Eng 1 group which meant that they benefited more from the mediated lesson. Although the Eng 2 group had a slightly higher SR mark, they scored consistently lower on technikon academic marks with the differences on credits obtained being significant ( $t = 2.203$ ,  $p = 0.045$ ,  $df = 86$ ). Booyesen (1996) obtained the same results in his study with Peninsula Technikon students. An explanation for this could be that the Eng 2 group's SR marks were obtained by way of focusing on a surface approach to learning and that they did not have the necessary problem solving skills needed to do well at the technikon. This explanation is supported by the Eng 2 group's significantly higher score on the surface approach to learning ( $t = -2.268$ ,  $p = 0.025$ ,  $df = 83$ ) and significantly lower scores on the Learning Potential Test. The Eng 2 group might also be having problems in adapting to the lectures and notes being in English. This conclusion is supported by the Eng 2 group's significantly lower score on the Reading Comprehension Test.

students' relatively poor academic performance. The female students' inability to manage their test anxiety in comparison to the male students seems to suggest that this also influenced the differences in performance.

A comparison of the correlation patterns of male and female students showed similar patterns. Both groups showed moderately high and significant correlations between the SR score and academic performance (final mark). The male group:  $r = 0.45$ ,  $N = 74$ ,  $p = 0.004$ ; the female group:  $r = 0.53$ ,  $N = 15$ ,  $p = 0.043$ . At the same time low to negative relationships between LPT2/CRT and academic performance (final marks) were found. For the male group: LPT2  $r = 0.08$ , CRT  $r = -0.01$ ; for the female group: LPT2  $r = 0.13$ , CRT  $r = 0.05$ . The results tend to show that gender does not play a significant role in moderating the prediction of academic performance. This is in line with the findings of Shochet (1986) who found that gender does not have a moderator effect on cognitive modifiability predicting academic performance.

### **3.5 ENGINEERING STUDENTS VERSUS BUSINESS STUDENTS**

The Electrical Engineering students were compared with the Business Management students on academic performance, cognitive factors, non-cognitive factors and SR score to see whether there are any differences in cognitive and learning profiles between the two groups of students. The Engineering course could be linked with a problem solving approach to learning while the Business course could be closer to a memorising type of approach. Where the electrical Engineering Department makes use of continuous assessment, the Business Management course is more examinations orientated. The results of a t-test for independent samples are shown in Table 8.21.

Table 8.21

Comparison between Engineering and Business Students

Variable	Engineering			Business			df	p
	Mean	Std dev.	N	Mean	Std dev.	N		
YEAR	56.19	12.559	72	50.68	15.626	62	132	0.013*
FINAL	55.81	12.708	71	47.67	17.344	62	131	0.002*
SR	37.04	6.704	41	26.03	4.290	33	72	0.0004*
RCT	6.35	2.849	54	5.10	2.332	65	117	0.01*
CRT	19.00	4.705	56	15.95	4.688	65	119	0.001*
SURF MOTIVES	25.60	3.797	68	27.72	4.008	61	127	0.003*
SURF STRATEGIES	25.20	3.998	68	28.55	3.853	61	127	0.0004*
DEEP MOTIVES	24.57	4.344	68	25.00	4.446	61	127	0.579
DEEP STRATEGIES	26.29	3.583	68	23.98	3.956	61	127	0.001*
ACH MOTIVES	25.10	4.505	68	27.62	3.925	61	127	0.001*
ACH STRATEGIES	25.94	4.793	68	23.67	5.085	61	127	0.01*
SURF	50.80	6.254	68	53.27	6.537	61	127	0.03*
DEEP	50.86	6.594	68	48.98	7.497	61	127	0.134
ACH	51.04	7.440	68	51.29	7.723	61	127	0.846
ANX	23.32	6.271	71	20.44	6.286	61	130	0.009*
MOT	200.77	15.779	71	188.50	19.817	61	130	0.0001*
META	60.26	9.811	71	57.96	8.650	61	130	0.159
COG	161.19	23.708	71	154.28	23.080	60	129	0.105
RES	95.64	13.515	71	88.42	14.145	61	130	0.003*

\*p&lt;0.05

An inspection of Table 8.21 shows that there are quite a few significant differences between the Engineering students and Business students. The Engineering students obtained significantly higher SR scores which translated into significantly higher year and final marks at the technikon. Looking at the cognitive factors, the group of Engineering students obtained significantly higher scores in both the RCT and the CRT.

An investigation of the differences in approaches to learning between the two groups shows that the Business students obtained significantly higher scores in the surface approach to learning. This held true for both the subscales of the surface approach, surface motives and surface strategies, with the surface strategies showing the larger difference between the two groups. Both the deep and achieving approaches to learning show very similar scores for the two groups. Looking at the subscales of the two approaches there are indications of significant differences. The Engineering students had significantly higher scores on the deep strategies and achieving strategies subscales. At the same time the Business students had significantly higher scores on the achieving motives subscale. The Business students also tended to obtain higher scores on the deep motives subscale although the difference was not significant.

Looking at the subscales of the MSLQ it is clear that the Engineering students generally obtained higher scores on all the variables. Highly significant differences are found on motivation with the Engineering students obtaining the highest score. They also obtained significantly higher scores in management of resources and management of test anxiety.

In conclusion it can be stated that there are clear differences in cognitive and learning profiles between the Engineering and Business students. The Engineering students seemed to be better in problem solving and implementing deep strategies as opposed to the surface strategies implemented by the Business students. The Engineering students also showed themselves to be more motivated and to be better managers of resources and test anxiety.

### **3.6 MORE SUCCESSFUL VERSUS LESS SUCCESSFUL STUDENTS**

The combined group of Electrical Engineering and Information Technology students were divided into a less successful group and more successful group using the upper quartiles and lower quartiles of credits obtained as criteria. The less successful group were those students who obtained twelve and less credits. For the Electrical Engineering group it meant having failed three or more of their six subjects, while for the Information Technology students it meant failing two or more of their four subjects in the first year. The more successful group consisted of those students who had obtained 24 credits, which meant that students in this group passed all their subjects. The results of a t-test for independent samples are shown in Table 8.22.

Table 8.22

Comparison between More Successful and Less Successful Students for the Combined Group

Variable	Mean		t-value	df	p
	Less Successful	More Successful			
RCT	5.94	6.75	-1.221	70	0.225
CRT	19.42	19.59	-0.134	70	0.893
MOT	184.22	190.89	-1.731	70	0.087
META	55.42*	62.59*	-2.836*	70*	0.005*
COG	146.68*	162.37*	-2.539*	70*	0.013*
RES	92.08	92.10	-0.006	70	0.994
ANX	17.20	19.16	-1.377	70	0.172
SURF	49.42	50.08	-0.360	68	0.719
DEEP	46.65*	50.94*	-2.173*	68*	0.033*
ACH	47.94*	53.62*	-2.962*	68*	0.004*
LPT1	15.77	17.45	-1.455	70	0.149
LPT2	19.82*	21.91*	-2.012*	70*	0.047*
DIFF	4.05	4.45	-0.551	70	0.582
SR	28.08*	35.88*	-5.390*	69*	0.0004*

Variable	Std dev.		Valid N	
	Less Successful	More Successful	Less Successful	More Successful
RCT	2.600	3.022	35	37
CRT	5.621	4.827	35	37
MOT	16.392	16.252	35	37
META	10.233*	11.149*	35*	37*
COG	28.102*	24.290*	35*	37*
RES	13.977	14.889	35	37
ANX	6.957	5.030	35	37
SURF	7.701	7.535	35	35
DEEP	6.940*	9.374*	35*	35*
ACH	8.561*	7.456*	35*	35*
LPT1	5.724	4.011	35	37
LPT2	5.321*	3.311*	35*	37*
DIFF	3.324	2.853	35	37
SR	4.673*	7.218*	35*	36*

\*p<0.05

From Table 8.22 it can be seen that a few variables significantly differentiate between the groups of less successful and more successful students. The more successful students had higher SR scores. This difference between the two groups was highly significant. Another significant difference between the two groups was on the posttest score of the LPT. The implications of this is that, because there were no significant differences on the pretest, the mediated lesson played a larger role in improving the LPT2 scores of the more successful students as opposed to the less successful students. It is also an indication that a dynamic assessment procedure can differentiate between more successful and less successful students.

The non-cognitive factors that significantly differentiated between the more and less successful groups of students were a deep and achieving approach to learning and cognitive and metacognitive strategies. In each case the more successful students had higher scores on these variables. The more successful students scored higher on the motivation scale, but the difference was not significant.

From these results the profile of a more successful student would consist of someone with higher symbols in matric; who has well-developed problem solving abilities and is able to benefit from mediation; who follows a deep and achieving as opposed to a surface approach to learning; who has the ability to implement cognitive and metacognitive strategies when learning.

The combined group of Information Technology and Electrical Engineering students were divided into a pass and fail group. The pass group consisted of those students who passed all their subjects at the end of the first year. The fail group consisted of those students who failed one or more subjects.

Discriminant analysis (Kerlinger, 1964) was used as the appropriate method to find an equation that best combines the different variables, SR score, cognitive factors and non-cognitive factors, to predict passing or failing. Table 8.23 shows the results of the discriminant analysis.

**Table 8.23**

Summary of Discriminant Analysis with the Combined Group for the Prediction of Pass/Fail

		Wilks' Lambda: 0.78580    F=11.313    p<0.00004			
N=86		Wilks' Lambda	Partial Lambda	F-remove	p-level
	SR	0.934	0.841	15.685	0.0001
	META	0.831	0.945	4.802	0.0312

**Classification Functions**

Variable	Fail p=0.616	Pass p=0.383
SR	0.781	0.931
META	0.532	0.583
Constant	-27.183	-35.569

**Classification Matrix**

Group	Percent Correct	Predicted Fail p=0.61628	Predicted Pass p=0.38372
Actual Fail	85.714	48	8
Actual Pass	52.777	17	19
Total	72.826	65	27

From Table 8.23 it can be seen that the SR score and metacognition were the two variables that would provide 73% correct classifications of pass/fail. If metacognition is included with the SR score the Wilks' Lambda comes down to 0.83. Wilks' Lambda is the multivariate extension of R-squared. Its interpretation is the reverse of R-squared. It varies from one to zero. Values near one imply low predictability, while values close to zero imply high predictability.

The SR score and the metacognitive score together correctly predicted 86% of the students that failed, while they correctly predicted 53% of the students that passed. This is an indication that it would be incorrect to use the SR score exclusively in selecting students for Information Technology and Electrical Engineering and that a non-cognitive variable such as metacognitive strategies plays a role in enhancing the prediction of academic performance.

### 3.7 THIRD YEAR STUDENTS VERSUS FIRST YEAR STUDENTS

The Information Technology students who were in first year in 1993 were followed up in 1995 when they were in third year. A comparison was made between their scores on the subscales of the SPQ and MSLQ in their first and third year to see whether there were any differences. The results of a t-test for independent samples is shown in Table 8.24.

Table 8.24

Comparisons between Information Technology Students in First and Third Year

Variable	Third Year			First Year			t-value	df	p
	Mean	Std dev.	N	Mean	Std dev.	N			
SURF MOTIVES	26.88	4.867	25	25.96	7.452	25	0.516	48	0.607
SURF STRATEGIES	26.16	5.022	25	23.92	5.574	25	1.492	48	0.142
SURF	53.08	6.981	25	49.88	9.858	25	1.324	48	0.191
DEEP MOTIVES	27.12	4.013	25	24.76	4.390	25	1.983	48	0.050*
DEEP STRATEGIES	25.52	4.174	25	24.64	4.280	25	0.735	48	0.465
DEEP	52.64	5.566	25	49.80	7.926	25	1.465	48	0.149
ACH MOTIVES	26.28	5.940	25	26.40	3.640	25	-0.086	48	0.931
ACH STRATEGIES	25.00	5.590	25	25.00	4.462	25	0.000	48	1.000
ACH	51.28	10.261	25	51.48	7.000	25	-0.080	48	0.936
ANX	16.28	7.976	25	17.08	7.168	24	-0.370	47	0.712
MOT	186.36	17.686	25	186.20	16.872	24	0.030	47	0.975
ELABORATION	36.36	5.106	25	30.88	5.932	25	3.500	48	0.001*
META	67.20	9.517	25	59.64	8.674	25	2.935	48	0.005*
COG	177.96	23.654	25	164.88	28.776	25	1.755	48	0.085
RES	95.12	13.781	25	95.24	21.733	25	-0.023	48	0.981

\*p<0.05

An inspection of Table 8.24 shows that the third year students obtained significantly higher scores in metacognitive strategies and elaboration. This indicates that the students had developed the ability to think about their learning and relate it to past learning to a much greater extent than in first year. As regards the students' approach to learning, the scores on the deep motives subscale of the deep approach to learning improved significantly ( $t = 1.983$ ,  $p = 0.05$ ,  $df = 48$ ), while the surface approach to learning scores also showed an improvement. This suggests that the students became more versatile in their learning.

In general the students' scores in third year showed improvements on their scores in the first year. The exceptions were in the achieving approach to learning, their management of resources and their ability to manage test anxiety which all showed a slight decrease from the first year.

#### **4. CONCLUSION**

In conclusion it can be reported that different prediction patterns are identified when students' response to mediation is taken into consideration. For students with good symbols in matric, the SR score seems to be the best predictor of academic performance at the technikon. There are however exceptions in the case of those students who have a low initial score in a problem solving exercise, but in their response to mediation show that they are modifiable. For these students a dynamic assessment procedure and in some cases, non-cognitive learning factors, seem to be better predictors of academic performance. In the case of DET students, the results suggested that the SR score might not be the best predictor and that dynamic assessment procedures and non-cognitive learning factors might be more appropriate in differentiating between more and less successful students at the technikon.

Two groups that seem to need specific support from the technikon are the female students and the Afrikaans-speaking students. The female students obtained substantially higher scores in test anxiety, which could have affected their final marks and the number of subjects that they passed. In the case of the Afrikaans-speaking students their matriculation symbols indicate that they should be obtaining higher marks at the technikon and that their lack of proficiency in the English language might be the reason for their relatively lower performance at the technikon. Third year students in Information

Technology obtained significantly higher scores in the deep motives subscale of the deep approach to learning, metacognitive abilities and elaboration as opposed to their scores in the first year. It was possible to differentiate between more successful and less successful students according to the SR score, the posttest of the LPT, the use of metacognitive and cognitive strategies, as well as a deep and achieving approach to learning.

A discussion of the results in Chapters 7 and 8 will be done in the next chapter (Chapter 9).

## Chapter 9

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# DISCUSSION

### 1. INTRODUCTION

As mentioned in Chapter 1 the aim of this study is to investigate the practical application of Vygotsky's (1978) concept of the zone of proximal development (ZPD) to the problem of selecting disadvantaged students. More specifically the study explores the relative values of various cognitive and non-cognitive predictors and how students' response to mediation can be linked to their academic performance. In order to achieve this aim the problem statement was divided into several subproblems and hypotheses and various studies were conducted to address them.

Each hypothesis is briefly addressed before going on to a more detailed discussion of the different studies.

#### Hypothesis 1

The results supported this hypothesis for the CRT and the LPT with the use of a stricter research design. With the second Solomons Four Group study a significant difference was found between the posttests scores of the students who received the lesson and those who did not, while controlling for the practice effect. The subjects of this study were randomly assigned to the different groups as opposed to the first study where the groups consisted of discipline specific groups (with the Engineering group showing more advanced problem solving skills). A placebo in the form of a handout on problem solving hints was used in the first study. This seemed to have also increased this groups' posttest scores.

#### Hypothesis 2

This hypothesis was partially supported by the data. The use of the posttest score of the LPT when added to the matriculation marks substantially improved the variance explained by academic performance for the Electrical Engineering students. The investigation showed that although the matriculation marks were the best indicator of future academic performance for the total group of students, for the group of DET

students the dynamic tests (LPT2, CRT) were better predictors than the matriculation marks or static tests. The use of non-cognitive learning factors such as metacognition together with the matriculation marks made a significant contribution in predicting academic performance.

### **Hypothesis 3**

This hypothesis was generally supported by the results. Significant differences in correlation patterns were found between the more modifiable and less modifiable groups. The more modifiable group showed significantly higher scores in an achieving approach to learning. Modifiability and the schooling backgrounds of the students (DET as opposed to non-DET) had a moderator effect on the prediction of academic success whereas SES, language and gender did not. The third year students scored significantly higher scores on metacognition and elaboration than the first year students, while Engineering students obtained significantly higher scores on a number of cognitive and non-cognitive factors.

The discussion of the results of the different studies can be summarised under the following main themes:

#### **(1) The usefulness of dynamic assessment procedures and the effectiveness of the mediated lesson**

This would include looking at issues such as test wiseness, the practice effect, the retest effect and coaching.

#### **(2) Prediction of academic performance**

The predictive validity of different criteria, such as previous academic achievement, non-cognitive learning related factors and static as opposed to dynamic assessment procedures, will be compared.

#### **(3) Response to mediation**

This entails a discussion of how different groups of students respond to a mediated lesson and the subsequent differences in correlation patterns between the groups.

#### **(4) Academic success**

This will include looking at which factors discriminate between successful and less successful students.

### **(5) Moderating factors**

Different groupings of students according to various biographical and background factors are compared to establish a moderator effect for predicting academic performance.

In the discussion a short summary of the results will be provided, followed by a comparison with other research findings. This will be done under the headings of the different studies conducted. Finally a pattern that will link all the different studies with the aims of the investigation will be established.

## **2. EFFECTIVENESS OF THE MEDIATED LESSON**

A relatively clear pattern emerges regarding the effectiveness of the mediated lesson. Two studies with the LPT (using a Solomons Four Group design) and two with the CRT (using a Two Group design), with different samples of students, were conducted. Although mixed results were found with the different studies, the majority of the evidence seems to indicate that the mediated lesson was effective. With the second Solomons Four Group study, where random selection was used, the results showed significant differences in posttest scores between the students who received the mediated lesson and those who did not while controlling for the practice effect. As regards the Two Group design, both the studies showed significant differences in test scores between the students who received the lesson and those who did not. In the case of the second study the DET students were excluded.

The use of the Solomons Four Group design in evaluating the effectiveness of the mediated lesson included in the LPT (Leedy, 1989), acts as a control for differentiating between test wiseness and the practice effect on the one hand and the influence of the mediated lesson on the other hand. The implications of the findings of the second study with the LPT are that, although test wiseness and practice did seem to play a role in increasing students' posttest scores, the mediated lesson was instrumental in significantly improving the students' score on the posttest of the LPT. In this study the retest effect was negligible.

The lesson combined with the practice effect had resulted in the largest differences between the pre- and posttest. The lesson on its own had a significant effect which

cannot be attributed to the practice effect. Further evidence of this was that the posttest scores of the two groups who received the lesson were almost identical.

In the first study with the LPT the results suggest a marked practice effect. The reasons for this could possibly be found in the fact that the students were Engineering students who might have benefitted more from the practice effect. Another reason could be that the control group in this study had received a placebo in the form of a list of hints on how to approach problem solving. This might have assisted them to perform just as well in the posttest as the experimental group who received the lesson.

The typical design of a dynamic test with a pretest, an intervention or instructional phase, and final posttest is a classical quasi-experimental design. The effects of the intervention and the effects of retesting are inseparably entangled. Bringing in a control group that does not include an intervention changes it into a true experimental design and helps to differentiate between the influence of the intervention and the practice and retest effects (Klauer, 1993). The repeated administration of parallel tests allows for an investigation of the role that test wiseness and the practice effect plays on the scores of the test. The LPT makes use of a test-teach-test format with the second test being a parallel form of the first test. With a parallel test memory does not play such an important role as opposed to when the same test is used. In the case of a parallel test the application of the rules and principles for problem solving, which are acquired during the lesson, is of more importance (Guthke, 1993).

Klauer (1993) argues that a normal lesson can be conceived of as a gross effect, consisting of two additive components – the proper lesson effect and the practice effect. Retesting as such can be seen as a kind of treatment which provides the subjects with learning experiences during the pretest, the posttest and the time in between. That the practice effect plays a role in increasing students' scores seems to be evident. Some research shows that the greatest gain in test scores may be effected by simply retaking the test (Bellar, 1994). The implications of a practice effect in a dynamic assessment procedure would be that the test becomes a test of memory instead of reasoning and problem solving. Students memorise the problem solving sequences during the first application and simply repeat it during the second test. The use of a parallel test rather than simply repeating the same test again guards against memory playing such a large role. The results of this study indicate that although the practice effect played a role, the mediated lesson as such had a significant influence on the LPT scores. The implication of

this finding is that the mediated lesson was able to provide the students with the opportunity to gain an understanding of the principles underlying the problem solving process. These principles could then be applied by the students in different problems presented in the posttest.

Training experiments, using a pretest-posttest training and control group design, can be used to calculate the amount of gain of the control groups which can be attributed to the retest effect only. Klauer (1993), in an analysis of studies, found considerable variation between the different estimations of the effect size. He concludes that gains due to retesting vary according to the time span between the two tests, the kind of tests involved and the pretest levels of the subjects. LeGagnoux, Michael, Hocevar and Maxwell (1990) retested more than 2 000 primary school children with 26 different subtests, using either a parallel or an identical test. Several subtests revealed greater gains when the same rather than a parallel form was used, but the differences were significant only in two out of 26 cases. A meta-analysis done on retest effects by Wilson and Putnam (1982) did not show a significant difference between test scores using the same or a parallel form.

The conclusion that Klauer (1993) comes to in a review of different studies is that there is a comparatively high variability of retest effects between different subtests, but also with the same subtests between different samples. Some subtests are less and others are more susceptible to retest effects. Relatively large changes occur as a consequence of retesting, but this varies from individual to individual. The strong variation in retest effect of different samples using the same test, found in this study, supports the findings of other studies as reported by Klauer (1993).

Although declarative knowledge is not acquired in the test-retest situation, at least not to a large extent, several authors have shown that general as well as specific procedural knowledge can be acquired in test-retest situations (Anastasi, 1981; Wing, 1980). Sets induced by the first testing, for instance, working at a somewhat higher speed without reducing quality, or increasing reflexivity, might be transferred to other test-taking situations. Test-taking skills acquired during the first test are also applied to other test situations. More general effects are to be expected if the subjects learn a strategy for solving a certain type test item during the first testing. Solving number series items can enable the subjects to better solve any other number series problems encountered later on.

Guthke (1993) reports on a number series test done with sixth grade children where control groups without training achieved a practice gain through simple test repetitions. The experimental groups (those who followed the pretest-training-posttest condition) had significantly higher learning gains than the control groups. This suggests that relatively short training (90 minutes) is sufficient for significant learning gains on intelligence tests, while controlling for practice.

Generally, pretests and posttests in learning potential test designs correlated much lower than first and second testings within the framework of studies of retest or parallel test reliability. The conclusion is that training provides additional diagnostic information that cannot be found in the administration of the posttest only. In some cases, major changes in rank order of subjects were observed between the first and second testing (Guthke, 1993). This finding is consistent with the results obtained by other researchers who used well-known, highly reliable tests, such as the Raven, as learning potential tests (Lidz, 1987).

Besides the LPT, the other dynamic test used in this study, the CRT, is an example of a test where the lesson is incorporated into the test. There is no pretest and hints are provided as part of the first few items of the test. The use of the CRT bypasses the use of difference scores and provides the opportunity for comparisons with the LPT. Overall the results of the two studies performed with the CRT indicate that the lesson was effective in significantly increasing the students' scores on the test. There was evidence that the lesson was not as effective for the group of DET students (in the second study) and that they as a group were unable to benefit from the mediated lesson to the same extent as the group of non-DET students. If it is assumed that the non-DET students had more exposure to testing and are thus more test wise, then one of the conclusions that can be made is that test wiseness contributed more to the increase of scores than the practice effect. Practice does not play an important role with the CRT, as there is only one test and no opportunity to gain practice experience.

It has been shown that test wiseness can differentially influence the performance of cultural diverse groups (Sarnacki, 1979). Test wiseness refers to subsidiary skills, such as the skill to deal with time limits in speed tests where the testee has to find a balance between the speed and accuracy needed in the response. Kendall, Verster and Von Mollendorf (1988) observed a classical learning curve (i.e. diminishing score increments) in repeated test administrations of a paper-and-pencil classification test to

black miners in South Africa. The miners were without previous test experience. These increments reached their peak around the fourth administration. The authors argued that test wiseness in addition to the practice effect could be the reason for the score increments.

If the results of the CRT are compared to that of the LPT (where the sample consisted entirely of DET students), the influence of test wiseness becomes more clear. In the case of the LPT the DET students had the opportunity to experience the pretest, before attempting the posttest, which contributed to their test wiseness. The students in the second study with the LPT were able to significantly increase their score on the posttest.

An aspect that has a link with the practice effect is providing coaching to potential test users. Huysamen (1997) mentions studies done on the effect of coaching as providing indirect evidence of the role of long-term experiences on aptitude test scores. His argument is that if admission test scores should prove to be susceptible to short-term coaching in test-taking strategies and/or content areas, their validity as measures of general academic aptitude could be questioned. This is exactly where the dynamic test paradigm differs from static testing. According to a dynamic assessment approach coaching would be viewed as a form of mediated learning. The argument is that a true reflection of a person's ability can only be gained by providing coaching or mediated learning experience. Dynamic tests incorporate a mediated lesson where teaching and learning takes place. In other words, students would differ in the way that they respond to or benefit from the mediation period. The ability of a person to profit from intervention could be seen as a sample of their cognitive modifiability or learning potential.

A meta-analysis of studies of coaching effects on SAT scores (Powers, 1993) suggests that coaching appears to be more effective for the more curriculum-orientated mathematics section of the SAT than for the verbal section. According to Huysamen (1997) it would be the beta components (test wiseness and test taking skills) of the test scores rather than the alpha components (problem solving abilities) that are susceptible to short-term coaching. Although short-term coaching does not substantially increase SAT scores, the longer the coaching programme the greater the effects until a saturation point is reached where the students no longer benefit from the instruction.

According to the dynamic test concept disadvantaged students would benefit more from a coaching or mediation period than more advantaged students. Shochet's (1986) results indicated that this was not necessarily the case. In his study both the white and black students benefitted from a mediation period and were able to improve their scores. What did happen is that the black students started from a lower base and were able to improve their posttest scores to the level of the white students' pretest scores. The same trend was observed in this study as regards the DET and non-DET groups of students. The non-DET students benefitted more from the lesson. The mediated lesson built into the dynamic test could be seen as a controlled form of coaching where all the testees receive the same amount of coaching under standardised conditions.

The implications of using dynamic tests is that not only those students who can afford to be coached would have the opportunity to benefit from it. The use of dynamic testing would expose all the students to the same mediation period, ensuring that all have a fair and equal chance of showing how they would respond to mediation and improve their scores. Usually the more advantaged students would have access to coaching which tends to perpetuate the inequalities of the past and puts disadvantaged students at an even further disadvantage.

The overall finding of the present study that mediation is useful in improving subjects' posttest scores during a dynamic test supports the results of other studies, both in South Africa and other countries.

Skuy and Shmukler (1987) tested the effectiveness of Feuerstein's Learning Potential Assessment Device (LPAD), an example of a dynamic assessment procedure, among groups of educationally disadvantaged adolescents, aged between 13 and 15 years in South Africa. The sample consisted of 60 students from a school allocated for coloureds and 60 students from an Indian high school. The sample of students from each school was further divided into a group of academic best achievers and a group of the poorest academic achievers. Both high and low academic achievers were randomly assigned to an experimental and a control group. The experimental groups were exposed to dynamic testing, which comprised of their performances being assessed before and after receiving mediated learning experiences on the LPAD. Comparable, conventional measures were used to assess the transfer effects of mediation. The control groups received the same tests, but not the mediation. The control group acted as control for the effects of practice on the test tasks.

The results showed that a main group effect was obtained on The Set Variations 2 subtest, which consists of tasks based on the Raven matrices. On these tasks the experimental group benefitted from the mediation provided. The results also indicated that those students who initially performed better, benefitted more from exposure (both mediated and non-mediated) to the materials than their peers. Mediation was not generally effective in producing change on the transfer measures. On certain of the tests there was a mediation effect in interaction with the variables of academic performance and cultural/race group. High academic status students scored consistently higher than low academic status students which according to the authors tends to underscore the importance of basic intellectual ability or academic aptitude in affecting the individual's ability to benefit from mediation. There was a consistent tendency for the experimental subgroups to demonstrate greater improvements in percentile standing, relative to their control counterparts.

Van de Vijver (1993) reports on a cross-cultural study involving pupils in the highest grade of primary schools in Zambia, Surinam and the Netherlands. Three tests involving letters and figures were administered to the pupils after which they were randomly divided into experimental and control groups. The experimental groups received additional training in one of the three tests forming three experimental conditions (Letter training, Figures training and Fruit training). The training, which lasted half a school day, provided the pupils with skills in detecting and applying the underlying rules of the different items. The control group did not receive any additional instructions. Parallel and isomorphic versions of the pretest were administered as the posttest.

Overall the results indicated score increments in both experimental and control groups. In each cultural group the largest score gains were obtained on the tests which were the topic of training, while slight gains were made in the isomorphic tests. The Dutch nearly always obtained the highest scores and the Zambians the lowest scores. On average the posttest increments were largest in the Zambian group. Van de Vijver (1993) explains the presence of high learning gains in both the experimental and control groups in Zambia as possibly caused by an increased familiarity with the tests and the testing situation in general (test wiseness). The conclusion was that the extent of cross-cultural differences can be affected by mediation and training and is not evidence of the unequal innate ability of the groups as interpreted by Jensen (1980).

In summary, the overall results suggest that the mediated lessons in both the LPT and the CRT were effective in that they substantially increased the subjects' scores after the lesson. These increases were significant after the retest and practice effects were controlled for in using the Solmons Four Group design. The implications are that some of the students were able to benefit from the lesson and used the rules and principles learned in the lesson to improve their posttest scores.

The influence that test wiseness and the practice effect has on especially black students' test results, has implications for fair testing. Individuals with previous experience of testing and a certain amount of test wiseness tend to act in an automatised fashion when it comes to the general elements of testing (e.g. instructions and use of answersheets) whereas those students with no prior exposure to testing, tend to focus more of their time and energy on becoming knowledgeable about testing and less on the actual problem solving content of the test. Bringing the ZPD into a testing situation provides non-testwise students an opportunity to compete on a more equal basis with others who have had more exposure to testing (Nell, 1999).

### **3. PREDICTORS FOR DISADVANTAGED STUDENTS: A COMPARISON BETWEEN PAST ACADEMIC ACHIEVEMENT, STATIC TESTS, DYNAMIC ASSESSMENT AND NON-COGNITIVE FACTORS**

The overall results of the studies done with the students in different disciplines (Business, Engineering and Information Technology) indicate that past academic achievement in the form of the total matriculation marks (using the Swedish rating point system) was the best single predictor of academic performance for all the disciplines. The dynamic tests (for the Engineering and Business) and non-cognitive learning factors such as metacognitive abilities (Engineering) and an achieving approach to learning (Information Technology) were found to be the next best predictors, followed by the static aptitude tests. The best results in predicting academic performance seem to be a combination of matriculation marks, the dynamic tests and the non-cognitive learning factors (metacognition and an achieving approach to learning). The differences between the Engineering students and the Information Technology students regarding predictors could possibly be explained by the different assessment methods used. Engineering makes use of continuous evaluation whereas Information Technology makes use of an examinations

orientated assessment procedure. The individual matriculation subjects did not play a significant role in predicting performance in technikon subjects. The only exception was mathematics. The learning factors and dynamic tests seem to have had equal impact as predictors. These results were obtained by looking at the total group of students in each course.

The finding of this study that the SR score of the matriculation marks was the single best predictor of academic performance for the total group of students, echoes the results of Bokhorst, Foster and Lea (1990), Booysen (1996) and Nunns and Ortlepp (1994) who found that matriculation marks or a rating system based on the matriculation marks was the single best predictor of not only academic performance for groups of advantaged (white) students but also for groups of disadvantaged (black) students. As pointed out by Miller (1992) the students in these samples were a highly select group who had to obtain high matriculation symbols to gain entry to tertiary education.

A common problem with prediction studies at tertiary education is that students who are being used as subjects in the studies are a select group to begin with. It is unfortunately not possible to investigate those students who were not selected in the course with regard to their academic performance at the institution. In the case of this investigation both the psychometric assessment and the students' previous academic achievement in the form of their matriculation results were used as criteria for selection. The students with adequately high matriculation symbols were selected on an outright basis while those with lower symbols were given an opportunity to gain selection through their scores on the psychometric tests.

When looking at various subgroupings within the total group of students in this study interesting differences in correlation patterns were found. The students were divided into a high and low group according to their matriculation marks. For the group with the higher marks the correlation patterns for both the Engineering and Information Technology groups indicated that the Swedish rating (SR) system was the best predictor of academic performance. For the group with lower matriculation marks (Engineering) the dynamic assessment procedures (LPT, CRT) were the best predictors, showing a high and significant relationship with academic performance (year, examination, final marks and credits obtained). The differences in correlation on CRT, LPT, test anxiety and a surface approach to learning for the high and low groups were significant. The implication of this finding is that past academic achievement seems to be an adequate

predictor for disadvantageded students with higher matriculation marks, but dynamic assessment procedures might be a better predictor for students with lower matriculation marks.

Entwistle, Percy and Nisbet (1977) found in their research with university students that at the lower range of school results (lower than B average) the relationship between school results and academic performance at university seemed to break down. The average student at the Peninsula Technikon tends to obtain a C symbol or lower in the matriculation examinations. The majority of the students at the technikon are first generation students in the sense that their parents had not received tertiary training. Only 14% of the students' parents have post matriculation qualifications and most are in semi-skilled jobs (Kanjee & De Villiers, 1989).

The fact that the dynamic tests (CRT and LPT) are better predictors of academic performance than the SR score for the group with lower matriculation marks, has important implications for the selection of disadvantageded students whose previous academic achievement do not reflect their academic potential.

In Louw, Meyer and Van Schalkwyk's (1998) study, done with 84 Technikon students in the Environmental Health course, they found the matriculation marks (converted to points according to the Swedish formula) to be the best predictor of academic performance in the first year of study. Factor B (intelligence) of the 16 PF also played a role. None of the other variables (a static assessment of aptitude, interest, personality factors and achievement motivation) used in the study formed part of the regression model. The students in the study were predominantly from an advantaged educational background.

When using the same variables to predict the academic performance of 47 of the same group of students in their third year of study, Louw and others (1998) found that the matriculation marks played an even bigger role in the prediction of academic performance. The aspirations of the students as measured on the achievement motivation questionnaire also formed part of the prediction model. The conclusion from this study is that cognitive factors, and particularly previous academic achievement, is still the best predictor of academic performance at tertiary level for a group of predominantly advantaged students.

The students in Louw and others' study were from Cape Technikon, which is a historically white institution. In a comparative study (using students from the five institutions of higher learning in the Western Cape region) done by De Jager and Sayed (1998) on academic literacy, some marked differences were found between the students of Peninsula Technikon and Cape Technikon. Whereas 40% of the respondents at Cape Technikon indicated that they are never given too much readings and 41% never have any difficulty in expressing themselves, 89% of the respondents at Peninsula Technikon reported that prescribed readings are difficult to understand at least some of the time. The results also indicated that students from Peninsula Technikon were among the least confident of expressing their own ideas.

The overall conclusions that can be drawn from the results of this study when comparing the static and dynamic tests are that the dynamic tests were better predictors of academic performance than the traditional static tests. This was particularly true of the Engineering group where continuous assessment was used. The expectations would be that the traditional tests, whose content seem to be a truer reflection of the academic curriculum, would have stronger predictive power. While the SR score proved to be the best single predictor of academic performance in all the cases involving the total group, the dynamic tests rather than the static tests made a useful contribution in explaining the variance in academic performance. In this study two types of traditional tests were used: verbal (MA, RCT) and non-verbal (EAT), representing crystallised and fluid intelligence respectively.

Various studies (Miller, 1998; Skuy, Solizzi, Mentis, Fridjhon & Cockcroft, 1996; Nunns & Ortlepp, 1994; Hessels & Hamers, 1993; Shochet, 1986) have looked at a comparison between traditional, static tests and dynamic assessment procedures as predictors of academic performance. The general conclusion of these studies is that the traditional tests tend to be biased and that they do not allow individuals with a disadvantaged background a fair opportunity to show their true abilities.

Skuy and his colleagues (1996) explored the relative value of various predictors for 18 disadvantaged (DET) versus 8 advantaged (white) students in a bridging course at a university in South Africa. They used two sets of predictor (independent) variables. The one consisted of a battery of static tests, while the other was made up of a battery of process tests. The former included examples of conventional psychometric tests which are used to assess current levels of functioning. The latter made use of a learning

orientated or dynamic assessment approach to testing (Resnick, 1976, 1979). The results for the total group of students indicated that only one measure showed a relationship with any of the criteria variables (Pattern Relations Dynamic Test showed a significant correlation with Accounting). Neither the matriculation results nor the Mental Alertness Test (static test) predicted success in any of the criteria measures. Low significant correlations were found between the learning factors as measured by the SPQ (deep approach and deep strategies) and Business Studies. The Attitude subscale of the Learning Activities and Study Skills Inventory (LASSI, Weinstein, Zimmerman & Palmer, 1983) also showed low significant correlation with the subject Statistics.

A comparison between the advantaged and disadvantaged groups of students indicated that while a number of variables showed significant correlation with criterion variables with the group of advantaged students, the only correlation of significance ( $r(8) = 0.47$ ,  $p < 0.05$ ) for the disadvantaged group was the deep strategy subscale of the SPQ. For the advantaged students particularly the Mental Alertness (as an example of a static test) and a surface approach to learning showed high correlation with the academic subjects Business Studies and Statistics. The Attitude scale of the LASSI also showed significant correlation with some academic subjects. The link between a surface approach to learning and academic performance for more advantaged students echoes the findings of this study with the less modifiable students, while the more modifiable students tended to reflect the findings for the disadvantaged students in Skuy and his colleagues' study. The conclusion that the matriculation marks were not a significant predictor for the disadvantaged group was expected and consistent with other findings (Mitchell & Fridjhon, 1993). The matriculation results were also not a significant predictor for the advantaged group, maybe because these students gained entry to the university through a special foundation course because of their low matriculation marks.

Nunns and Ortlepp (1994) report on a predictive study that looked at finding alternatives to the matriculation examinations as valid predictors of disadvantaged students' academic performance. The tests that were used were the Conceptual Reasoning Test (CRT), the updated version of HSRC's Mental Alertness and Reading Comprehension Tests of the Intermediate Battery. The sample comprised of 133 first year Psychology students (26 students who were educationally disadvantaged and 107 who can be described as being educationally advantaged). The results indicated that for the advantaged students the Arts Faculty Rating, the CRT, the Mental Alertness and the Reading Comprehension correlated significantly with the Psychology 1 mark with the Rating system showing the

best results. For the group of disadvantaged students, only the CRT yielded a significant correlation ( $r(26) = 0.48, p < 0.01$ ) with the final Psychology 1 mark. The findings testify to the efficacy of the rating of matriculation symbols as a significant predictor for advantaged students. For the dis-advantaged students only the CRT correlated significantly with academic performance. These results echo that of this study where the CRT as an example of a dynamic test showed significant correlation with academic marks for the Engineering students.

Miller (1998) evaluated 213 students' academic performance in their second year after following a foundation course in Psychology. The course consisted of a highly structured, materials based, tutorial learning system in which students are required to complete tutorial tasks based on guided reading and discussion. His findings indicate that performance in second year was not simply a function of initial abilities. There was clear evidence that performance on the first-year tutorials was related to the grades obtained in second year indicating that the course is effective as a foundation course. The differential effects found with different groups of students indicate that the foundation course might not be appropriate for all students. The study was not able to identify categories of students that would benefit more or less from the course using factors such as language, initial competence and achievement. Students separated into these categories did not constitute homogeneous groups and different initial levels of ability and patterns of learning were evident. Variables such as second language, basic proficiency in language and mathematics, and initial performance levels had limited predictive validity.

Correlation studies done by Guthke (1993) with school pupils indicated that learning potential tests yielded higher validity indices than the corresponding conventional static tests. The external criteria used were teacher ratings of intelligence and school grades. The same results were obtained by Ruijssenaars, Hamers and Castelijns (1993) and Lidz (1987). However, the differences in validity between the pretests (conventional intelligence tests) and posttests (learning potential tests) were often negligible. The relatively small increase in validity would not justify the more complicated and time consuming learning potential test unless it provides some extra information or is seen to be more fair to use with disadvantaged students. A review of research studies found that the learning potential test was much better at predicting school failures than the static test. Learning potential tests also tended to be less sensitive to environmental factors and were better at reducing the effects of non-intellective components such as neuroticism on test results (Guthke, 1993).

Traditionally learning potential tests have often been used with populations where the use of conventional intelligence tests are assumed to be unfair. Examples are children from ethnic minorities, children with language disorders, mentally retarded children or learning disabled children. Lately learning potential tests have also been used with disadvantaged children and students in South Africa. The results of this study support the notion that although the posttest can be considered as a sound predictor in comparison with a pretest and conventional static tests, the differences are usually not significant. The advantage of dynamic tests seems to be that they are viewed as a more fair indicator of academic performance for disadvantaged populations.

A learning orientated approach to assessment makes it possible to analyse the gains individuals make under given conditions of test administration and to investigate interactions of affective (motivational) and cognitive processes. Analysing the individual differences in performance on Intelligence C could provide valuable information that could be used for academic development purposes. Traditional testing approaches do not include modifications aimed at increasing levels of performance into their procedures. In this way inferences regarding Intelligence B could be biased and not provide a true reflection of an individuals' cognitive competencies. Dynamic testing could be a way of providing a more fair assessment method as opposed to static testing. Carlson and Wiedl's (1992) research was based on the assumption that the best estimates of Intelligence B can be made by the use of testing procedures that enhance performance and reduce the effects of non-cognitive factors (such as motivation, anxiety and metacognition) on cognitive tasks. They conceptualised performance as a result of a dynamic interaction between the individual, the test materials and the test situation. Variations in how the test is conducted would affect this interaction and provide insight into individual-difference factors that influence test performance.

Research on non-cognitive predictors of academic performance has increasingly focused on students' metacognitive ability, learning strategies and approaches to learning, rather than their study habits and methods (Biggs, 1985; Cloete, 1985). There has also been a link between cognitive modifiability and the use of metacognitive and other learning strategies in the work of Feuerstein (1980).

When non-cognitive learning factors were included in the search for the best predictors of academic performance, some interesting results were found. Again the SR score proved to be the best predictor, but this time metacognitive skills and an achieving approach to

learning made a useful contribution to the matriculation marks in explaining the variance in academic performance. The increase in the value of  $R^2$  was significant for both metacognitive skills and an achieving approach to learning. Studies done in the USA with black (Afro-American) students have shown non-cognitive factors to be better predictors of academic performance than cognitive factors (Shochet, 1986). Potter and Van der Merwe (1993) found in a South African study that non-cognitive factors had a firmer relationship with academic performance for a black as opposed to a white group of Engineering students.

Generally, non-cognitive factors like personality, attitude and interest were found to possess moderate predictive validity. It is usually used in conjunction with the matriculation marks and explain between 50% and 60% of variance in academic performance (Weideman, 1990). Postma (1991) included the LASSI, the SAT (Aptitude), the 19 Field Interest Inventory and the Survey of Study Habits and Attitudes in his predictive study and found that matric was the single best predictor of academic performance. The six best indicators explained 51% of the variance in Chemistry 1. In the study of Louw, Meyer and Van Schalkwyk (1998), measurements of interest and various personality factors failed to predict academic performance. Watkins and Hattie (1985) found with a group of Australian university students that correlations between depth of learning approaches and their grades tended to be low.

How academic performance as criteria is assessed becomes important when the differences between the results of the two courses used in the present study are compared. For the Electrical Engineering group (continuous assessment) metacognitive skills made a significant contribution to the SR score in predicting academic performance. For the Information Technology students (examinations based assessment) an achieving approach to learning made a significant contribution in predicting students' academic performance. These findings have implications for the kind of enrichment programme that is needed to help students academically. It also confirms Entwistle and Ramsden's (1983) findings that students tend to adapt their learning approaches according to the kind of assessment that will be done in a particular subject or course. With an examinations based assessment more value is placed on an achieving and surface approach.

Research done by Botha (1971) has indicated that the most correct study habits and methods tend to be applied by the less successful students rather than the academically

more successful. This could be because of inaccurate reports from students regarding their study methods or it could be that cognitive ability plays a more important role in successful studies than the students' study habits or methods. Some students who score high on indices of study methods or learning strategies, might know what the correct strategies are, but are unable to apply it on a day to day basis. Another explanation is the uncritical application of study recipes without understanding the underlying principles and knowing why they are using it (De Villiers, 1996) which is a legacy of the secondary school system.

Biggs (1985) reported that certain non-cognitive factors, such as metalearning play a mediating role in the prediction of students' academic performance. The non-cognitive factors can be used to compare different correlation patterns for the different groups. Boeyens (1989b) suggests that different selection procedures and criteria could be used with different students according to the learning strategies and approaches of that particular student. The results of this study tend to reinforce the notion that different correlation patterns exist for different groups, and that the particular pattern needs to be taken into account in predicting the academic performance of students. The use of multiple assessment methods and a variety of criteria for selection would enhance the prediction of academic performance. The benefit of using dynamic tests lies in the fact that it provides an opportunity to evaluate how students differ in their response to a period of mediation. The next section will focus on the students' response to the period of mediation.

#### **4. RESPONSE TO MEDIATION**

The results of all the studies in this investigation show that students generally benefitted from the mediated lesson and were able to significantly increase their scores on the posttest of the LPT. Those students who were not able to gain admission on the strength of their matriculation marks were provided an opportunity to gain entry into the course if they were able to obtain high scores on the posttest of the dynamic assessment instruments. Dynamic tests make it possible to measure students' response to mediation. In this study the students were divided into more and less modifiable groups according to how they responded to the lesson. A further division into a lesser achieving/more modifiable group was made taking the students' initial score in the LPT into consideration. This group represented those students who showed low initial problem solving skills, but

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were able to benefit from the mediated lesson. In looking at the correlation patterns of the more modifiable and less modifiable groups it was interesting to note that the results varied according to the course the students were doing.

With the Information Technology students the findings of Shochet (1986) were confirmed regarding the low correlation between the pretest of the LPT (as an example of a static test) and academic performance for the more modifiable group. His findings of a high and significant correlation between the pretest of the LPT and academic performance could not be duplicated for the less modifiable group, although the correlation between the pretest and academic performance tended to be stronger for the less modifiable group than the more modifiable group. This concurs with the findings of Boeyens (1989b) who also made use of the LPT in his study. There was a tendency for the posttest of the LPT scores to have higher correlation with academic performance than the pretest for the more modifiable group. For the less modifiable group the pretest tended to have higher correlation with academic performance than the posttest (year mark and credits obtained). The differences were not significant.

Looking at the non-cognitive factors the less modifiable group showed significant correlation between a surface approach to learning and academic performance (examinations), while for the more modifiable group there was a negative correlation. The differences were significant. This fits in with the notion that the less modifiable group focused on achieving high marks in the examinations to obtain academic success and used a surface approach to learning to realise this. Significant correlation between an achieving approach to learning and academic performance was obtained for this group. The less modifiable group in this study could be viewed as students who had already obtained a certain level of problem solving skills and whose surface and achieving approach to learning is an indication of their ability to obtain academic success. Students with a surface and achieving approach to learning tend to do well in an environment where examinations are valued (Biggs, 1987).

For the Engineering group the results of this study support the findings of Shochet (1986) only to a certain extent. For the less modifiable group the correlation between the EAT (which is an example of a traditional, static aptitude test) and academic performance (credits obtained) was moderately high, while for the more modifiable group the correlation was negative. These differences were not significant.

A result that stood out and which differs from the results of Shochet's study was the high and significant correlation between the CRT and posttest of the LPT (which are examples of dynamic tests) and academic performance for the more modifiable group of students. Shochet (1986) did not report any predictor of academic performance for more modifiable students. The results of this study indicate that the dynamic tests are more valid predictors than the SR score of the matriculation marks for the more modifiable students. The opposite is true for the less modifiable, where the SR score of the matriculation marks showed moderately high and significant correlation with academic performance. The differences in correlation between the two groups are significant for the CRT. When controlling for speed in problem solving (number of items attempted for problem solving) these results still held.

When looking at the lower achieving/more modifiable group the previous trends found with the Information Technology and Engineering students became more pronounced. The matriculation marks are not good predictors for this group (as opposed to the total group), while the posttest of the LPT (Information Technology and Engineering) and CRT (Engineering) seem to show themselves as more valid predictors of academic performance. For the lower achieving/more modifiable group of Information Technology students the deep and achieving approach to learning also proved to be valid predictors of students' academic performance.

The results of this study showed some similarities with those of Shochet, but also some differences. For the less modifiable Electrical Engineering students the correlation between the LPT1 (as an example of a static test) and academic performance tended to be low and not significant. For the more modifiable students the correlation between LPT1 and academic performance was high and significant ( $p = 0.001$ ). The differences in correlation for the two groups was significant ( $p = 0.05$ ). These results are the opposite to that reported by Shochet (1986) and the reason for this might be found in the differences in the student samples used.

When looking at the CRT (an example of a dynamic test) the tendency as reported with the LPT is reinforced. Whereas Shochet (1986) did not find any significant correlation for the dynamic test used by him, this study found a high and significant correlation between the CRT and academic performance for the more modifiable group. For the less modifiable group a negative correlation was found between the CRT and academic performance. The posttest of the LPT also showed a high and significant relationship with

academic performance (although lower than the pretest correlation). The conclusion is that for the more modifiable group the use of a dynamic test would be more valid for predicting academic performance than either an example of a static test (EAT) or previous academic achievement (in the form of matriculation marks). The practical implications are that a differentiation of criteria might have to be implemented during selection of disadvantaged students.

If one investigates the correlation between the EAT (an example of a static aptitude test) and academic performance (final marks and credits obtained) the pattern is closer to that reported by Shochet (1986). For the less modifiable group the correlations are low but positive, while for the more modifiable group the correlations between the EAT and academic performance (final marks and credits obtained) are negative. The differences between the correlation for the two groups were not significant.

The results of the Information Technology students tend to lean more towards the findings as reported by Shochet regarding the more modifiable group of students. The correlation between the pretest of the LPT (as representing a static test) and academic performance tended to be low. This study did not support Shochet's findings of a strong and significant relationship between the static test (pretest) and academic performance for the less modifiable group. The correlation between the pretest and academic performance for this group was also low and not significant. The correlation between the pretest and academic performance (examinations, final marks and credits obtained) tended to be higher for the less modifiable group than the more modifiable group which supports the findings of Boeyens (1989b). As the differences between the groups were not significant, the sentiments of Boeyens have to be echoed that no convincing support for the findings reported by Shochet (1986) could be found in this study.

For the other example of a dynamic assessment procedure, the CRT, the differences are even clearer. A negative relationship exists between the CRT and academic performance (credits obtained) for the less modifiables, while for the more modifiable group a positive and significant relationship was found between the CRT and credits obtained. The differences in correlation between the two groups were significant. The SR score did not show a significant correlation with academic performance for this group.

In controlling for speed (number of attempts on the pretest of the LPT) the correlation patterns of the less modifiable and more modifiable groups of students retained the same

pattern as previously reported. This means that speed did not play an important role in influencing the scores of the two groups. For the less modifiable students the SR score showed a significant relationship with academic performance, while for the more modifiable students the posttest of the LPT and CRT showed a significant relationship with academic performance. Significant differences in motivation were found between the two groups, with the more modifiable group showing a strong and significant relationship with academic performance.

The LPT, as a dynamic assessment procedure, allows for an analysis of processes involved in the problem solving part of the test. A further analysis was done on the number of attempts students made at solving problems in the pre- and posttest of the LPT and how they applied the mediated lesson. A number of students who had a lower number of attempts (one or more) at problem solving on the posttest as opposed to the pretest were identified as rigidly applying the principles acquired in the mediated lesson. This was done to such an extent that it hindered them in their problem solving and their speed was affected. These students subsequently attempted less problems in the posttest than they attempted in the pretest. The results showed that the rigid group obtained significantly higher scores for resource management which seems to emphasise their tendency to cover all options by following a detailed and methodological approach.

The rigid group also showed an atypical correlation pattern when compared with the total group. A negative correlation was obtained between the dynamic test and academic performance. While high correlation was obtained between the matriculation marks and academic performance (year mark), low correlation was found with credits obtained. There were also differences in the correlation with metacognition and motivation, with the latter proving itself to be a good predictor of academic performance, but metacognition abilities showing negative correlation with academic performance.

The results of this study showed that it was possible to distinguish between different groups of disadvantaged students according to their response to mediation in a dynamic assessment procedure. This provides support to the findings of other researchers working with a variety of subjects.

Carlson (1983) was able to differentiate between a group of impulsive learning disabled children as opposed to a group of children without learning disabilities on the basis of

their response to instruction (benefitting from mediation). Both groups scored significantly better on the Ravens test when pupils' verbalisation on the problem solving were presented without feedback. The author concluded that children with specific learning problems are able to overcome their impulsive style by verbalising their problem solving strategies and developing self-regulation strategies.

Most dynamic tests measure factors that are also present in conventional tests. The only difference is usually in the administration. With dynamic tests mediation or hints would be included as part of the testing process. In a sense intelligence and learning potential are two related concepts. The way that they are measured would make them different from each other. Intelligence could also be viewed as a prerequisite for learning ability but at the same time one could say that learning potential (as a product of a different measuring instrument) would be different from intelligence. Learning ability, learning potential and intelligence are different but related concepts and they interact with each other. Both intelligence and cognitive processes seem to play a role in the measurement of learning potential. The issue is not really whether high intelligence leads to high learning potential but rather in looking at the way in which the concepts are measured. This is where dynamic tests become useful. The possibilities of enhancing the cognitive and affective processes during a period of mediation play an important role in changing the width of the zone of proximal development and in its turn affects the way individuals utilise their intelligence.

The question is whether more modifiable students are also more intelligent. This might hold for some of the students but certainly there is a group that started off with a lower initial score on the LPT which is an indication of lower initial intelligence. These students were then able to improve their scores on the posttest of the LPT. Intelligence plays a role in learning but learning also plays a role in intelligence. Intelligence includes aspects of innate abilities but also affective and cognitive processes. The focus of a dynamic test is on increasing performance on the test in order for type C intelligence to be more accurately measured. Static tests do not provide a true reflection of Intelligence B, while dynamic tests provide an opportunity to improve performance on Intelligence C by addressing affective and cognitive processes. This allows for a more accurate inference of Intelligence B.

If the LPT1 results are interpreted as an indication of intelligence then high intelligence does indeed play a role as can be seen in the moderately high correlation

between LPT1 and academic performance. The differences between more and less modifiable students make it possible to differentiate which factors play a role in predicting academic performance for the different groups. Static tests seem to underrepresent the intellectual abilities of some students and here the LPT2 might be a better indicator of academic performance. The more modifiable students would most probably improve more from remedial and academic development activities than the less modifiable group.

The conclusion of this study is that the use of dynamic tests would facilitate the process of identifying those disadvantaged students who are able to benefit from mediation and show modifiability. This is seen as an alternative to the use of traditional and static tests and prior academic achievement in the form of high school results. It is further argued that it is not only the beta components (such as test wiseness) of the test scores that are affected, but that students are able to, with the help of mediation, improve the alpha components (problem solving) of the test scores. The testing situation can provide a glimpse of the learning potential that exists and that needs to be developed in an enriched academic setting. The use of dynamic testing would provide all students with an equal opportunity to show whether they can benefit from a mediated phase in the form of an academic development enrichment programme.

## **5. ACADEMIC SUCCESS**

Clear distinctions were found between those students who were academically successful (passing all their subjects) and those who were less successful (failing one or more of their subjects in a year). A discriminant analysis indicated that the SR score of the matriculation marks and self-reported metacognitive abilities together predicted 86% of the students that failed, while correctly predicting 53% of the students that passed.

A further comparison between more successful (passing all their subjects) and less successful (failing one or more of their subjects) students showed that besides the SR score the successful students made more use of metacognitive and other cognitive strategies. This group also obtained significantly higher scores in the deep and achieving approaches to learning. The implications of this is that they focused on understanding

rather than memorising the learning material, but also showed their intent on obtaining good marks to a much greater extent than the less successful students. From this it can be deduced that more successful students are aware of the academic demands made on them and are able to adapt to these demands (De Villiers, 1996).

Another significant difference between the more and less successful groups was found on the posttest of the LPT, with the more successful group having the higher scores. This supports the trend that a dynamic test would be useful for differentiating between groups of more and less successful students. If the pretest of the LPT alone, or any other static test, was used as admission criteria, they would not have been able to differentiate between the two groups. The mediated lesson provided the students the opportunity to improve their scores in the problem solving exercise and achieve significantly higher scores on the posttest of the LPT. This is evidence of support for the use of dynamic assessment when selecting disadvantaged students.

In a study done by Booyesen (1996) with Peninsula Technikon Engineering students he found that an adapted Swedish rating score of the matriculation marks (the points for mathematics and physical science were doubled) and an indication of students' work experience before coming to the technikon, were the two factors that discriminated between successful and less successful students. None of the other traditional static tests in the equation (Mental Alertness, Technical Reading, Mechanical Comprehension and Gottschaldt Test) showed significant differences between the groups. The use of dynamic tests and learning strategies seem to be a viable alternative to matriculation marks and static tests for selecting disadvantaged students.

## **6. MODERATOR EFFECT**

A number of factors were analysed for their moderator effect on predicting students' academic performance. The first factor to be investigated was the school that the students attended (non-DET or DET schools) and whether this played a role in the various variables' predictive power. Other factors that were analysed were socio-economic status (SES), language, gender, the course students were enrolled for and their level of study (first year as opposed to third year). These factors were also investigated as to whether they would differentiate between various cognitive and non-cognitive variables.

## 6.1 SCHOOLING

The DET and non-DET students were separated into two distinct groups to analyse the role that the educational experiences in the different schools played in preparing students for tertiary education. Various researchers have highlighted the large differences in DET and non-DET schooling (Bunting, 1994; Potter & Van der Merwe, 1993; Shochet, 1986). The DET students in this study are a selected group of students and cannot be seen as being representative of all DET students. A comparison between the matriculation results of the two groups confirms this. The SR score and symbols for individual matriculation subjects are very similar for the DET and non-DET groups. In fact, in the case of subjects such as Mathematics, Physical Science and a second language, there is a trend for the DET students to have slightly higher symbols.

In general the results of this study indicated a pattern where the DET students consistently obtained lower scores on the cognitive measurements. This was particularly evident in the case of the RCT, which reflects on students' previous language development and academic experiences. (English is a second language for all DET students.) The DET students also obtained significantly lower scores on the CRT, which is an example of a dynamic assessment procedure. The conclusion that can be made from this finding is that the DET students were not able to benefit as much from the mediated lesson incorporated into the test as the non-DET students. This conclusion is supported by the results of the two group design which indicated that for the DET group no significant differences between the control group (who did not receive the lesson) and the experimental group (who did receive the lesson) were found. With the LPT the trend was that the non-DET students not only obtained higher scores on the pretest but also showed that they benefitted more from the mediation by obtaining higher difference scores. The DET students also obtained significantly higher scores in test anxiety when compared to the non-DET students, which could also be a reason for their lower scores.

Research reviewed by Snow and Yalow (1982) showed that students with high initial ability seem to benefit more from a period of instruction (mediation) than students with lower initial ability. An explanation found in some of the studies is that lessons which overload the less abled students with problem solving strategies, might actually be hindering them. More able students were able to assimilate the new information into their existing repertoire of problem solving strategies more easily and are able to be more

flexible in their responses. It seems that the type of lesson used in the present study might have been more conducive for the more able students to benefit from. The fact that the DET students obtained significantly higher self-reported scores in test anxiety when compared to non-DET students suggests that a different mediation approach might have to be used for DET students in future studies.

An analysis of the correlation patterns of the groups indicates that the DET students show an atypical pattern when compared to the rest of the group. The matriculation marks showed a negative correlation with academic performance, while the dynamic assessment procedures showed high and significant correlation with academic performance (credits obtained). The opposite results were obtained for the non-DET students, where the matriculation marks together with the reported use of metacognitive strategies and a deep and achieving approach to learning showed significant positive relationships with academic performance. The results suggest that the use of dynamic assessment procedures would be a more valid predictor of academic performance for DET students, while the traditional matriculation marks seems to be an adequate predictor for the non-DET students. The differences in correlation for the two groups were significant.

The only non-cognitive factor that showed a significant correlation with academic performance (final mark) was test anxiety. Those students with lower test anxiety scores tended to do better academically. This links up with work done by Meijer (1993) which found that children with high levels of achievement motivation and test anxiety as a combination, tend to do worse in a test situation. Although the students are motivated to perform well, the high level of anxiety causes them to perform below their potential. The DET students obtained significantly higher scores in test anxiety when compared to non-DET students which is an indication of the pressure on them to perform well and their inability to manage their anxiety.

In comparing a larger sample of DET students with the non-DET group, significant differences were found between some cognitive and non-cognitive factors. In each case the DET students obtained lower scores on the cognitive factors, while obtaining higher scores on the non-cognitive factors. The DET students obtained significantly higher scores in metacognition, cognition, and a deep and achieving approach to learning. This seems to suggest that the DET students, who are a select group, compensate for their relative poor performance in problem solving skills through their high levels of self-

reported motivation, use of cognitive strategies and approaches to learning. School subject symbols for the two groups showed no significant differences.

The above findings suggest that the type of school that students attended, had a moderating effect on the factors predicting academic performance. The implications are that different selection and academic development strategies might have to be implemented for the different groups of students. The DET students seem to have an initial drawback as regards to the problem solving skills measured by the instruments in this study, but showed that they are able to adapt and be academically successful. Dynamic assessment procedures seem to be a more valid and fair way of predicting DET students' academic performance.

## 6.2 SOCIO-ECONOMIC STATUS (SES)

Traditional static tests have been found to be sensitive to high and low variations in socio-economic status (SES) (Anastasi, 1985). Individuals with high SES tend to score higher on tests of intelligence. At the same time dynamic tests and particularly learning potential should not be greatly influenced by either high or low SES. The results of this study show the scores of the dynamic tests are less dependent on a high or low SES. In comparing a high and low SES it was found that the CRT score was almost the same for the two groups. While there was a significant difference on the pretest of the LPT (an example of a static test) for the two groups, the scores on the posttest of the LPT showed no significant differences. These findings indicate that the students with the lower SES were able to benefit from the mediated lesson to improve their posttest scores to such an extent that the effect of the SES was neutralised.

Other general tendencies seem to be that the students with a lower SES obtained lower scores on the cognitive factors, but higher scores on motivation and approaches to learning, while showing lower scores on cognitive strategies and resources of management. The lower SES group also tended to have lower matriculation marks but subsequently obtained lower marks and credits at the technikon. No differences in correlation patterns between the two groups were observed, which indicates that the SES did not have a moderator effect on variables predicting academic performance.

### 6.3 LANGUAGE

The results of this study found significant differences between English first language users (EFL) and English second language users' (ESL) (Afrikaans) scores on a number of factors. The exclusion of the DET students (who are also ESL) controls for the influence of schooling. The most glaring difference was performance on the RCT. The test is an English reading comprehension test and the ESL performed significantly poorer than the EFL.

A good case can be made not to use English language skills as a criterion for selection to tertiary education institutions. The instrument used in this study to assess English reading comprehension did not prove to be a good predictor of academic performance. In research done with an English language proficiency test at the Peninsula Technikon (Himunchul, 1995) it was found that a high score on the test did not predict academic performance. The study did find that if the proficiency index is below a certain cut-off point, students tend to have problems with academic work. What it seems to indicate is that students with very low English language proficiency will have difficulty in adapting to the academic demands, but that English language proficiency as such is not a good predictor of academic performance.

Miller, Bradbury and Wessels (1997) examined the relationship between academic performance, first/second language use, and underpreparedness with respect to different forms of assessment in the context of a structured tutorial based mode of instruction. The data concerning underpreparedness was derived from the performance of 543 first year Psychology students (340 EFL and 203 ESL) on English language and mathematics items included in a questionnaire. The results appear to indicate that the critical factors underlying performance is not whether students are EFL or ESL but to what extent they are underprepared for higher education as shown by their results on the English language and Mathematics items. When comparing performance within the high/low categories, that reflect basic English language and Mathematical proficiencies, the differences between EFL and ESL disappear and are replaced by performance differences that relate to levels of academic preparedness. The apparent differences between EFL and ESL are a function of the fact that a far higher proportion of ESL fall into the lower performance category.

In this study the ESL had significantly lower scores on both the pre- and posttest of the LPT. The results also showed that the ESL favoured a surface approach to learning. There were no significant differences in the SR score of the matriculation marks between the groups, but the ESL seemed to have relied more on a rote memorising approach to learning at secondary school level, which did not prepare them adequately for tertiary education. Although there were no significant differences on the year and final marks, the ESL showed a significantly lower number of credits obtained than the EFL. It must be mentioned that the language of instruction and examination of both the courses involved in this study is English. It is possible that this affected the students' performance and together with the surface approach to learning adopted, left them inadequately prepared for the academic demands at the technikon.

The implications of these findings seem to be that the ESL (Afrikaans) group passed their matriculation examinations by making use of and relying on memorising instead of an understanding approach. Their academic performance at the technikon did not mirror their achievement at school, most probably because their surface approach to learning was less appropriate for success at the technikon. The significantly poorer academic performance of the ESL (Afrikaans speaking students) supports the findings of Booysen (1996) in an earlier study done at the Peninsula Technikon and has implications for the future academic development of this group.

Although there were significant differences on most of the static measures, which represent past learning experiences, there were no significant differences on the CRT between the two groups. This indicates that a dynamic assessment procedure (which is primarily non-verbal in nature) was able to circumvent the language barriers that exist for the ESL. This notion is supported by the trend that the ESL showed a higher difference score between the pre- and posttest of the LPT.

Generally, a comparison of the correlation patterns of the group of EFL and ESL show similar patterns. Both groups obtained moderately high and significant relationships between the SR score and academic performance (credits obtained). The relationship between the dynamic tests (LPT and CRT) and academic performance (credits obtained) was low to negative for both groups. From these results it can be inferred that language does not have a moderator effect regarding the SR score of the matriculation marks or learning potential scores in predicting academic performance, but that differences exist regarding approaches to learning and learning strategies.

## 6.4 GENDER

In comparing a group of male as opposed to female students, significant differences were found on the SR score, the final mark and credits obtained. The female students' lower matriculation marks were followed by achieving lower final marks and also obtaining less credits at the technikon when compared to the male students. The only other difference of note was that the female students reported significantly higher test anxiety. Having to perform in a male dominated faculty (Engineering) seems to have had an influence on their academic performance. The female students also seemed not to have received enough specific support to enable them to improve on their secondary education results.

Ablard and Lipschultz (1998) obtained data on the self-regulated learning (Self-regulated Learning Interview Scale) and achievement (mastery and performance) of over 200 high achieving students in their 7<sup>th</sup> grade. The results showed certain gender differences. The female students reported more frequent use of self-regulated learning strategies than the male students. Gender differences were also related to the type of self-regulated strategy. Female students indicated that they make more use of strategies that optimise the immediate environment or optimise personal regulation. One explanation of these differences is that male and female students use different pathways to reach the same high achievement. Female students also seem to be more aware of self-regulated strategies.

Shochet (1986) found in his study that being male or female did not have a moderator effect on cognitive measures predicting academic performance. The results of this study support this in that the correlation patterns for male and female students were found to be very similar. Both groups showed moderately high and significant relationships between the SR score of the matriculation marks and academic performance (final mark), while low to negative relationships between the dynamic tests (LPT and CRT) and academic performance (final marks) were found. The female students had significantly lower matriculation marks, but they then subsequently also performed significantly poorer than the male students at the technikon (final marks and credits obtained). The female students also indicated on the MSLQ that they were significantly more anxious in a test situation. Overall the results show that gender did not have a moderator effect in the prediction of academic performance with either the matriculation marks or dynamic tests which support the findings of Shochet.

## 6.5 STUDY COURSE

Several significant differences were noted between a group of Business and Engineering students. The Business students' course is examinations-orientated, while the Engineering course is based on continuous evaluation. The Engineering students are also a more select group in the sense that a more stringent process is followed in selecting Engineering students. The Engineering students' significantly higher SR score was followed by significantly higher scores in academic performance at the technikon (year mark, final mark and credits obtained).

In looking at the motivational and learning profiles of the two groups, significant differences in scores seem to indicate the differences in approach to learning followed by the students at the two departments. The Business students obtained significantly higher scores on the surface approach to learning scale. This is a reflection of a memorising approach which seems to be a response to an examinations-orientated course where high value is attached to memorising and factual information. This notion is reinforced by the fact that the Engineering students obtained significantly higher scores on the deep strategies subscale of the deep approach to learning. Students with this approach try to understand the learning material and make sense of it, rather than only resorting to memorising. The different approaches to learning of the two groups seem to be a reflection of the differences in assessment used in the two departments. Students tend to pick up what activities would be of the most advantage to them in an assessment situation (Ramsden, 1988). With a continuous evaluation approach the projects, assignments and tests written during the year carry just as much weight as the examinations at the end of the year, which might encourage an understanding approach to learning, while an examinations-orientated course seems to encourage a memorising approach.

The students' score on the achieving approach to learning scale supports the above finding. Whereas the Business students scored significantly higher in the achieving motives subscale, the Engineering students obtained significantly higher scores in the achieving strategies subscale of the achieving approach to learning. A possible interpretation of this finding is that the Business students with their surface approach to learning, are motivated to obtain success in their studies by using memorising strategies. For the Engineering students the combination of both deep and achieving strategies is a way of achieving success by applying strategies that would lead to an understanding of the learning material.

The results indicated that there seem to be different profiles for Engineering as opposed to Business students, with the Engineering students obtaining significantly higher scores on the cognitive factors. The latter group also obtained significantly higher marks in both their previous academic achievement and academic performance at the technikon. This seems to link with the fact that the Engineering students are a highly select group of students with well developed abilities in problem solving and an interest in their chosen career. The Engineering students also reported higher scores on the non-cognitive factors. Their motivation and resource management scores were significantly higher than those of the Business students. Scott (1991), in her comparison of students in different courses, found that university students with certain motivational patterns (expectancies and values) tend to choose subjects and courses according to the content-domain and information processing style linked to that subject or course. The closer the match between the student and the course, the better the possibility of being academically successful.

## **6.6 YEAR OF STUDY (FIRST VS THIRD YEAR)**

An analysis of the motivational and learning scores of Information Technology students in their first year as opposed to their third year showed some significant differences. The students in their third year showed significant gains in the deep motives subscale of the deep approach to learning, which is in line with the notion that these students had developed a more understanding approach to learning at the end of the course and were preparing to apply it in the work situation. The other significant gains were on metacognition and elaboration (a subscale of cognition). The students seemed to have developed those particular skills which were linked to making them successful students and which enabled them to reach the final year of their studies. These findings concur with those of Alexander and Murphy (1998) that students had significantly increased their use of deeper processing strategies after a semester.

Busato, Prins, Elshout and Hamaker (1998) studied the development of learning styles during a group of first, second, third, fourth and fifth year Psychology students' stay at an university. They used a combination of a cross-sectional and longitudinal design. The learning styles were operationalised using the Inventory of Learning Styles (ILS) developed by Vermunt (1998) and consists of the following: undirected, reproduction directed, application directed and meaning directed learning. Different results were

obtained for the cross-sectional and longitudinal studies. In the cross-sectional data no systematic relation was found between year of study and learning style. The application and meaning directed learning style scores were not higher in later years. At the same time neither were the undirected and reproduction learning style scores lower in the later years. In the longitudinal study, the means of the meaning directed and application directed learning style scores increased over the years, while the means of the reproduction and undirected learning style scores decreased over the years. For the score on the meaning directed learning style, the increase was significant.

The implications are that the students developed the ability to think about their learning to a much greater extent and were able to relate their learning more to the task demands in their third year than they were able to do in their first year. They were able to develop an awareness and an intention of a deep approach to learning over time, although this did not always lead to the implementation of strategies for a deep approach to learning.

The practical implications of the results of the different studies as well as some limitations and future research possibilities will be discussed in the next chapter (Chapter 10).

## Chapter 10

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# CONCLUSION

### 1. INTRODUCTION

Most tertiary education institutions are busy searching for ways of selecting students that will reflect accuracy as well as fairness. Part of this process includes looking for alternatives to the system of using matriculation marks, which does not presently seem to be a fair or accurate predictor of academic performance for all disadvantaged students. In this process many researchers have looked at developing an admission test that would correlate strongly with academic performance, but be independent of socio-economic factors and past schooling. Usually the search for such a test has involved static assessment of aptitude, ability or achievement that reflect an individual's previous learning experiences rather than using dynamic assessment procedures that would reflect learning potential.

Overall the results obtained in this study seem to suggest that Vygotsky's theory of learning potential can be successfully operationalised and applied in an assessment procedure. Furthermore the differentiation of different groups of students on the basis of their response to mediation seems useful as a tool in improving the validity and accuracy of predicting academic performance of disadvantaged students.

The present study has provided some evidence for a relationship between disadvantaged students' affective and cognitive processes, their ability to benefit from mediation (modifiability) and their subsequent academic performance. The practical implications of these findings will be discussed in the next section.

## **2. PRACTICAL IMPLICATIONS**

The research objectives of this study were firstly to provide empirical information concerning the relationship between selection criteria and subsequent academic performance, and secondly to investigate the role of the affective and cognitive processes in disadvantaged students' preparedness for tertiary studies. Translated to practical terms the goal was to find refined criteria for selection purposes and to develop an understanding of the affective and cognitive processes involved so as to inform the nature of educational development programmes.

The challenge faced by South African institutions of higher learning is to both equalise access and redress imbalances in success rates. This calls for selection procedures which capture the potential ability of students for study and constitutes a shift in focus from previous academic performance to the assessment of learning potential.

Some of the practical implications involved in the implementation of the concept of learning potential that need to be addressed are:

- (1) The use of subgroups with assessment
- (2) Alternative selection practices
- (3) The design of academic development programmes.

### **2.1 THE USE OF SUBGROUPS WITH ASSESSMENT**

The institutions of higher education in South Africa have approached the problem of selection in different ways. Many of them have experimented with various admission tests in order to develop fair and accurate selection criteria that would serve as an alternative to the matriculation marks. Both the Higher Education Act (1997) and Employment Equity Act (1998) have made it essential that valid and fair methods are used to select students. At the same time there are strong subsidy incentives to make sure that students are academically successful.

One of the conclusions from this study is that disadvantaged students do not constitute a homogeneous group and that subgroups should be treated differently both in the selection process and the academic development programmes designed for them. An

assessment of disadvantaged students' response to mediation combined with their motivational and metacognitive profiles could provide an indication of which groups of students would need a specific kind of development programme.

In order to cut out any bias in favour or against any particular group, a differentiation in selection criteria could be implemented. Each group of students could have different criteria for selection to tertiary education. The differentiation does not necessarily have to be made between DET and non-DET students. Some institutions already have a system where the matriculation system is being used to select non-DET students, while the DET students are being selected using different criteria. This approach is based on a quota system, with all the problems associated with such a system.

The development of dynamic tests have provided the opportunity to differentiate between groups of students who are more modifiable as opposed to less modifiable. This study has shown that it is possible to make this kind of differentiation and that differences exist between these groups with regards to factors predicting academic performance.

The results of this study supports the findings of Shochet (1992, 1994) that disadvantaged students can be differentiated according to how they respond to mediation. In some cases there were students who relied heavily on previous learning achievement and for these students the matriculation results or static ability tests seemed to be better predictors of academic performance. These students can be described as high achievers and less modifiable. Another group of students did not rely that heavily on previous achievement and for these students the matriculation results and static tests did not seem to be a good predictor of academic performance. It seems that these students should rather be selected on the basis of non-cognitive criteria and learning potential indicators. This group could be described as low achievers, with high modifiability. Each one of these groups showed that they would need a different kind of intervention to help them succeed at a tertiary institution.

The high positive correlation between the posttest scores of a dynamic test and academic performance suggests that these procedures can be effectively used as an alternative to the matriculation marks in selecting students. This is especially true for those groups of students who have lower matriculation marks and who showed that they were more modifiable. The trend emerging from the results is that with the more modifiable group of students the dynamic test is a better predictor of academic performance than either a

traditional static test or the matriculation marks. The opposite was true for the less modifiable group of students, where the matriculation marks seemed to be a better predictor of academic performance.

Besides modifiability and the type of course that students are enrolled for, another variable that had a moderator effect was the type of schooling that students received. Whereas the matriculation marks constituted an adequate predictor of academic performance for the non-DET students, the dynamic tests, rather than the matriculation marks, proved to be significantly better predictors for the DET students.

Both the DET and non-DET groups benefitted from the mediated lesson echoing the findings of Shochet (1986) who reported that both the white group and the black group benefitted from the mediated lesson. The differences between the two groups in the present study tended to be less than the differences between the groups for the Reading Comprehension Test which is an example of a static test. The scores of the DET students on the posttest of the LPT improved to such an extent that it equalled that of the non-DET students' pretest scores. The implication of this is that the DET students were able to compete on an equal footing after the mediated lesson, which would not have been the case if both groups had completed only the pretest (static test). This improvement in scores would most probably have to be partly attributed to an increase in test wiseness or test-taking abilities, but seems to be more than just that if the results of the Solomons Four Group design is taken into consideration. Another reason for this increase could be the improvement of cognitive processes (learning and metacognitive abilities) which would lead to an increase in the application of mental abilities (Haywood & Switzky, 1992). Where the DET students did not seem to benefit as much from the mediated lesson as was expected, this might be explained by the lesson itself. The lesson might have placed an extra burden on them instead of assisting them, especially with test anxiety playing a debilitating role.

A comparison between the correlation patterns of English First Language (EFL) users and English Second Language (ESL) (Afrikaans speaking) users showed that they were very much the same for the cognitive measures but differed on the non-cognitive factors. The moderator effect of language on the prediction of students' academic performance would thus be in the learning strategies and approaches to learning areas.

The results attained by Miller, Bradbury and Pedley (1998) in their study with 543 first-year Psychology students at the University of Natal support the argument that second language, rather than being a direct cause of underpreparedness, acts to compound a more basic cognitive problem. The critical factor is not whether students are first or second language speakers but whether or not they are adequately prepared for the demands of university tasks. Not all the disadvantaged students (African language speakers) were underprepared for tertiary studies and not all underprepared students necessarily failed.

The present study provides indirect evidence that comparisons between different cultural groups cannot be based on a single frame of reference such as aptitude or intelligence scores. Other factors such as individuals' response to mediation, and the cognitive processes and motivational factors which play a role in the application of mental ability have to be taken into consideration. While Sternberg (1985) and Borkowski (1985) stress the importance of metacognition in the development of learning and problem solving, metacognitive abilities are likely to be culturally mediated during childhood. Feuerstein (1980) mentions that the lack of mediated learning experiences leads to cognitive deficiencies which leads to poor learning and problem solving abilities. This study has shown that students of different cultural backgrounds differ in their approach to learning and problem solving and this can be seen in their performance on cognitive tests. The differences in static test results seem to be reflecting differences in affective and cognitive processes as well as motivational approaches to problem solving rather than genetic differences in intelligence between different cultural and racial groups (Jensen, 1980).

The results of this study suggested that Gender does not play a moderator role in the prediction of academic performance. There are indications that female students tend to do more poorly in both the matriculation results and subsequent academic performance at tertiary level. This seems to be particularly true of the engineering and science directions. One explanation for this finding is that cultural attitudes and gender stereotyping still play a role. Women are generally not encouraged to do well in subjects such as mathematics and science which would provide entry to courses in engineering and technology (Macleod, 1995; Visser, 1987).

The practical implications are that mechanisms need to be put in place where female students can receive specific support and development to counter gender stereotyping of abilities. A Women in Engineering and Science Group recently started at the Peninsula

Technikon is an example of what could be done to increase female students' academic performance in male dominated disciplines such as Engineering.

The results of the present study indicated that the SES did not act as moderator of academic performance, although the group with a lower SES tended to have lower matriculation marks as well as lower academic performance at the end of the first year at the technikon. The group of students with the lower SES also tended to have lower scores on the cognitive measurements. It can be assumed that these students have not been exposed to the same opportunities in experiencing psychometric testing and problem solving. Lidz (1991) found that students with lower SES benefitted less from the practice effect than those students who showed a higher SES. The students with lower SES also needed more intensive training for them to increase their posttest scores. Dynamic tests seem to provide less differentiation between low and high SES individuals than the traditional IQ tests. Large differences in IQ scores are often attributed to differences in environmental conditions or social class.

Besides the use of dynamic assessment procedures it was important to investigate the role of affective and cognitive processes. There is some evidence in the study that students' differences in responses to the mediated lesson can be explained by their approaches to learning and learning strategies. A group of students who rigidly applied the mediated lesson to problem solving scored significantly higher on resource management as opposed to the non-rigid group. The reliance on external resources seems to lead to a lack of flexibility in integrating and applying their own problem solving strategies to those acquired in the lesson. When looking at the less modifiable group of students, the students with a lower number of problems attempted on the pretest scored significantly higher in problem solving than a group with a higher number of attempts. Test anxiety seemed to have hindered the former group of students in assimilating and applying the principles acquired in the mediated lesson. The dynamic tests did not prove to be good predictors of academic performance for this group.

The fact that a deep and an achieving approach to learning significantly differentiated between successful and less successful students indicates that students need to be versatile learners who are able to form an awareness of their own learning and adapt their learning strategies to the academic demands (Pask, 1976).

A specific profile emerges for the more successful students, which include both cognitive and non-cognitive factors. Besides the matriculation marks, the self-reported meta-cognition, cognition and a deep and achieving approach to learning, as well as the dynamic test (posttest of the LPT) seem to play an important role in the academic success of disadvantaged students. Here again differences in correlation patterns between Information Technology and Electrical Engineering students indicate that the manner in which academic performance is assessed (continuous as opposed to examinations) acts as a mediating factor in identifying those factors that play a role in predicting students' academic success.

Another illustration of the mediating role that the non-cognitive factors (affective and cognitive processes) played in students' adaptation to the academic demands is the comparison of the students when they were in their first year as opposed to their third year. When in their third year, the students reported significantly higher scores on the deep motives approach to learning scale and metacognitive strategies as opposed to when they were in their first year. The implications are that the students were able to benefit from interventions over time and significantly improved their learning strategies and ability to organise their environment to achieve academic success.

The choice of a specific battery of tests for selection purposes is an aspect that could be dealt with in both a very specific and an universal manner. There are some general skills that all individuals need to be able to be successful at tertiary education level. Dynamic assessment procedures could be designed to simulate the academic demands placed on students. Some of the universal skills are linked to cognitive skills needed in reading, writing, numeracy and problem solving. A case could also be made for including some very specific course content in a test battery. Here one could distinguish between Engineering students on the one hand and Business students on the other hand. Practical aspects such as the time and available resources would have to be considered in the design of dynamic procedures.

In the present study the mediated lesson in the dynamic test provided an opportunity for students to show that their performance level on a test could improve with metacognitive assistance. Certainly it does not necessarily mean that their mental capacity has improved. That kind of change would have to happen over a longer period of enriched educational intervention. What it does imply, is that a differentiation could be made between those students with poor problem solving ability and those who are able to

benefit from mediation and show modifiability and learning potential. Cilliers and Kilpin (1997) have shown with their cognitive programme for disadvantaged students that it is possible to enhance students' metacognitive skills and improve academic performance.

Any institution of higher learning would have to make a decision about incorrect acceptances from disadvantaged groups or incorrect rejections from an advantaged group. Besides bringing in fairness into selection one also has to look at who will best respond to the kinds of development programmes being offered. With the use of dynamic testing it would be essential to have an educational development programme in place to develop students' potential. Identifying students' learning potential or being modifiable is only half the picture. A deeper understanding of the individual's profile of efficient and deficient functioning as well as to what kind of mediation they respond to is important for developing appropriate curricula that would support disadvantaged students (Moulder, 1991).

## **2.2 ALTERNATIVE SELECTION PRACTICES**

While many tertiary institutions in South Africa still rely on the assessment of manifest academic performance and aptitude, some have developed alternative selection practices by looking at the assessment of learning potential. The latter approach seeks to assess the ability of an individual to respond to actual learning challenges by incorporating a teaching/learning element into the selection procedure. A learning potential assessment procedure presents the individual with actual learning challenges and monitors the learning process. Although the majority of students are still selected according to their matriculation marks, some students are able to gain access through alternative admission projects.

The first examples of these alternative admission projects were the Alternative Admissions project at the University of Cape Town (UCT), the Test-Learn-Test project at the University of Natal and the research of Shochet (1986) at the University of the Witwatersrand. These English speaking universities have a long history of accommodating black students and had started grappling with finding alternative predictors for the matriculation marks at a much earlier stage than the historical Afrikaans speaking universities.

The dynamic assessment instrument designed by Yeld and Haeck (1993) at the University of Cape Town's Alternative Admission Research Project uses task scaffolding which targets the areas of language proficiency and numeracy (mathematics). This approach does away with the problems inherent in the use of difference scores. Students are assisted in solving problems by way of written material included in the test. Later in the test they are provided with more complex problems to assess their ability to benefit from the written mediation. Only those DET students who were not able to gain admission to UCT through their matriculation marks are targeted. This project is still in a research phase but initial results indicate that many students selected in this way are academically successful. This project is founded on the recognition that selection procedures and educational development work are closely related. It has provided a strong argument for the value of diagnostic testing for all students that would inform the development of underprepared students.

The University of Natal has established a dynamic assessment procedure that differs from the conventional testing instrument approach (Griesel, 1992). The Teach-Test-Teach (TTT) programme is based on a two week programme. Potential students have to attend the programme which provides them with the opportunity to display their potential in real university academic settings. Students are given a slice of the academic life at university condensed into two weeks. They have to attend lectures within the faculties of Arts and Social Sciences. The students also receive input on consolidating information and the production of knowledge (Mseleku, 1993). Students are evaluated throughout the whole process to assess their academic potential.

Researchers' reports on the success rates of students admitted through this project seem to be encouraging with 37% of the first group having graduated in minimum time. The programme is still in an experimental stage but tends to be resource-intensive and can only cope with a limited number of students at a time.

The Afrikaans speaking universities started taking in significantly larger numbers of black students since 1994 and many of them had to re-think their admission criteria. A few initiated research using dynamic tests as an alternative to the matriculation marks. Examples of these universities are the Rand Afrikaans University (RAU) and the Potchefstroom University of Christian Higher Education (PU for CHE) that have conducted research on the predictive validity of the Ability, Processing of Information and Learning (APIL) Test Battery (Kotzé, Van der Merwe & Nel, 1996).

The use of a bridging or foundation course could be one way of exposing students to appropriate learning experiences (in the form of tutorials) to enable them to develop capabilities in meeting the learning demands of higher education (Miller, 1997). Various projects using bridging and access programmes are in existence where students are provided with enriched educational settings and have the opportunity to show that they have the academic potential to be successful. Other institutions have explored the notion of using the Community College concept of providing students with a stepping stone to gain admission to institutions of higher learning (Strydom, 1991). Certainly the initiation of the National Qualification Framework and the recognition of prior learning experiences will assist those students who have the work experience but no formal education qualifications to access institutions of higher learning (South African Qualifications Authority Act, 1995).

The Peninsula Technikon's mission statement is based on the principle of equity and the admissions policy was developed to consolidate non-discriminative practices. Due to the legacy of poor secondary schooling the technikon finds itself in a position where it has to cater for the needs of predominantly educational and economical disadvantaged students. In the preamble to the technikon's admissions policy, a sensitivity to the demand for access to tertiary education from these disadvantaged students is clearly stated. This is coupled with an understanding of the kind of problems that would need addressing and which include those associated with language, multiculturalism and unevenness in academic achievement. The Policy states that "... students will be admitted to the Technikon on the basis of their potential, aptitude, interests, experience and motivation. The Technikon strives to assess each of these qualities in its prospective students using the most reliable, valid and fair instruments available." (Admissions Policy, 1997:8).

The Admissions Policy states that the admission and thus selection process and procedures should be fair, valid and free from cultural or gender bias. In this regard the institution's emphasis is on selecting those students who are able to demonstrate the potential to be academically successful, while committing itself to providing academic support to educationally underprepared students. Dynamic assessment procedures could play an important role in identifying those students who would benefit from academic development programmes.

## 2.3 THE DESIGN OF ACADEMIC DEVELOPMENT PROGRAMMES

In South Africa the underprepared students are those who, for a variety of reasons, have not required the academic literacy necessary for higher education. The literacies they do have are not congruent with those of the academic culture of the institutions they have applied for. A change of emphasis has taken place over a number of years at tertiary institutions from academic support to academic development with the emphasis on changing institutions that are underprepared to meet the needs of a diverse body of students (Angéllil-Carter & Thesen, 1993). The move has been towards staff development as well as student development, with scaffolded learning, academic reading and writing tasks, independent learning and peer group learning being some of the elements that were implemented.

Various explanations have been given for students' educational underpreparedness: linguistic competence in second language learners (Miller, Bradbury & Pedley, 1998; Mol & Slominsky, 1989), factors associated with orality and literacy (Bradbury & Griesel, 1994) and socio-political factors (Nyamapfene & Letseka, 1995). Students' academic preparedness can be viewed in relation to how well they are able to meet the cognitive demands of tertiary education tasks (Miller, 1997). Putting in place educational development programmes requires an understanding about the nature of underpreparedness and the capacity of underprepared students to constructively engage with the learning-teaching process and in that way improve their academic performance (Miller, 1998).

Amos and Fischer (1998) argue that students do not always lack the inherent abstract cognitive capability necessary for success in the higher education context, but rather that they have not learnt to mobilise and apply the particular cognitive processes found in the groundrules of a discipline. The groundrules define the structure of values, attitudes, and way of thinking and doing necessary to succeed within a particular discipline. Rather than assuming that students are not intellectually capable of meeting the academic demands of tertiary education, the assertion is that the underprepared students are not making use of the correct cognitive processes to meet the demands of tertiary education. Academic development programmes need to be aimed at preparing students to mobilise the cognitive processes required for success.

The main thrust of the Educational Development Unit at the Peninsula Technikon has focused on curriculum development (Wood, 1998). The argument is that a new emphasis

on learning within the curriculum should lead to methodological shifts in teaching. A greater awareness of learning issues and the use of educational material to mediate cognitive development make it impossible to ignore students' cognitive processes. This means integrating cognitive development strategies into the learning material, instead of dealing with the strategies outside the curriculum. Integration of cognitive development activities with subject content has the added advantage of potentially removing the transfer problem.

Some of the suggestions for the design of academic development programmes include establishing links between students, staff and the curriculum. There is a need for a curriculum that allows students access to the fundamental ways in which disciplines structure knowledge. This could be incorporated in a newly developed curriculum for diversity (Starfield, 1996). Lectures can act as facilities in the meta-curriculum through a process of modelling in which the "how to do it" is shown. In the diversity curriculum the more traditional academic skills of listening, speaking, reading and writing are learnt in relation to the deep structures of the curriculum that represent academic literacy. Together with this would be teaching for transfer skills. Learning packages can be devised which would lead students through the arguments and material to be covered in a discipline (Craig, 1996). Students are often underprepared because of the lack of socio-educational opportunities or inadequate mediation into the world of learning (Kilfoil, 1996) and this needs to be addressed.

Craig and Kernhoff (1995:25) suggest the purpose of intervention programmes is "... to make explicit to underprepared students the epistemic assumptions underlying academic tasks to enable them to interpret the nature of problem solving tasks and to develop appropriate strategies and metacognitive control for task engagement." Biggs (1996) indicated that it is possible to improve the quality of students' learning by designing learner activities that create meaning. Assessment practices would have to be adapted to encourage this.

In a study with 488 first year students Elen and Lowyck (1998) assessed the students' instructional metacognitive knowledge (conceptions about the relationship between instructional intervention and learning). Their findings indicated that students regarded instructional intervention directed toward or supporting surface-level processing to be very efficient. These results have implications for resistance to changes in the teaching-learning setting of students.

Hattie, Biggs and Purdie (1996) conducted a meta-analysis on a large number of studies in which interventions were used to enhance student learning. They found that most interventions work most of the time and a respectable effect size of 0.57 was found for academic performance. Their conclusion was that the best results came when the strategy training was used metacognitively, with appropriate motivational and contextual support. One of the implications is that any intervention has to be included in the teaching of content to obtain maximum transfer. Hattie and his colleagues (1996) recommended that training should be in context, tasks within the same domain as the target content should be used, and a high degree of learner activity and metacognitive awareness should be created.

It would be important for the group of disadvantaged and modifiable students to receive some form of academic development. As institutions move away from the deficit model and focus on the individual student's strengths (Shochet, 1992), the identification of these students' affective and cognitive processes will be important in planning adequate developmental programmes. This study has indicated evidence for a relationship between modifiability, cognitive and learning processes and academic performance that could be used to improve students' academic performance.

### **3. GENERALISIBILITY**

One of the issues that need to be discussed in a study such as this is the question of generalisibility. The study used a sample of disadvantaged technikon students and the question is whether the findings can be generalised to other institutions of higher learning such as universities as well as whether the results have currency in an international setting.

Dynamic assessment procedures have been used with a variety of populations where static tests are assumed to be unfair. Examples of these populations are children from ethnic minorities, children with language disorders, mentally retarded or learning disabled children and adolescents (Lidz, 1987). The use of dynamic tests with educationally disadvantaged students in institutions of higher learning has shown an increase in the last decade. A large number of tertiary institutions in South Africa is experimenting with the use of dynamic assessment procedures for alternative admission purposes.

Although certain elements such as the type of students with their particular level of preparedness and assessment needs could be very context specific, other elements such as the theoretical aspects of learning potential and students' motivational and cognitive processes are universal. In other words, it could be that university students would need another type of dynamic assessment procedure (test content and type of instruction) than technikon students, but the principles of dynamic assessment would stay the same for both groups. There could even be a difference in the types of problem solving that science opposed to arts students need to be exposed to, but students' response to a period of mediation and their affective and cognitive processes could be seen as being universal.

Although different cultures might have different educational backgrounds which place different emphasis on what constitutes intelligent behaviour, the scientific technological society into which members of the different cultures are moving, makes for an universal context. Whereas intelligence could be seen in a cultural context, cognitive processes and information processing could be seen as being more universal in nature. Cognitive processes are also more open to development and change. In South Africa there is a need for black students to make the transition into a science and technology culture.

There seems to be a common quest in all countries with diverse population groups to find assessment methods that would be fair and accurate for all individuals, whether they belong to the dominant culture group or not. In that sense the results of this study could be used for other disadvantaged groups in different countries. Individuals' response to a period of mediation and their affective and cognitive processes would be useful in the particular disadvantaged context of each country.

There are certain factors that affect the generalisability of this investigation. The first factor is the preselected nature of the students used. Although there were some who were selected on the basis of the test results, most students were selected on the basis of the matriculation results which resulted in those students with higher matriculation marks having a better chance of being selected. The second factor is the small sample of DET students used in the predictor studies. This in itself is a reflection of how difficult it is to obtain valid matriculation results for DET students.

The DET students were separated from the non-DET students to study them as a separate group in the following studies:

## 5. FUTURE RESEARCH

Dynamic assessment is still in its developing stages and a great deal of effort still has to be devoted to researching concepts of modifiability, cognitive processes and their links with instruction and learning. There are still some practical issues associated with dynamic assessment that need clarification and this could be grounds for further research.

A challenge for the future would be to research differentiation within the various applications of dynamic assessment procedures. Some of the areas that could be looked at are the use of different tasks, different population groups, various intervention methods and the use of different criteria. Dynamic assessment measures are tapping something different to that of IQ tests and this difference seems to lie in the individual's functioning in a learning situation. The research of different instruction methods and students' learning strategies and approaches to learning seem to be important in this regard (Resnick, 1979). The issue of criteria presents an ongoing challenge in validity studies done with dynamic assessment procedures. A variety of criteria have been used by researchers, including static achievement scores, gain scores, learning curves and academic performance (Lidz, 1991). Future research could look at the use of different criteria with students that show differences in levels of modifiability.

Although it is useful when significant correlations occur in relation to static criteria, it is not a basis for negative evaluation of the dynamic assessment instrument when this does not occur. Future research would have to look at linking the psychometric aspects of dynamic assessment with the cognitive processes taking place during the individual's response to instruction. The results of dynamic assessment procedures would only be possible to use for the practical selection of students if the processes could be quantified and related to future academic success.

Another area of importance that needs ongoing research is the role of culture in learning. One of the tasks of dynamic assessment is to try and identify the nature of the learner, and to increase the match between this nature and the outcomes required for success within the learner's culture. Dynamic assessment has a special value, in conjunction with cognitive education, for students whose early experiences have not adequately prepared them for the demands of a technological orientated society.

In future more attention would have to be paid to individuals' approaches to learning, analysis of errors, metacognition and learning strategies. These factors would then have to be reflected in the educational setting, rather than the emphasis on rote memorisation. The measuring instruments would have to focus on diagnostic assessment so that assessment and teaching are able to be integrated. An assessment of the changes taking place in students' affective and cognitive processes (motivation, metacognition, approaches to learning) will give an indication to what extent students are able to apply their intellectual abilities and subsequently fulfil their learning potential. The identification of students' learning processes and strategies and the link to their response to mediation would facilitate the design of developmental programmes.

Future research would have to look in more detail at the role that motivation plays in dynamic assessment. Cognitive functioning and motivational-affective factors are two sides of the same coin and the assessment of cognitive ability is influenced by the motivational and affective factors. The relationship between dynamic assessment and motivational-affective factors should be more stable (results should be less affected by factors) than that between static assessment and motivational-affective factors (Tzuriel, 1997).

The following issues could be addressed in further research:

- (1) Whether an improvement of students' affective and cognitive processes will lead to a better application of intelligence and performance.
- (2) Whether affective and cognitive processes are able to differentiate between more and less modifiable students and gains that are due to a practice effect.
- (3) Comparison of different kinds of instructions in a dynamic assessment procedure to assess suitability for different groups of students.
- (4) The use of mediation in materials development. Affective and cognitive process development and mediation of concepts could be built into learning material.
- (5) Establishing a link between students' affective and cognitive processes and their ability to benefit from a period of mediation. (This period could either be short-term or a longer period of intervention which could stretch over a period of one year.)

## 6. CONCLUSION

The aim of a fair selection process is to obtain an indication of individuals' potential to develop their competence. To achieve this it seems necessary to obtain a measurement of optimal performance on a test. A dynamic assessment procedure seems to be the ideal instrument to use for this purpose. Taking it a step further: individuals need to be developed to show an optimal application of their mental ability. In this regard affective and cognitive processes seem to play an important role in assisting individuals in achieving their full mental competence. Suboptimal representation of individuals' cognitive ability by static tests requires assessment methods that would assist them in increasing their performance to the level where it represents their competence.

The weight of evidence of the present study suggests that it is possible to find alternatives to matriculation marks and static tests in selecting disadvantaged students by making use of learning potential as an index of the zone of proximal development. Many students applying for studies at institutions of higher education are underprepared for the academic demands of tertiary education. Dynamic assessment procedures, where assessment and instruction are combined, seem a fairer and for some groups a more accurate indication of students' academic potential. Differentiation between more and less modifiable students facilitates development strategies. Non-cognitive factors such as motivation, approaches to learning and learning strategies, which play an important role in the application of mental ability, form a mediating relationship with level of modifiability and subsequent academic performance. The more modifiable group of students showed significantly higher scores on measures of an achieving approach to learning which indicates flexibility in learning. These students seem to have benefited more from the mediated lesson.

The results further show that disadvantaged students cannot be seen as a homogeneous group but that it is possible to differentiate between different groups of students according to how they respond to a period of mediation. Modifiability had a moderator effect on the predictive power of variables. For the higher achieving, less modifiable group the use of matriculation marks and static tests seem to be an appropriate method of selection. For the group of students who are identified as being lower achieving and more modifiable, dynamic tests and the use of certain non-cognitive factors might be a fairer way of predicting their academic performance.

Others factors which had a moderator effect on the prediction of academic performance were schooling and type of assessment used in a course. The matriculation marks were the best predictor for the non-DET students, whereas the dynamic tests proved to be the best predictor for the DET students. A deep approach to learning is linked to continuous evaluation while students tend to use a surface approach to learning with examination-orientated assessment.

The practical implication for these findings is that all students would have to be assessed to establish their level of modifiability. Information of the different subgroups together with an evaluation of their affective and cognitive processes could be used as a diagnostic resource to provide educational development programmes at the tertiary institutions.

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## LIST OF APPENDICES

- Appendix A**      **Original version of the Study Process Questionnaire (SPQ)**
- Appendix B**      **Adapted version of the Study Process Questionnaire (SPQ)**
- Appendix C**      **Original version of the Motivated Strategies for Learning Questionnaire (MSLQ)**
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- Appendix E**      **Conceptual Reasoning Test (CRT) lesson with examples of test items**
- Appendix F**      **Learning Potential Test (LPT) lesson with examples of test items**
- Appendix G**      **Examples of test items in the Reading Comprehension Test (RCT)**
- Appendix H**      **Examples of test items in the Mental Alertness Test (MA)**
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- Appendix J**      **Checklist of errors in problem solving**

**A P P E N D I X A**

**ORIGINAL VERSION OF  
THE STUDY PROCESS QUESTIONNAIRE  
(SPQ)**

# SPQ

## Study Process Questionnaire

### WHAT THE SPQ IS ABOUT

On the following pages are a number of questions about your attitudes towards your studies and your usual ways of studying.

There is no *right* way of studying. It all depends on what suits your own style and the courses you are studying. The following questions have been carefully selected to cover the more important aspects of studying. It is accordingly important that you answer each question as honestly as you can. If you think that your answer to a question would depend on the subject being studied, give the answer that would apply to the subject(s) most important to you.

### HOW TO ANSWER

For each item there is a row of boxes for a five-point scale on the Answer Sheet:

5	4	3	2	1
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

A response is shown by marking *one* of the five boxes for an item to underline the desired number.

The numbers stand for the following responses:

- 5 – this item is *always* or *almost always* true of me
- 4 – this item is *frequently* true of me
- 3 – this item is true of me about *half the time*
- 2 – this item is *sometimes* true of me
- 1 – this item is *never* or *only rarely* true of me

#### Example:

I study best with the radio on.

If this was almost always true of you, you would underline 5 thus: 

5	4	3	2	1
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Underline the number on the Answer Sheet that best fits your *immediate* reaction. Do not spend a long time on each item: your first reaction is probably the best one. Please answer each item.

Do not worry about projecting a good image. Your answers are **CONFIDENTIAL**.

Thank you for your co-operation.

## STUDY PROCESS QUESTIONNAIRE

**Underline one number for each item.**

1. I chose my present courses largely with a view to the job situation when I graduate rather than out of their intrinsic interest to me.
2. I find that at times studying gives me a feeling of deep personal satisfaction.
3. I want top grades in most or all of my courses so that I will be able to select from among the best positions available when I graduate.
4. I think browsing around is a waste of time, so I only study seriously what's given out in class or in the course outlines.
5. While I am studying, I often think of real life situations to which the material that I am learning would be useful.
6. I summarize suggested readings and include these as part of my notes on a topic.
7. I am discouraged by a poor mark on a test and worry about how I will do on the next test.
8. While I realize that truth is forever changing as knowledge is increasing, I feel compelled to discover what appears to me to be the truth at this time.
9. I have a strong desire to excel in all my studies.
10. I learn some things by rote, going over and over them until I know them by heart.
11. In reading new material I often find that I'm continually reminded of material I already know and see the latter in a new light.
12. I try to work consistently throughout the term and review regularly when the exams are close.
13. Whether I like it or not, I can see that further education is for me a good way to get a well-paid or secure job.
14. I feel that virtually any topic can be highly interesting once I get into it.
15. I would see myself basically as an ambitious person and want to get to the top, whatever I do.
16. I tend to choose subjects with a lot of factual content rather than theoretical kinds of subjects.
17. I find that I have to do enough work on a topic so that I can form my own point of view before I am satisfied.
18. I try to do all of my assignments as soon as possible after they are given out.

19. Even when I have studied hard for a test, I worry that I may not be able to do well in it.
20. I find that studying academic topics can at times be as exciting as a good novel or movie.
21. If it came to the point, I would be prepared to sacrifice immediate popularity with my fellow students for success in my studies and subsequent career.
22. I generally restrict my study to what is specifically set as I think it is unnecessary to do anything extra.
23. I try to relate what I have learned in one subject to that in another.
24. After a lecture or lab I reread my notes to make sure they are legible and that I understand them.
25. Lecturers shouldn't expect students to spend significant amounts of time studying material everyone knows won't be examined.
26. I usually become increasingly absorbed in my work the more I do.
27. One of the most important considerations in choosing a course is whether or not I will be able to get top marks in it.
28. I learn best from lecturers who work from carefully prepared notes and outline major points neatly on the blackboard.
29. I find most new topics interesting and often spend extra time trying to obtain more information about them.
30. I test myself on important topics until I understand them completely.
31. I almost resent having to spend a further three or four years studying after leaving school, but feel that the end results will make it all worthwhile.
32. I believe strongly that my main aim in life is to discover my own philosophy and belief system and to act strictly in accordance with it.
33. I see getting high grades as a kind of competitive game, and I play it to win.
34. I find it best to accept the statements and ideas of my lecturers and question them only under special circumstances.
35. I spend a lot of my free time finding out more about interesting topics which have been discussed in different classes.
36. I make a point of looking at most of the suggested readings that go with the lecturers.
37. I am at college/university mainly because I feel that I will be able to obtain a better job if I have a tertiary qualification.

38. My studies have changed my views about such things as politics, my religion, and my philosophy of life.
39. I believe that society is based on competition and schools and universities should reflect this.
40. I am very aware that lecturers know a lot more than I do and so I concentrate on what they say is important rather than rely on my own judgment.
41. I try to relate new material, as I am reading it, to what I already know on that topic.
42. I keep neat, well-organized notes for most subjects.

**A P P E N D I X B**

**ADAPTED VERSION OF  
THE STUDY PROCESS QUESTIONNAIRE  
(SPQ)**

# SPQ

## Study Process Questionnaire

### WHAT THE SPQ IS ABOUT

On the following pages are a number of questions about your attitudes towards your studies and your usual ways of studying.

There is no *right* way of studying. It all depends on what suits your own style and the courses you are studying. The following questions have been carefully selected to cover the more important aspects of studying. It is accordingly important that you answer each question as honestly as you can. If you think that your answer to a question would depend on the subject being studied, give the answer that would apply to the subject(s) most important to you.

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For each item there is a row of numbers for a five-point scale on the Answer Sheet:

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If this was almost always true of you, you would mark 5 thus:        5   4   3   2   1

Mark the number on the Answer Sheet that best fits your *immediate* reaction. Do not spend a long time on each item: your first reaction is probably the best one. Please answer each item.

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1. I chose my present courses largely with a view to the job situation when I graduate rather than out of their intrinsic interest to me.
2. I find that at times studying gives me a feeling of deep personal satisfaction.
3. I want top marks in most or all of my courses so that I will be able to select from among the best positions available when I graduate.
4. I think browsing around is a waste of time, so I only study seriously what's given out in class or in the course outlines.
5. While I am studying, I often think of real life situations to which the material that I am learning would be useful.
6. I summarize suggested readings and include these as part of my notes on a topic.
7. I am discouraged by a poor mark on a test and worry about how I will do on the next test.
8. While I realize that truth is forever changing as knowledge is increasing, I feel compelled to discover what appears to me to be the truth at this time.
9. I have a strong desire to excel (do well) in all my studies.
10. I learn some things by rote, going over and over them until I know them by heart.
11. In reading new material I often find that I'm continually reminded of material I already know and see the latter in a new light.
12. I try to work consistently throughout the term and review regularly when the exams are close.
13. Whether I like it or not, I can see that further education is for me a good way to get a well-paid or secure job.
14. I feel that virtually any topic can be highly interesting once I get into it.
15. I would see myself basically as an ambitious person and want to get to the top, whatever I do.
16. I tend to choose subjects with a lot of factual content rather than theoretical kinds of subjects.
17. I find that I have to do enough work on a topic so that I can form my own point of view before I am satisfied.
18. I try to do all of my assignments as soon as possible after they are given out.
19. Even when I have studied hard for a test, I worry that I may not be able to do well in it.

20. I find that studying academic topics can at times be as exciting as a good novel or movie.
21. If it came to the point, I would be prepared to sacrifice immediate popularity with my fellow students for success in my studies and subsequent career.
22. I generally restrict my study to what is specifically set as I think it is unnecessary to do anything extra.
23. I try to relate what I have learned in one subject to that in another.
24. After a lecture or lab I reread my notes to make sure they are legible and that I understand them.
25. Lecturers shouldn't expect students to spend significant amounts of time studying material everyone knows won't be examined.
26. I usually become increasingly absorbed in my work the more I do.
27. One of the most important considerations in choosing a course is whether or not I will be able to get top marks in it.
28. I learn best from lecturers who work from carefully prepared notes and outline major points neatly on the blackboard.
29. I find most new topics interesting and often spend extra time trying to obtain more information about them.
30. I test myself on important topics until I understand them completely.
31. I almost resent having to spend a further three or four years studying after leaving school, but feel that the end results will make it all worthwhile.
32. I believe strongly that my main aim in life is to discover my own philosophy and belief system and to act strictly in accordance with it.
33. I see getting high grades as a kind of competitive game, and I play it to win.
34. I find it best to accept the statements and ideas of my lecturers and question them only under special circumstances.
35. I spend a lot of my free time finding out more about interesting topics which have been discussed in different classes.
36. I make a point of looking at most of the suggested readings that go with the lectures.
37. I am at technikon mainly because I feel that I will be able to obtain a better job if I have a tertiary qualification.
38. My studies have changed my views about such things as politics, my religion, and my philosophy of life.

39. I believe that society is based on competition and schools and technicians should reflect this.
40. I am very aware that lecturers know a lot more than I do and so I concentrate on what they say is important rather than rely on my own judgment.
41. I try to relate new material, as I am reading it, to what I already know on that topic.
42. I keep neat, well-organized notes for most subjects.

**A P P E N D I X C**

**ORIGINAL VERSION OF  
THE MOTIVATED STRATEGIES  
FOR LEARNING QUESTIONNAIRE  
(MSLQ)**

# M S L Q

## MOTIVATED STRATEGIES FOR LEARNING QUESTIONNAIRE

### PART A. MOTIVATION

The following questions ask about your motivation for and attitudes about this class. **Remember there are no right or wrong answers, just answer as accurately as possible.** Use the scale below to answer the questions. If you think the statement is very true of you, circle 7; if a statement is not at all true of you, circle 1. If the statement is more or less true of you, find the number between 1 and 7 that best describes you.

1	2	3	4	5	6	7
not at all true of me						very true of me

- |  | not at all<br>true of me |   |   |   |   |   | very true of<br>me |
|--|--------------------------|---|---|---|---|---|--------------------|
| 1. In a class like this, I prefer course material that really challenges me so I can learn new things. | 1                        | 2 | 3 | 4 | 5 | 6 | 7                  |
| 2. If I study in appropriate ways, then I will be able to learn the material in this course.           | 1                        | 2 | 3 | 4 | 5 | 6 | 7                  |
| 3. When I take a test I think about how poorly I am doing compared with other students.                | 1                        | 2 | 3 | 4 | 5 | 6 | 7                  |
| 4. I think I will be able to use what I learn in this course in other courses.                         | 1                        | 2 | 3 | 4 | 5 | 6 | 7                  |
| 5. I believe I will receive an excellent grade in this class.  | 1                        | 2 | 3 | 4 | 5 | 6 | 7                  |
| 6. I'm certain I can understand the most difficult material presented in the readings for this course. | 1                        | 2 | 3 | 4 | 5 | 6 | 7                  |
| 7. Getting a good grade in this class is the most satisfying thing for me right now.                   | 1                        | 2 | 3 | 4 | 5 | 6 | 7                  |

		not at all true of me						very true of me
8.	When I take a test I think about items on other parts of the test I can't answer.	1	2	3	4	5	6	7
9.	It is my own fault if I don't learn the material in this course.	1	2	3	4	5	6	7
10.	It is important for me to learn the course material in this class.	1	2	3	4	5	6	7
11.	The most important thing for me right now is improving my overall grade point average, so my main concern in this class is getting a good grade.	1	2	3	4	5	6	7
12.	I'm confident I can learn the basic concepts taught in this course.	1	2	3	4	5	6	7
13.	If I can, I want to get better grades in this class than most of the other students.	1	2	3	4	5	6	7
14.	When I take tests I think of the consequences of failing.	1	2	3	4	5	6	7
15.	I'm confident I can understand the most complex material presented by the instructor in this course.	1	2	3	4	5	6	7
16.	In a class like this, I prefer course material that arouse my curiosity, even if it is difficult to learn.	1	2	3	4	5	6	7
17.	I am very interested in the content area of this course.	1	2	3	4	5	6	7
18.	If I try hard enough, then I will understand the course material.	1	2	3	4	5	6	7
19.	I have an uneasy, upset feeling when I take an exam.	1	2	3	4	5	6	7
20.	I'm confident I can do an excellent job on the assignments and tests in this course.	1	2	3	4	5	6	7
21.	I expect to do well in this class.	1	2	3	4	5	6	7
22.	The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible.	1	2	3	4	5	6	7

		not at all true of me						very true of me
23.	I think the course material in this class is useful for me to learn.	1	2	3	4	5	6	7
24.	When I have the opportunity in this class, I choose course assignments that I can learn from even if they don't guarantee a good grade.	1	2	3	4	5	6	7
25.	If I don't understand the course material, it is because I didn't try hard enough.	1	2	3	4	5	6	7
26.	I like the subject matter of this course.	1	2	3	4	5	6	7
27.	Understanding the subject matter of this course is very important to me.	1	2	3	4	5	6	7
28.	I feel my heart beating fast when I take an exam.	1	2	3	4	5	6	7
29.	I'm certain I can master the skills being taught in this class.	1	2	3	4	5	6	7
30.	I want to do well in this class because it is important to show my ability to my family, friends, employer, or others.	1	2	3	4	5	6	7
31.	Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class.	1	2	3	4	5	6	7

### PART B. LEARNING STRATEGIES

The following questions ask about your learning strategies and study skills for this class. **Again, there are no right or wrong answers. Answer the questions about how you study in this class as accurately as possible.** Use the same scale to answer the questions. If you think the statement is very true of you, circle 7; if a statement is not at all true of you, circle 1. If the statement is more or less true of you, find the number between 1 and 7 that best describes you.

	1	2	3	4	5	6	7	
	not at all true of me						very true of me	
					not at all true of me		very true of me	
32.	When I study the readings for this course, I outline the material to help me organize my thoughts.	1	2	3	4	5	6	7
33.	During class time I often miss important points because I'm thinking of other things.	1	2	3	4	5	6	7
34.	When studying for this course, I often try to explain the material to a classmate or friend.	1	2	3	4	5	6	7
35.	I usually study in a place where I can concentrate on my course work.	1	2	3	4	5	6	7
36.	When reading for this course, I make up questions to help focus my reading.	1	2	3	4	5	6	7
37.	I often feel so lazy or bored when I study for this class that I quit before I finish what I planned to do.	1	2	3	4	5	6	7
38.	I often find myself questioning things I hear or read in this course to decide if I find them convincing.	1	2	3	4	5	6	7
39.	When I study for this class, I practice saying the material to myself over and over.	1	2	3	4	5	6	7
40.	Even if I have trouble learning the material in this class, I try to do the work on my own, without help from anyone.	1	2	3	4	5	6	7

	not at all true of me						very true of me
	1	2	3	4	5	6	7
41. When I become confused about something I'm reading for this class, I go back and try to figure it out.	1	2	3	4	5	6	7
42. When I study for this course, I go through the readings and my class notes and try to find the most important ideas.	1	2	3	4	5	6	7
43. I make good use of my study time for this course.	1	2	3	4	5	6	7
44. If course readings are difficult to understand, I change the way I read the material.	1	2	3	4	5	6	7
45. I try to work with other students from this class to complete the course assignments.	1	2	3	4	5	6	7
46. When studying for this course, I read my class notes and the course readings over and over again.	1	2	3	4	5	6	7
47. When a theory, interpretation, or conclusion is presented in class or in the readings, I try to decide if there is good supporting evidence.	1	2	3	4	5	6	7
48. I work hard to do well in this class even if I don't like what we are doing.	1	2	3	4	5	6	7
49. I make simple charts, diagrams, or tables to help me organize course material.	1	2	3	4	5	6	7
50. When studying for this course, I often set aside time to discuss course material with a group of students from the class.	1	2	3	4	5	6	7
51. I treat the course material as a starting point and try to develop my own ideas about it.	1	2	3	4	5	6	7
52. I find it hard to stick to a study schedule.	1	2	3	4	5	6	7
53. When I study for this class, I pull together information from different sources, such as lectures, readings, and discussions.	1	2	3	4	5	6	7
54. Before I study new course material thoroughly, I often skim it to see how it is organized.	1	2	3	4	5	6	7

		not at all true of me					very true of me	
		1	2	3	4	5	6	7
55.	I ask myself questions to make sure I understand the material I have been studying in this class.	1	2	3	4	5	6	7
56.	I try to change the way I study in order to fit the course requirements and the instructor's teaching style.	1	2	3	4	5	6	7
57.	I often find that I have been reading for this class but don't know what it was all about.	1	2	3	4	5	6	7
58.	I ask the instructor to clarify concepts I don't understand well.	1	2	3	4	5	6	7
59.	I memorize key words to remind me of important concepts in this class.	1	2	3	4	5	6	7
60.	When course work is difficult, I either give up or only study the easy parts.	1	2	3	4	5	6	7
61.	I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for this course.	1	2	3	4	5	6	7
62.	I try to relate ideas in this subject to those in other courses whenever possible.	1	2	3	4	5	6	7
63.	When I study for this course, I go over my class notes and make an outline of important concepts.	1	2	3	4	5	6	7
64.	When reading for this class, I try to relate the material to what I already know.	1	2	3	4	5	6	7
65.	I have a regular place set aside for studying.	1	2	3	4	5	6	7
66.	I try to play around with ideas of my own related to what I am learning in this course.	1	2	3	4	5	6	7
67.	When I study for this course, I write brief summaries of the main ideas from the readings and my class notes.	1	2	3	4	5	6	7
68.	When I can't understand the material in this course, I ask another student in this class for help.	1	2	3	4	5	6	7

		not at all true of me					very true of me
69.	I try to understand the material in this class by making connections between the readings and the concepts from the lectures.	1	2	3	4	5	6 7
70.	I make sure that I keep up with the weekly readings and assignments for this course.	1	2	3	4	5	6 7
71.	Whenever I read or hear an assertion or conclusion in this class, I think about possible alternatives.	1	2	3	4	5	6 7
72.	I make lists of important items from this course and memorize the lists.	1	2	3	4	5	6 7
73.	I attend this class regularly.	1	2	3	4	5	6 7
74.	Even when course materials are dull and uninteresting, I manage to keep working until I finish.	1	2	3	4	5	6 7
75.	I try to identify students in this class whom I can ask for help if necessary.	1	2	3	4	5	6 7
76.	When studying for this course I try to determine which concepts I don't understand well.	1	2	3	4	5	6 7
77.	I often find that I don't spend very much time on this course because of other activities.	1	2	3	4	5	6 7
78.	When I study for this class, I set goals for myself in order to direct my activities in each study period.	1	2	3	4	5	6 7
79.	If I get confused taking notes in class, I make sure I sort it out afterwards.	1	2	3	4	5	6 7
80.	I rarely find time to review my notes or readings before an exam.	1	2	3	4	5	6 7
81.	I try to apply ideas from course readings in other class activities such as lecture and discussion.	1	2	3	4	5	6 7

**A P P E N D I X D**

**ADAPTED VERSION OF  
THE MOTIVATED STRATEGIES  
FOR LEARNING QUESTIONNAIRE  
(MSLQ)**

# M S L Q

## MOTIVATED STRATEGIES FOR LEARNING QUESTIONNAIRE

The MSLQ was developed to obtain information on students' study habits, learning skills and motivation. There are no correct or incorrect answers and it is not a test. You are requested to answer the questions as honestly and accurately as possible to reflect your attitudes and behaviour.

### SECTION A: MOTIVATION

The following questions ask about your motivation for and attitude about your course. Remember there are no correct or incorrect answers. Answer the questions as accurately as possible. Use the following scale to answer the questions.

1	2	3	4	5	6	7
not at all true of me						very true of me

If you think that the statement is very true of you, place a cross over no. 7. If a statement is not true of you at all, place a cross over no. 1. If a statement is more or less true of you, find a number between 1 and 7 to place your cross.

**Please note:**

Only one number per item may be marked. All questions must be answered.

1. I prefer course material that is a challenge so I can learn new things.
2. If I study correctly, I will be able to master the content of my course.
3. While I am writing a test, I think how badly I am doing in relation to other students.
4. If I don't understand work, it is because the work is too difficult.
5. I think that what I am learning in my course, I would be able to use in my career one day.
6. I think I will do well in my course (attain high points).
7. I am sure that I will be able to understand the most difficult work presented in this course.
8. To perform well academically is the most satisfying thing for me right now.
9. While I am writing a test I think about the questions that I cannot answer.

10. It is my own fault if I do not learn.
11. It is important for me to learn the material in my course.
12. Because it is important for me to increase my (average) marks in my course, good performances in the different subjects are important to me.
13. I am confident that I will be able to master the basic concepts that are taught in my course.
14. If possible I would like to perform better than most other students.
15. If I understand the work in my course it would be due to my lecturers.
16. While I am writing a test I think about the consequences of failing.
17. I am confident that I will be able to understand the most difficult work that the lecturers give in the class.
18. In a course such as mine, I prefer work that interests me even though it might be difficult to learn.
19. I am very interested in the content of my course.
20. If I try hard enough I will be able to understand the work in the course.
21. I feel upset and uneasy when I write examinations.
22. I am confident that I will produce good work in the tasks and tests in my course.
23. I expect to do well in this course.
24. The most rewarding thing for me in my course is to understand the work as well as possible.
25. I think it is useful for me to learn the material in this course.
26. When I get the opportunity I choose to do tasks/projects where I can learn something even though it does not guarantee good points.
27. If I do not understand work in my course it is because I did not try hard enough.
28. I like the work of this course.
29. It is very important to me to understand the work in my course.
30. If I do not master work in my course it will be the lecturers' fault.
31. My heart beats faster when I write examinations.
32. I am sure that I can master the skills that are taught in my course.
33. If I master work in my course it will be because the work is easy.

34. I want to perform well in my course because it is important to show my abilities to my family, friends and other people.
35. If I take the level of difficulty of my course, my own skills and the lecturers into consideration I think I will perform well in my course.

## SECTION B: LEARNING STRATEGIES

The following questions ask about your learning strategies (the manner and planning of your learning) and learning skills. There are no correct or incorrect answers. Use the following scale to answer the questions.

1	2	3	4	5	6	7
not at all true of me						very true of me

If you think that the statement is very true of you, place a cross over no. 7. If a statement is not true of you at all, place a cross over no. 1. If a statement is more or less true of you, find a number between 1 and 7 to place your cross.

**Please note:**

Only one number per item may be marked. All questions must be answered.

36. When I do reading tasks in my course I write down the main points to help me organise my thoughts.
37. Important points often pass me by in class because I am thinking about other things.
38. When I study I often try and explain work to a friend or classmate.
39. I usually study in a place where I can concentrate on the work.
40. When I have to do reading tasks related to my studies I ask questions to help focus my reading.
41. I often feel so lazy and bored when I study that I stop before I complete what I planned to do.
42. I often question things that I hear and read in my studies.
43. When I learn (study) I often say the work over and over to myself.
44. Even when I have problems in knowing the material in my course I still try to master the work on my own without anyone's help.
45. When I become confused with work that I have to study in my course I start from the beginning again and try and understand it.
46. When I study I go through the study material and study notes to try and identify the most important ideas.

47. I make good use of my study time for this course.
48. When I don't understand what I read, I change the way that I read it.
49. I try to work with other students to finish tasks and assignments.
50. When I study I read the prescribed work and class notes over and over again.
51. When a theory, interpretation or conclusion is presented in the class or study material I try to decide if there is good supporting evidence.
52. I work hard to perform well in the course even if I don't like the work we are doing.
53. I make simple charts, diagrams or tables to help me to organise the work.
54. When I study I often make time to discuss the work with a group of other students in the class.
55. I see the study material as a starting point and try and develop my own ideas around it.
56. I find it difficult to stick to a study time table.
57. When I study I combine information from different sources such as class notes, reading tasks and discussions.
58. Before studying new work in detail, I often page through it to see how it is organized.
59. I ask myself questions to make sure I understand the work that I have studied in my course.
60. I try and change the way I study/learn to fit the demands of my course and the lecturer's style.
61. It often happens that I do a reading task but do not actually know what it is about.
62. I ask that concepts which I do not understand be explained again by the lecturer.
63. I memorise key words to remind me of important concepts.
64. If work becomes difficult I leave it or only study the easy parts.
65. I try and think about a topic and decide what I am supposed to learn from it rather than just reading it over when I study.
66. I try and relate ideas in one subject to those in another subject whenever possible.
67. When I study I write down an outline of important concepts.
68. When I do reading work I try and relate it to what I already know.
69. I have a fixed place for studying.

70. I try and play with my own ideas that relate to what I am learning in my course.
71. When I study I make brief summaries of the main ideas from different sources such as text books, class notes and reading work.
72. When I don't understand work I ask another student in the class to help me.
73. I try and understand the work by relating the reading work with the work in the class.
74. I make sure that I keep up to date with tasks and reading work for this course.
75. When I read or hear a statement or conclusion in my course I think of possible alternatives.
76. I make lists of important terms and memorise it.
77. I regularly attend my classes.
78. Even when the work is boring and uninteresting I manage to work until I finish.
79. I try and identify students in my class whom I can ask for help if necessary.
80. When I study I try to establish which concepts I do not understand well.
81. I often find that due to other activities I don't spend a lot of time on my course.
82. When I study I set goals for myself in order to direct my activities in each study period.
83. If I get confused when I take notes in the class I make sure I sort it out afterwards.
84. I rarely find time to review my work before an examination.
85. I try to apply ideas from reading tasks to other class activities such as lectures and discussions.

**A P P E N D I X E**

**C O N C E P T U A L R E A D I N G T E S T**

**(C R T)**

**L E S S O N W I T H E X A M P L E S O F T E S T I T E M S**

# C R T

## Conceptual Reasoning Test

This is a test of your ability to apply logical reasoning strategies to problems. In the test there are four types of problems. You will be shown examples of these and how to solve them. The types of problems you will encounter are: SERIES problems, TWO-WAY CLASSIFICATION problems, TRANSFORMATION problems and OPERATION problems.

In this test all the problems occur within large blocks. Inside each large block, smaller blocks containing drawings occur. One of these smaller blocks contains a question mark. Your task will be to choose the figure that best fits into the block containing the question mark. You must choose the correct answer from the six alternatives that are (marked A to F) at the bottom of each large block.

Try the following example. Mark your answer on the answer sheet, by making a cross over the correct letter next to "EXAMPLE 1".

### Example 1

	1	2	3	4	5	6	7
	•						
			• •				
		•					
					•• ••		
						•••• ••••	
						?	
				•• ••			
A	•	B	••	C	•• ••		
D	•• ••	E	•••• ••	F	•••• ••••		

In EXAMPLE 1 the number of dots within each block increases by one in each successive column, from left to right. The answer to this problem is F. If you did not mark the correct answer, rub out your answer and make a cross over F.

In the test you will encounter four types of problems. Understanding the differences between the types of problems will improve your score on the test.

### SERIES PROBLEMS

A series can either run from top to bottom or from left to right. The elements of a series problem follow each other sequentially according to specific rules. When solving a series problem you have to determine the rule(s) of the series.

EXAMPLE 2 is a simple series problem with only one rule (which happens to be shape). Try to find the answer to this problem and mark your answer by making a cross over the appropriate letter next to EXAMPLE 2.

#### Example 2

The puzzle consists of a 7x7 grid. The rows are numbered 1 to 7 on the left side. The shapes in the grid are as follows:

1						△
2	□					
3						△
4		□				
5		?				
6					□	
7				△		

Below the grid are six options, each in a square box:

- A: △
- B: □
- C: ○
- D: ⬆
- E: ○
- F: ▽

The SERIES in EXAMPLE 2 runs from top to bottom. In the first row one finds a triangle, in row 2 a square, in row 3 a triangle, in row 4 a square. The series running from top to bottom is therefore: triangle, square, triangle, square, triangle, square, triangle. The answer to this problem is A (a triangle).

If you did not mark the correct answer and you do not understand why the answer is A, please ask now.

### TWO-WAY CLASSIFICATION PROBLEMS

The elements of TWO-WAY CLASSIFICATION problems share certain characteristics with one another. All figures in a certain column will have a characteristic in common (for example, they may have the same colour), and all figures in a certain row will have the same characteristic (for example, they may have the same shape).

Try to find the answer to the following problem. Mark your answer by making a cross over the correct letter next to EXAMPLE 3.

#### Example 3

A		B		C	
D		E		F	

In the TWO-WAY CLASSIFICATION problem in example 3, all the shapes in a given column are the same, and all the colours in a given row are the same.

All the shapes in column 1 are triangles and all the shapes in column 2 are squares.

In row 1 all the shapes are black and in row 2 all the shapes are white.

The answer to this TWO-WAY CLASSIFICATION problem is A.













If you did not mark the correct answer and if you do not understand why A is the correct answer, please ask now.

In more difficult TWO-WAY CLASSIFICATION problems all the blocks will not be filled in. However, enough blocks will always be filled in to enable you to find the answer.







### TRANSFORMATION PROBLEMS

In TRANSFORMATION problems one set of blocks is arranged (or transformed) into a second set of blocks. In order to solve the problem you should find the rules whereby these changes occur. Try to find the answer to the following problem. Mark your answer by making a cross over the correct letter next to EXAMPLE 4.

#### Example 4

A		B		C	
D		E		F	

In the TRANSFORMATION problem in example 4 the figures at the top are changed (transformed) to give the figures at the bottom. One can see that all triangles undergo a change in shape. One also sees that a circle undergoes a change in colour. The answer is therefore D.

If you do not understand why D is correct, please ask now.




### OPERATIONS PROBLEMS

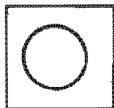

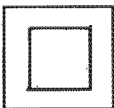
In OPERATIONS problems, two sets of blocks and a set of operators occur. The set of operators indicates how the figures in the first set of blocks change to become the figures in the second set of blocks.

Try to find the answer to the following problem. Mark your answer by making a cross over the correct letter next to EXAMPLE 5.

#### Example 5

?

A  B  C 

D  E  F 

The explanation for the OPERATIONS problem in example 5 is that the operators are the ellipses in the diagonal. The operators act on the figures on the left and change them into the figures at the bottom. In this problem there are two types of operators: upright ellipses and ellipses on their sides. An upright ellipse changes the colour of a figure. An ellipse on its side does not change a figure.

The answer to this problem is therefore C.

If you do not understand why the answer is C, please ask now.

Here is a summary of the most important aspects of each type of problem in the test.

### **SERIES**

A series contains a string of figures that may run from left to right or from top to bottom. When two (or more) series cross each other, the rules of both the series must hold.

### **TWO-WAY CLASSIFICATION**

All elements of a row have some feature in common and all elements of a column have some feature in common. Each element therefore has features from the row and the column in which it is located.

### **TRANSFORMATIONS**

The figures in one set of blocks are transformed (changed) into the figures in a second set of blocks.

### **OPERATIONS**

Operators determine how the figures of one set of blocks are changed into the figures of a second set of blocks. An operations problem will always consist of: a set of blocks, a set of operators, a second set of blocks.

In the test the type of problem will be indicated at the top of the first eight items. For instance, if an item is a two-way classification problem, the words "2-way" will appear above the item. These are hints to help you solve the first eight items.

You will now be given three minutes to revise the instructions, and you should ask if there is anything you are uncertain about. To review the instructions you may turn back to the beginning of the instructions.

There are 35 items in the test, you will be given 35 minutes to complete them.

**DO NOT GO ON UNTIL YOU ARE TOLD TO DO SO.**

**APPENDIX F**

**LEARNING POTENTIAL TEST**

**(LPT)**

**LESSON WITH EXAMPLES OF TEST ITEMS**

# L P T

## Learning Potential Test

### SERIES PROBLEMS LESSON

The test you have just completed consisted of series problems. In a short while you will be given a similar test.

The following exercises are designed to provide hints that will be helpful when one attempts to solve letter series problems.

Every series problem consists of one or more "strings".

Below is very simple string, complete it by filling in the next three letters:

(a) R R R R R \_ \_ \_

The continuation of this string is easy; all the elements of the string are COPIES of each other. The next three letters are therefore also likely to be COPIES.

The answer is: (a) R R R

Below is a different type of string, complete it by filling in the next three letters:

(b) A B C D E \_ \_ \_

In this string the letters follow each other in the same way as they do in the alphabet. To get from A to B we have to move FORWARDS in the alphabet. To get from B to C we must again move FORWARDS in the alphabet. Therefore, to get the next three letters in this string we must move FORWARDS in the alphabet.

The answer is: (b) F G H

Complete the following string by filling in the next three letters:

(c) Z Y X W V \_ \_ \_

The letters in this string follow each other in the opposite way to their order in the alphabet. To get from Z to Y we have to move BACKWARDS in the alphabet. To get from Y to X we must also move BACKWARDS in the alphabet. All the letters in this string follow each other BACKWARDS. To find the next three letters of the string we must therefore also move BACKWARDS in the alphabet.

The answer is: (c) U T S

Attempt to do the following series problem by filling in the next three letters:

(d) R A R B R C R D R E \_ \_ \_

In this series problem there are two strings.

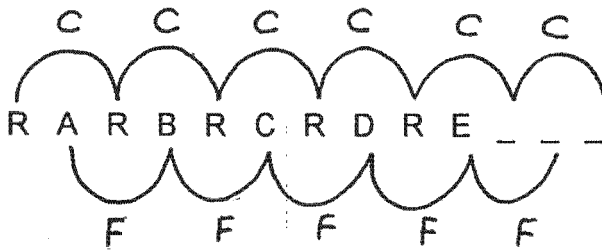
The first string consists of COPIES: R R R R R

In between the elements of the first string we have those of the second string.

The second string consists of FORWARDS relations: A B C D E

These two strings were combined to give the series (d) above.

When attempting to solve a series problem it can be very useful to mark the relationships between the elements of the strings. For example we can mark the series in (d) with "loops" as follows:

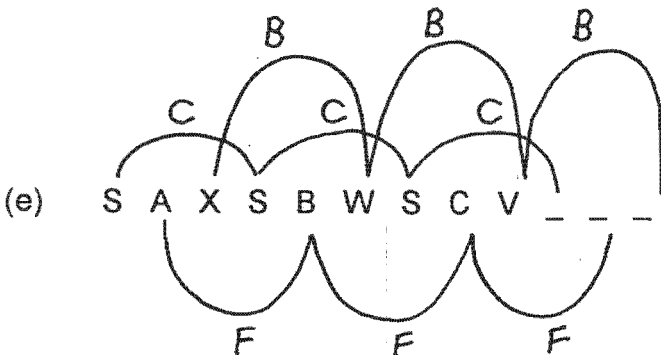


It is now easier to see that the answer must be: (d) R F R

In the series problem below there are three strings. One string consists of COPIES, one goes FORWARDS and one goes BACKWARDS. Mark all these strings as we did in the previous problem before reading further:

(e) S A X S B W S C V \_ \_ \_

Once the relationships within the series have been marked, it becomes much easier to solve the problem.



After marking the series we can see that it consists of the following three strings:

- S    S    S    - COPIES
- A    B    C    - FORWARDS relationships
- X    W    V    - BACKWARDS relationships

Now (before reading further) try to fill in the next three letters in this series:

S A X S B W S C V \_ \_ \_

The answer is: (e) S D U.

If you did not get this answer, and you do not understand why your answer is wrong, please ask now.

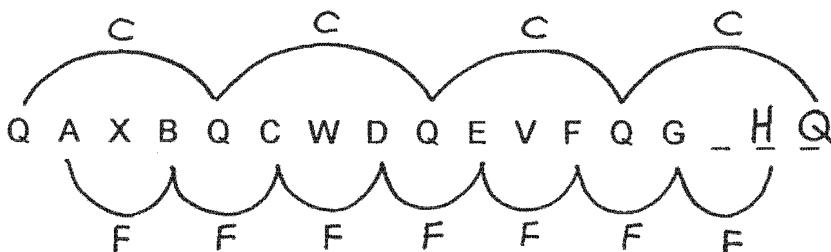
Let's consider the marking of a series problem in more detail. Look at the following series:

(f) Q A X B Q C W D Q E V F Q G \_ \_ \_

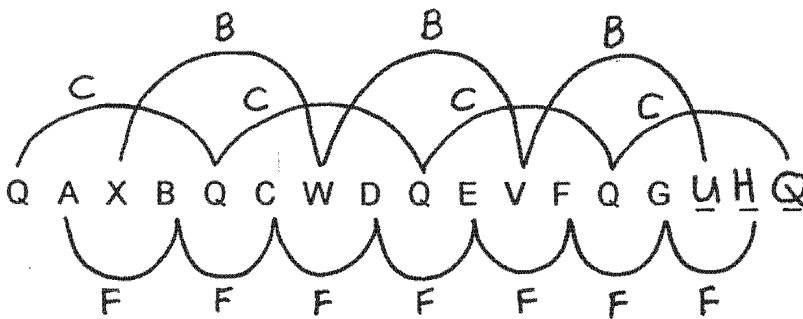
First we look at the first letter (Q), and try to see if we can find any other letters in the series that may belong to the same string as this letter. Below all the letters that belong to the same string as Q have been marked. (They are COPIES):



Note that we extend the marking past the end of the given series, this helps us to find the answer. Look at the next letter, (A). We now look for all the letters that might belong to the same string as A, and mark them. (They have FORWARDS relationships with each other):



The next letter is (X). Below all the letters that belong to the same string as X have also been marked. (They have BACKWARDS relationships with each other.) All the letters in the series have now been marked.



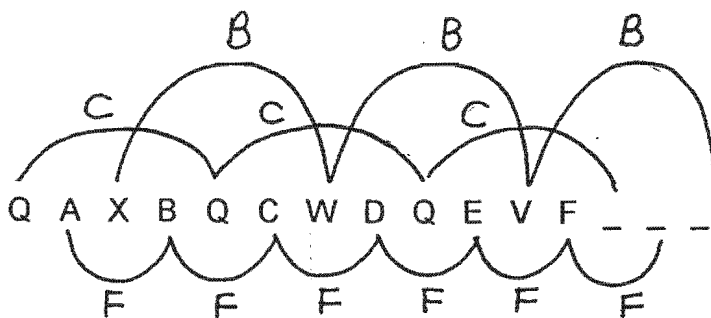
Mark all the COPIES and all the FORWARDS and BACKWARDS relationships in the series problem below before reading further:

(f) Q A X B Q C W D Q E V F \_ \_ \_

In this series problem there are again three strings:

Q	Q	Q								- COPIES
A	B	C	D	E	F					- FORWARDS relationships
X		W	V							- BACKWARDS relationships

Below is the same series with all the relationships marked. Attempt to fill in the next three letters of this series yourself before reading further:



The answer to this problem is: (f) Q G U.

If you did not get this answer, and you do not understand your mistake, you must ask now.

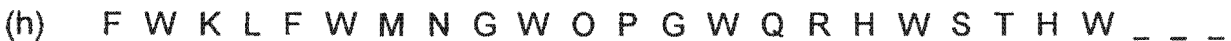
Until now the strings in all the examples we looked at contained only one type of relationship. But it is possible for a string to have more than one type of relationship, such as COPIES and FORWARDS relationships. A string can even have FORWARDS and BACKWARDS and COPY relationships.

Consider the string below:

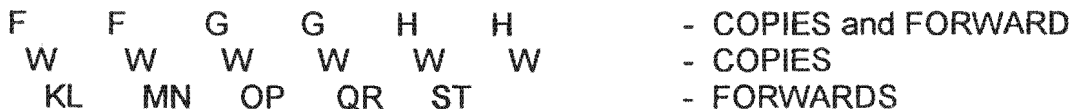


In this string we find that the A is repeated (a COPY), and the first B has a FORWARDS relationship with A; B is then copied, and so on. The next three letters in this string are thus: H H I.

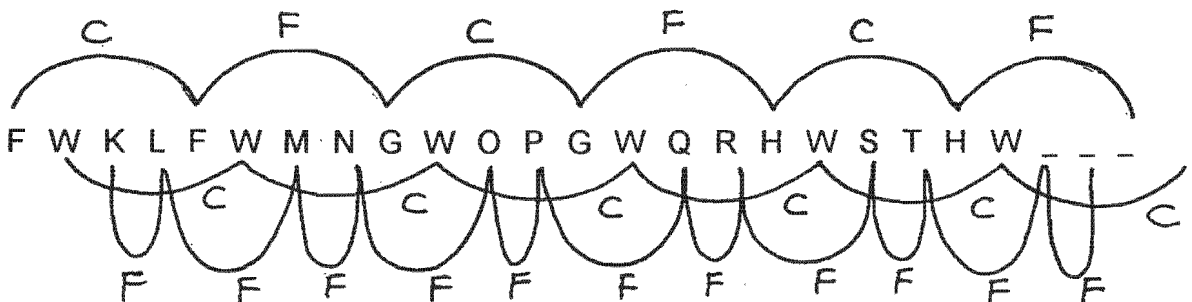
Mark all the COPIES, FORWARDS and BACKWARDS relationships in the series below before reading further:



The series consists of the following strings:



The series should therefore have been marked as follows:



Fill in the next three letters of this series before reading further.

The answer to this problem is: (h) U V I.

If you did not get this answer, and you do not understand why your answer is wrong, please ask now.

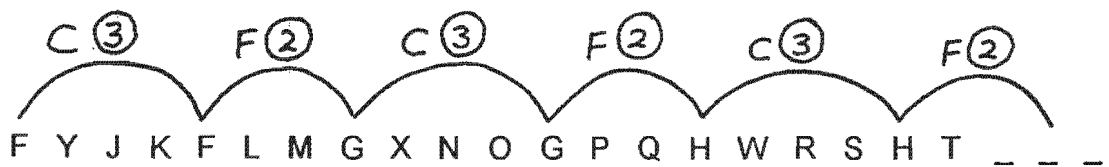
Let's consider the marking of a series problem with complicated strings. Consider the following series:

- (i) F Y J K F L M G X N O G P Q H W R S H T \_ \_ \_

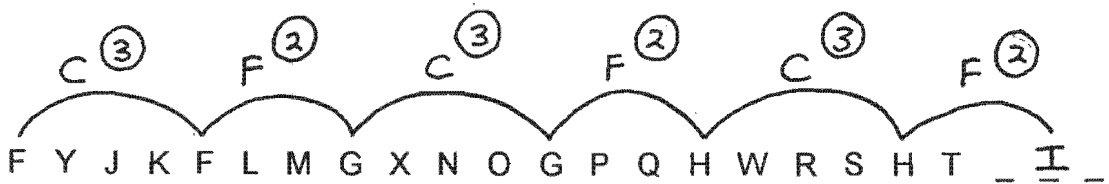
First we look at the first letter (F), and try to find all the letters that belong to the same string. We see that (F) is COPIED and is later followed by a (G) (this is a FORWARDS relationship). The (G) is then COPIED, followed by an (H) (a FORWARDS relationship) and so on. The first string in this problem is marked below.



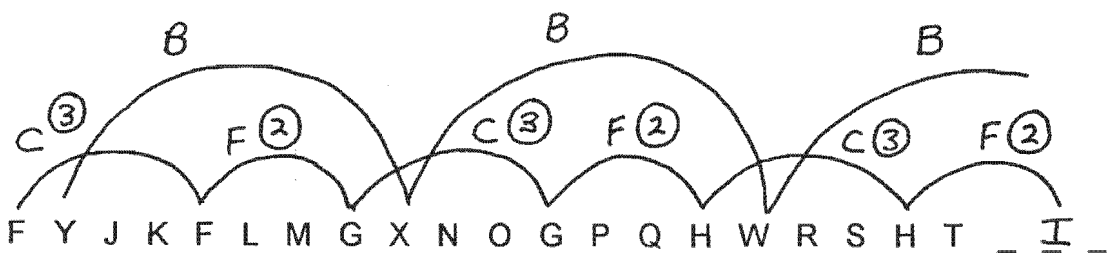
With a complicated string like this it is often difficult to decide on which of the lines (in the answer) to write the next letter in the string. To overcome this problem we count the letters inside each of the loops. Looking at the first string again, we see that 3 letters occur between (F) and (F). Between (F) and (G) 2 letters occur. Between (G) and (G) 3 letters occur. Below these numbers have also been filled in on the loops of the first string.



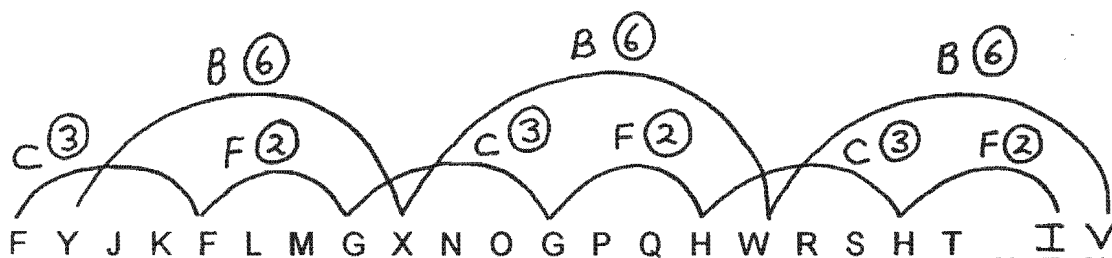
Note that the numbers also form a very simple series: 3 2 3 2 3. These numbers now help us to see how we should extend the loops to find the answer. Below the loops have been extended to help us find the answer.



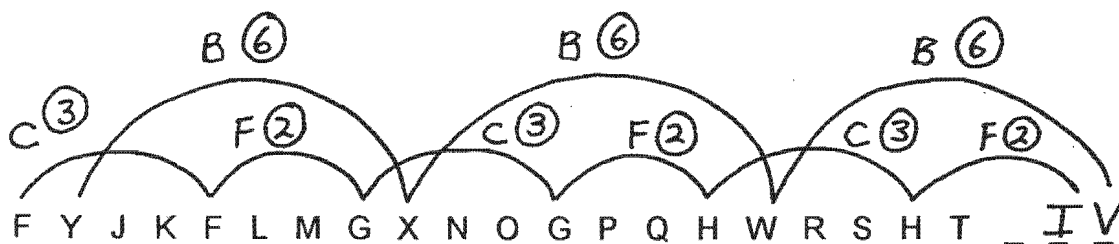
Now we look at the next letter (Y) in the series. This letter forms part of a BACKWARDS string. Below the letters that belong to the same string as (Y) have been marked.



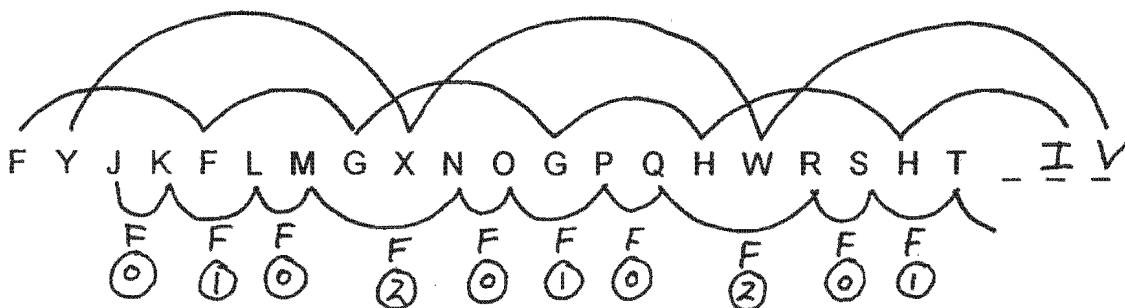
Next we can count the sizes of the loops. The size of the next loop must therefore also be 6. We can now draw in this loop and fill in the next letter:



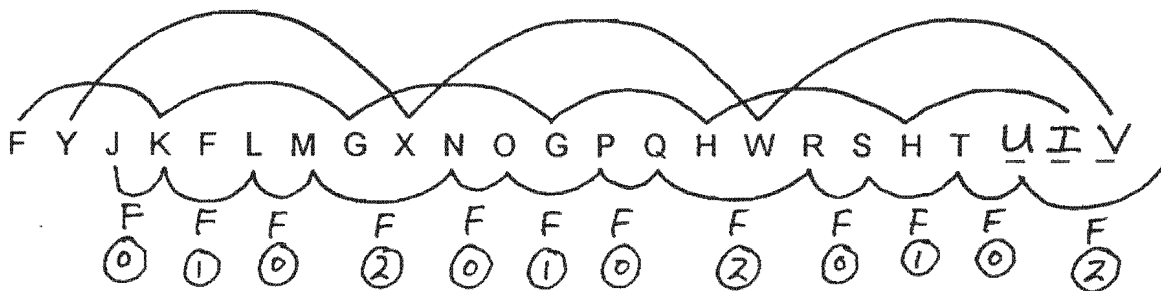
The next letter in this series is (J). Mark all the letters that are in the same string as (J), also indicate what relationships the letters have with each other, i.e. COPIES, FORWARDS and BACKWARDS relations.



Below these relationships have been marked. Draw the next two loops for this string before reading further.



The numbers form the following series: 0 1 0 2 0 1 0 2 0 1. The sizes of the following two loops must therefore be 0 and 2. Below these loops have been filled in, and the appropriate letter added to the answer.

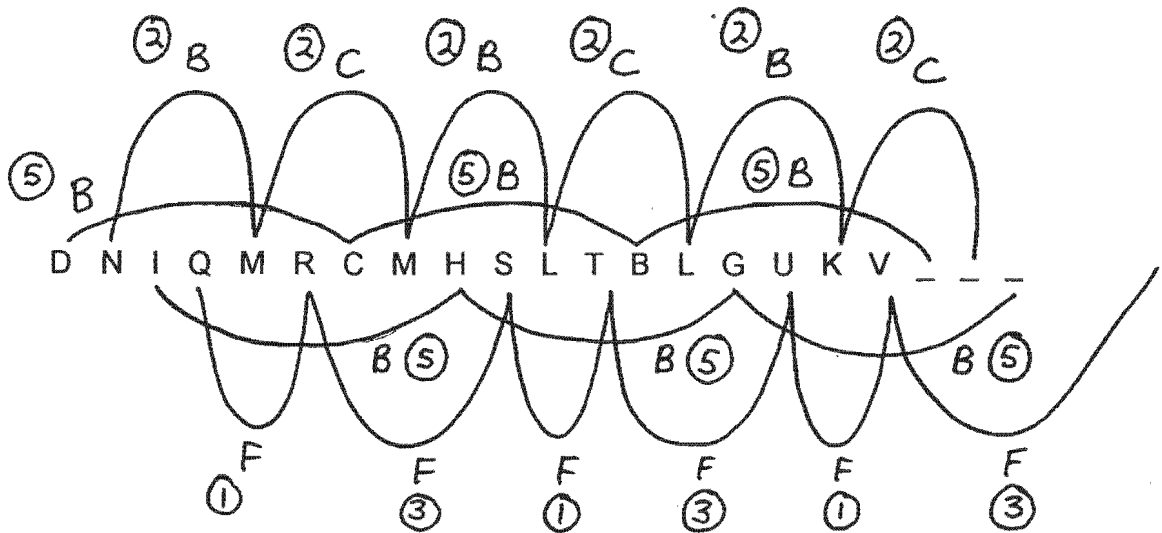


If there is anything you do not understand at this stage please ask now.

Mark all the relationships that occur in the series below. (There are 4 strings.) Also fill in the sizes of the loops.

(j) D N I Q M R C M H S L T B L G U K V \_ \_ \_

Below is the same series with all the relationships marked. Attempt to fill in the next three letters:



- String 1 is a BACKWARDS string.
- String 2 is a COPY and BACKWARDS string.
- String 3 is a BACKWARDS string.
- String 4 is a FORWARDS string.

The next three letters of this series is: (j) A K F.

If you did not get the correct answer and you do not understand why your answer is wrong, ask now.

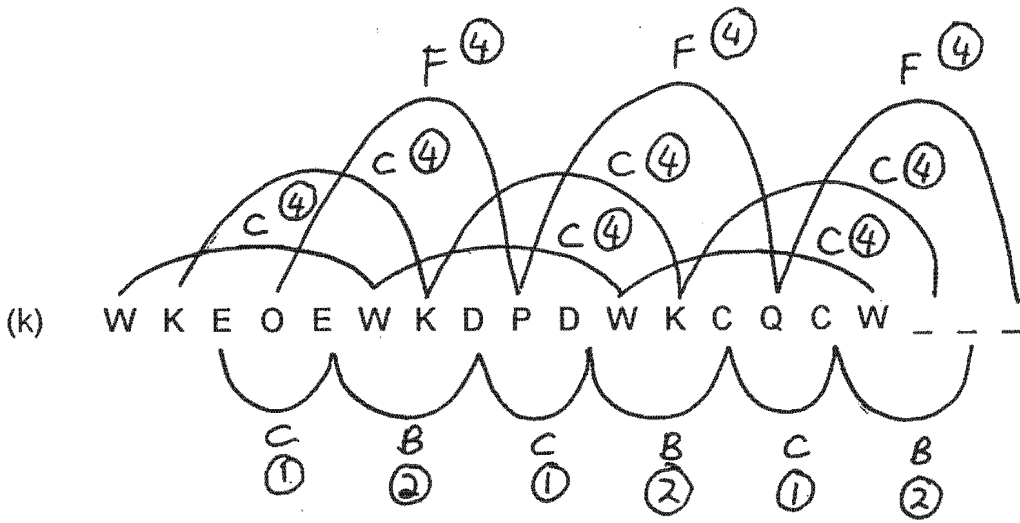
Below are two practice problems. Try to solve these problems. Remember to mark all the COPIES, the FORWARDS and the BACKWARDS relationships and the sizes of the loops.

(k) W K E O E W K D P D W K C Q C W \_ \_ \_

(l) W B W Z C K L V D V Z E M N U F U Z G O P \_ \_ \_

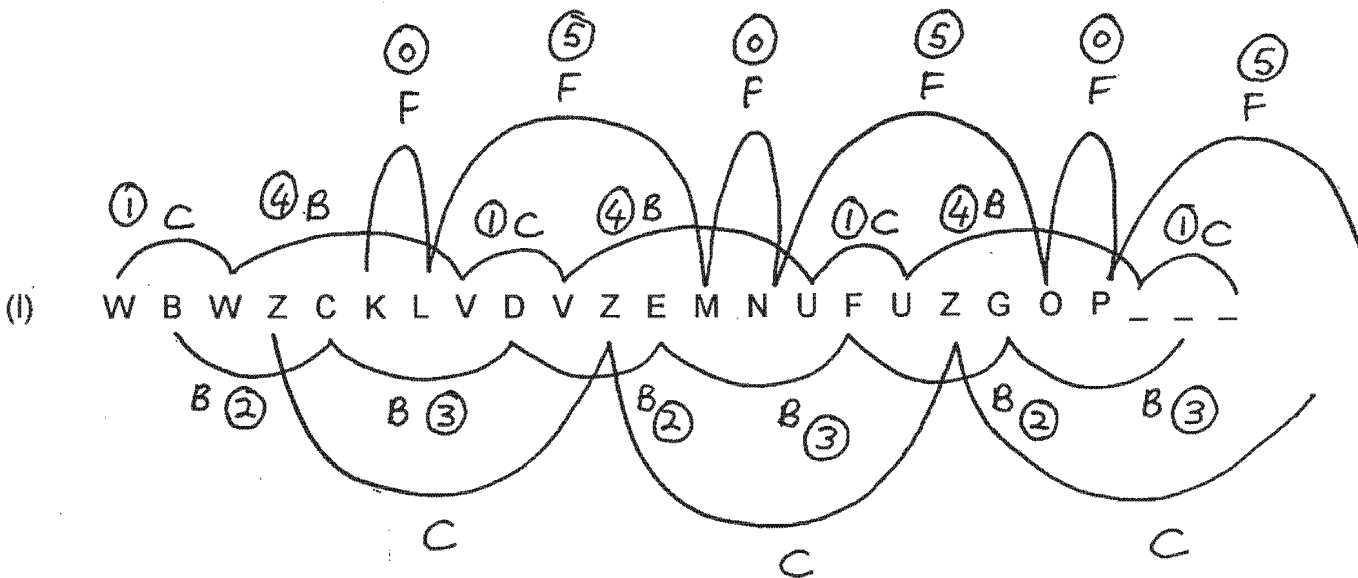
If you are having difficulty in solving these problems you may turn over to the next page for some clues on how to solve them.

In problem (k) the following strings occurred:



The answer is therefore: (k) K B R.

In problem (l) the following strings occurred:



The answer is therefore: (l) T H T.

If there is anything you don't understand ask now.

**A P P E N D I X G**

**EXAMPLES OF TEST ITEMS IN THE  
READING COMPREHENSION TEST  
(RCT)**

## PASSAGE

Engineers and scientists of the Radio Corporation of America have conducted investigations pointing to the technical feasibility of special-purpose satellites in several areas. They made detailed studies of the possible use of an artificial moon as an orbital office to speed up mail delivery between the United States and Europe. Ground systems on both sides of the ocean would link post offices in major American and European cities with transmitting and receiving stations communicating via the satellite relay. Letters written on special forms would be converted electronically into radio signals for transmission through space across the Atlantic. At the receiving end, high-speed electronic printing techniques would convert the signals back to letter form for postal delivery.

1. This report would be of interest to

- B supersonic pilots
- C postmen
- D astrologers
- E communications engineers
- F satellite countries

2. The satellite service would be used by

- M the general public
- N the military only
- O post office engineers
- P high speed electronics
- Q engineers and scientists of the R.C.A.

**A P P E N D I X H**

**EXAMPLES OF TEST ITEMS IN THE  
MENTAL ALERTNESS TEST  
(MA)**

1. a b c d e f g h i j k l m n o p q r s t u v w x y z

Suppose that the first and second letters of the alphabet were interchanged, also the third and fourth, the fifth and sixth, etc. What letter would then be the eighteenth letter counting from the left to the right?

R  
q

S  
s

T  
j

U  
r

V  
i

2. Ocean is related to **island** as continent is related to (?).

C  
headland

D  
sea

E  
land

F  
lake

G  
mountain

3. Which two numbers come next in the following series?  
33 40 47 54 61 - -

N  
67,74

O  
68,76

P  
68,75

Q  
69,76

R  
None of these

4. Which one of these five things:

S  
cotton-wool

T  
cheese

U  
plastic

V  
cold

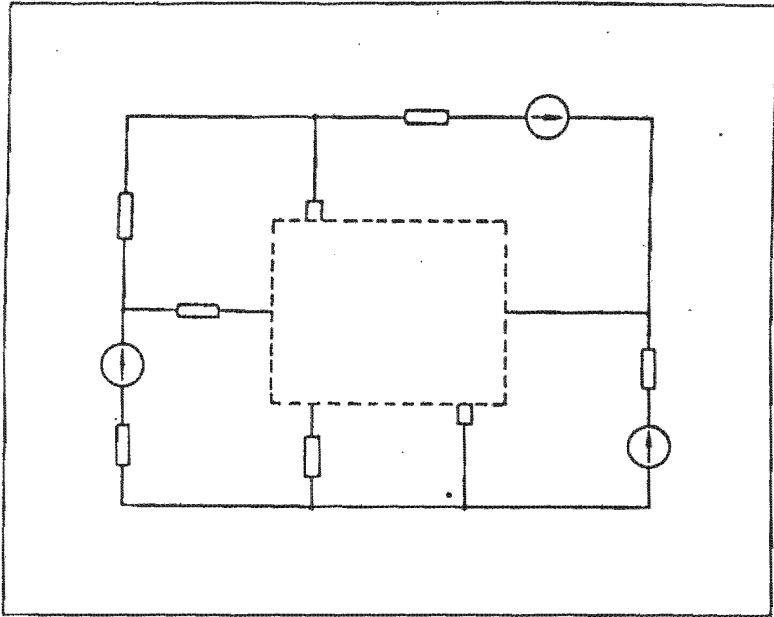
W  
water

is most like the following three?

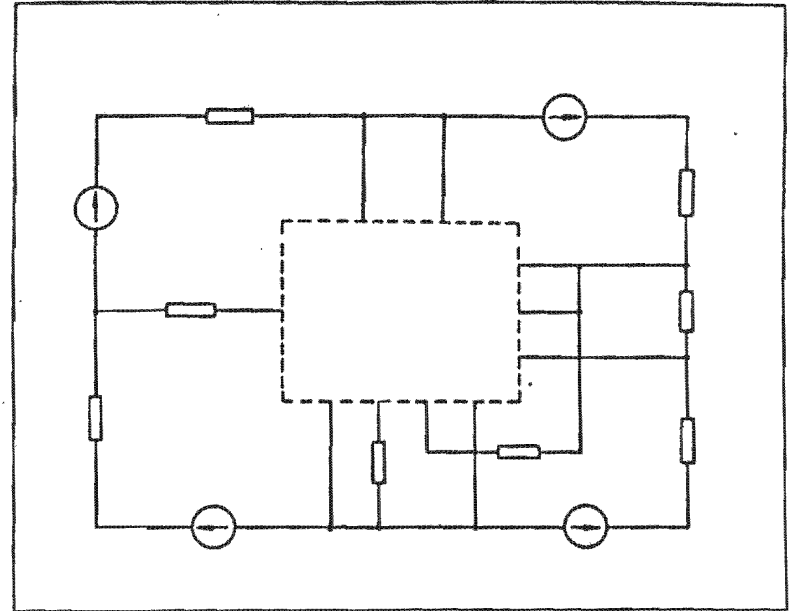
ivory, snow and milk.

# **A P P E N D I X I**

## **EXAMPLES OF TEST ITEMS IN THE ELECTRICAL ENGINEERING APTITUDE TEST (EAT)**

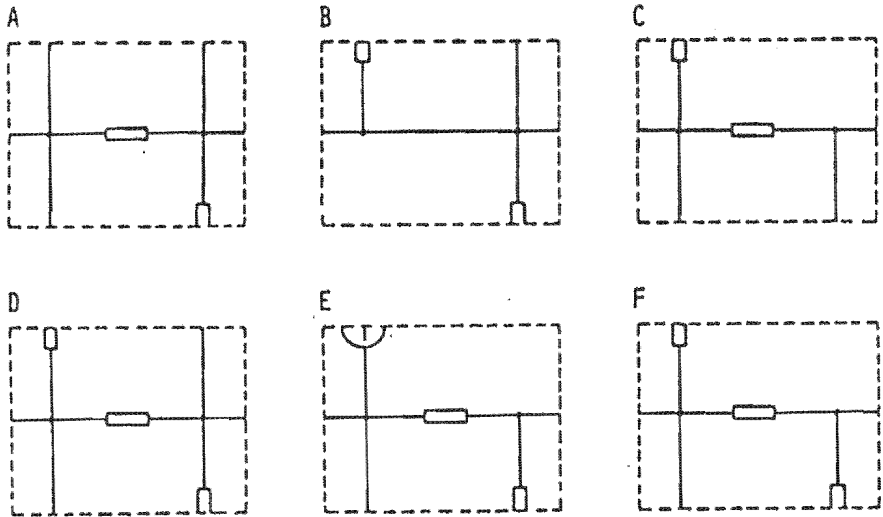


1-3

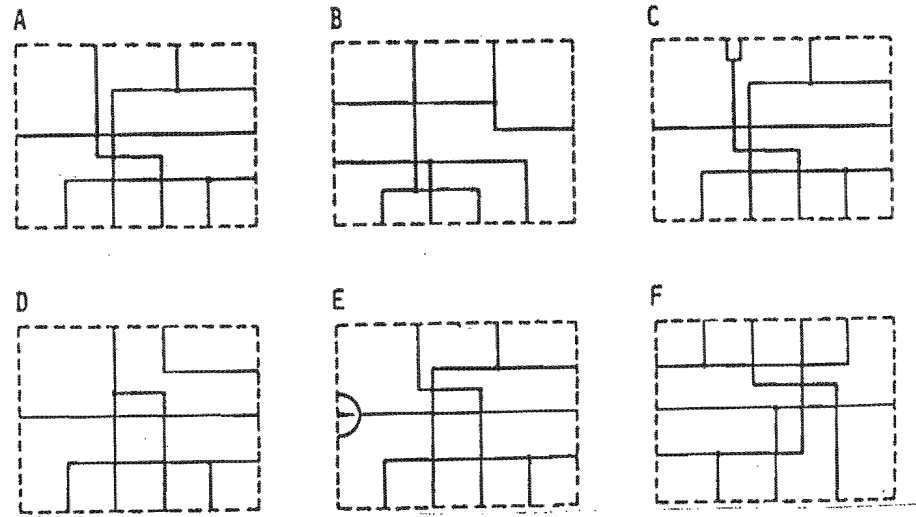


1-4

Select the appropriate fragment.



Choose the fragment to complete the circuit above.



**A P P E N D I X J**

**CHECKLIST OF ERRORS  
IN PROBLEM SOLVING**

# CHECKLIST OF ERRORS IN PROBLEM SOLVING

Following is a checklist of sources and types of errors in problem solving. Some of the items overlap, referring to different aspects of the same fault in working problems, but this overlap is unavoidable because the various factors that underlie problem solving skill are interrelated. Read the checklist aloud, discussing any items that are unclear. Then, as you solve problems, be careful not to make these errors. If you recognize some particular error to which you are especially prone, take extra pains to guard against it.

## INACCURACY IN READING

1. Students read the material without concentrating strongly on its meaning. They were not careful about whether they understood it fully. They read sections without realizing that their understanding was vague. They did not constantly ask themselves: "Do I understand that completely?" This showed up in errors they made later.
2. Students read the material too rapidly, at the expense of full comprehension.
3. Students missed one or more words (or misread one or more words) because the material was not read carefully enough.
4. Students missed or lost one or more facts or ideas because the material was not read carefully enough.
5. Students did not spend enough time rereading a difficult section to clarify its meaning completely.

## INACCURACY IN THINKING

6. Students did not constantly place a high premium on accuracy – They did not place accuracy above all other considerations such as speed or ease of obtaining an answer.
7. Students were not sufficiently careful in performing some operation (such as counting letters) or observing some fact (such as which of several figures is the tallest).
8. Students were not consistent in the way they interpreted words or performed operations.
9. Students were uncertain about the correctness of some answer or conclusion, but did not check it.
10. Students were uncertain about whether a formula or procedure they used to solve the problem was really appropriate, but did not check it.
11. Students worked too rapidly, which produced errors.

12. Students were inaccurate in visualizing a description or a relationship described in the text.
13. Students drew a conclusion in the middle of the problem without sufficient thought.

#### **WEAKNESS IN PROBLEM ANALYSIS: INACTIVENESS**

14. Students did not break a complex problem into parts. They did not begin with a part of the problem that they could handle in order to get a foothold. They did not proceed from one small step to the next small step, being extremely accurate with each one. They did not use the parts of the material they could understand to help them figure out the more difficult parts. They did not clarify their thoughts on the parts they did understand and then work from there.
15. Students did not draw upon prior knowledge and experience in trying to make sense of ideas which were unclear. They did not try to relate the written text to real, concrete events in making the meaning clear and understandable.
16. Students skipped unfamiliar words or phrases, or were satisfied with only a vague understanding of them, rather than trying to obtain a good understanding from the context and the remainder of the material.
17. Students did not translate an unclear word or phrase into their own words.
18. Students did not use the dictionary when necessary.
19. Students did not actively construct (mentally or on paper) a representation of ideas described in the text, where such a representation could have helped in understanding material.
20. Students did not evaluate a solution or interpretation in terms of its reasonableness, i.e. In terms of their prior knowledge about the topic.

#### **LACK OF PERSEVERANCE**

21. Students made little attempt to solve the problem through reasoning because they lacked confidence in their ability to deal with this type of problem. They took the attitude that reasoning would not work with this problem. They felt confused by the problem, so didn't start systematically by clarifying the portions of the problem which were readily understandable, and then attempting to work from there.
22. Students chose an answer based on only a superficial consideration of the problem – on an impression or feeling about what might be correct. Students made only a superficial attempt to reason the problem, then guessed an answer.
23. Students solved the problem in a mechanical manner, without very much thought.
24. Students reasoned the problem part way through, then gave up and jumped to a conclusion.