

USING THE DIFFERENTIAL APTITUDE TEST TO ESTIMATE INTELLIGENCE AND  
SCHOLASTIC ACHIEVEMENT AT GRADE NINE LEVEL

by

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**SUMMARY**

The newly developed Differential Aptitude Test – Form S (DAT) does not give an indication of general intelligence or expected achievement in Grade 9. The aim of the current study was to determine the relationships of the aptitude subtests (measured by the DAT) with intelligence and achievement. Two affective factors, motivation and self-concept, as well as study orientation, were included as variables predicting achievement. An empirical study was carried out in which 60 Grade 9 learners were tested. The variables were measured using reliable instruments. Correlations were calculated and multiple regression analyses used to predict achievement. Moderate to high positive correlations between aptitude and intelligence were found. Affective factors explained more of the variance in achievement in key subjects than aptitude variables. One conclusion is that Grade 9 achievement measures affective rather than cognitive factors. Recommendations are made regarding the use of the DAT-S in predicting school achievement.

Key terms:

Academic achievement; Grade 9 learners; Aptitude; Intelligence; Cognitive factors, Affective factors; Motivation; Self-concept; Study orientation; Prediction

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I declare that “USING THE DIFFERENTIAL APTITUDE TEST TO ESTIMATE INTELLIGENCE AND SCHOLASTIC ACHIEVEMENT AT GRADE NINE LEVEL” is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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SIGNATURE

(MRS A C MARAIS)

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DATE

## CHAPTER 1

### **AWARENESS AND ANALYSIS OF THE PROBLEM, AIM AND PROGRAMME OF THE RESEARCH**

*People are busily living their lives forward, they are oriented toward the future.*

Gordon Allport

#### **1.1 AWARENESS OF THE PROBLEM**

The above quotation is true for most people but has particular relevance to adolescents who are on the brink of adulthood. During adolescence young people are deciding what is important to them and making commitments to certain courses of action in order to attain their goals and ambitions. Optimal scholastic progress and making informed academic decisions will increase the likelihood of eventual success in their academic and vocational life.

In order to assist learners in achieving their academic and eventual career goals it becomes necessary to determine the factors that facilitate scholastic achievement through psychological measurement (Cohen & Swerdlik 2002:288). Knowledge obtained in this way gives direction to decisions made by the learners themselves, their parents, teachers, counsellors and psychologists working in the school system.

Bloom (1976:10) identified three main variables which are related to academic achievement, namely:

- Cognitive variables: These are variables such as intelligence, aptitude and thoughts about a learning task.
- Affective variables: These are variables such as motivation, self-concept and interest with which the learner approaches a task.

- Quality of instruction: This includes aspects such as good explanations, participation in the learning events, application of the learning content and regular evaluation.

Cognitive and affective variables are entry factors which lie within the learner and precede the learning process. Quality of instruction lies outside the learner and varies from teacher to teacher. In a high school situation where different subjects are taught by different teachers, it is difficult to research a variable such as quality of instruction. Therefore Bester (1998:10) used study orientation as a variable to predict scholastic achievement.

As stated above, intelligence and aptitude are cognitive variables which influence learning events. Intelligence is usually seen as  $g$  – the general complex problem-solving ability common to many skills, while aptitude refers to  $s$  – specific abilities, each involved in a certain domain or skill. However, research findings have revealed that the level of  $g$ , or general intelligence is very high in tests of specific intellectual factors. Intelligence and aptitude, therefore appear to have more similarities than differences from each other (De Bruin 1997:14). For this reason, in the past, aptitude has been used to predict intelligence. The Junior Aptitude Test (Verwey & Wolmarans 1983:71) and Senior Aptitude Test (Fouché & Verwey 1994:54) were previously used in this way. In so doing, they furnished not only information about the learner's specific abilities, but also about his or her approximate level of general intelligence, both of which are important in predicting achievement at school.

The Differential Aptitude Tests were developed in order to be used with all South African learners (Vosloo, Coetzee & Claassen 2000:1) and to replace the older Junior Aptitude Test and Senior Aptitude Test. Due to their recent publication little research has been carried out using these tests. Firstly, the Differential Aptitude Test Form S (DAT-S), for Grade 7 to 10 learners, has not been studied with regard to the prediction of general intelligence in learners.

There are important applications of intelligence scores in education. Grade 9 learners need to know their level of general ability so that they will be in a position to decide whether they are more suited to remain at school or to leave school at the end of the General Education and Training Band. They could then, for example enter a college or other learning institution. Another application of intelligence scores is to identify a learning problem. The existence of a learning problem is usually inferred when there is a discrepancy between a learner's intelligence score and his or her scholastic achievement (Wicks-Nelson & Israel 1997:272).

The test developers give guidelines to obtain only a rough indication of a learner's general ability (Vosloo *et al.* 2000:36-37). They state that Test 2: Verbal Reasoning is the one test which gives the best indication of the general intellectual level of the learner. A more reliable indication, they maintain, will be obtained by taking into consideration Test 2 score with the scores of Test 3: Nonverbal Reasoning (especially in the case of learners with a language backlog), Test 4: Computations and Test 5: Reading Comprehension. They conclude that should a learner obtain a mean stanine of 7 or higher in these four tests together, he or she will fall in the top 23% of the population and can be regarded as an above average learner. A mean stanine of 3 or lower indicates that the learner falls into the bottom 23% of the population and is considered as having below average intellectual ability and would not be likely to progress past Grade 9. A mean stanine of 4, 5 or 6 indicates that the learner falls between the 23<sup>rd</sup> and 78<sup>th</sup> percentile, in other words where the majority of his or her peer group find themselves and can therefore be regarded as an average learner. No empirical evidence is given for these interpretations of test results. The respective contributions of the four tests to the estimation of intelligence have not been determined by the test developers, nor have the possible contributions made by Tests 1, 6, 7, 8 and 9 been investigated.

General intelligence needs to be determined more accurately than what is given by the test developers of the DAT-S, before the information will be useful in education.

Learners at different levels of intellectual ability have different educational needs. For example, a learner who has above average intelligence, may continue in mainstream education, follow the standard curriculum and will probably perform better than many others in the class. Gifted learners, however, have special educational needs. They need to be provided with enrichment work, for example projects, which will satisfy their intellectual interests and allow them to achieve their individual potential.

Currently, the New South African Group Test (NSAGT) is used to determine the intelligence scores of learners in a group situation. The disadvantage of using the group intelligence test is that information about the learner's aptitudes is not obtained. Therefore, educational psychologists, counsellors, teachers and others in the education situation can only give limited educational guidance to the learner. Advice regarding future subject choices, school placement and remedial assistance regarding specific abilities cannot be provided.

Secondly, the DAT-S's relationship to scholastic achievement has not been studied widely. Only one study, of limited scope, has been carried out to determine correlations between scores on the individual tests of the DAT-S and scholastic achievement in learners (Vosloo *et al.* 2000:44). The study was carried out on a sample of 61 Afrikaans speaking, Grade 7 learners in one school. The sample size used is small when considering the expected wide application of this test in the South African learner population. The study involved only one grade, therefore nothing is known about the relationships between the aptitude tests and scholastic achievement in Grades 8, 9 and 10. Furthermore, the data was obtained from a study with learners who used the Afrikaans version of the test only. It does not provide information about the relationship between the English version of the test and achievement in English schools.

During the latter half of Grade 9, learners are required to choose subjects to study in Grade 10 to Grade 12. For this purpose, learners need to have information about their specific abilities which will give them an indication of how well they can expect to

achieve in certain subjects. The test developers state that certain combinations of DAT-S test scores give an indication of whether a learner is academically inclined, technically orientated or more suited to clerical, business-type tasks. Knowledge of the orientation of the learner can indicate that the learner should take certain subjects, for example a learner who is technically orientated may be advised to take Technical Drawing as a subject. There is no empirical evidence, however, to support the assertion that high scores in a certain group of DAT tests will lead to high achievement in specific school subjects.

Any attempt at prediction of academic performance also has to take affective factors into account (Bloom 1976:10). Two of the most important factors that influence school achievement are the learner's self-concept and motivation regarding academic tasks.

Many studies focus on one variable or on only a limited number of variables which makes prediction difficult because the interaction between different variables is ignored (Bester 1998:6). For example, in a study carried out by Brodnick and Ree (1995:583-594) only intelligence and socio-economic status with regard to achievement were studied. Intelligence explained 45% of the variance in achievement but socio-economic status could not explain any more of the variance. Affective variables such as self-concept and motivation, which could have contributed to the variance in the above study were not included. The researchers themselves pointed this out as a weakness in the study. The newly developed DAT-S has not been used in research using a combination of affective variables and DAT-S scores, in order to predict achievement. During the development of the test the researchers used only aptitude scores to predict achievement (Vosloo *et al.* 2000:44). When many relevant variables are used in one study, the most important predictive variables will be identified.

There are little research results available on the relationship between psychological variables and achievement in the new subjects (learning areas) developed for the

Outcomes Based Education (OBE) system introduced into Grade 9 in 2005. For example, the old History and Geography subjects have been subsumed under the subject of Human and Social Sciences, and novel subjects such as Economic and Management Sciences have been developed. Moreover, assessment methods for scholastic achievement have changed since the introduction of the OBE approach. There is less emphasis on formal tests while continuous assessments of class work, homework and projects take place. Other assessment methods such as peer and self assessments are also carried out. The relationship between cognitive variables, affective factors and scholastic achievement, as measured by these methods, is yet to be ascertained.

## **1.2 FORMAL STATEMENT OF THE PROBLEM**

If there is a strong relationship between two variables, one variable may be used, in a regression equation, to predict the other. When considering a learner's potential to complete school and directions for further study, it is necessary to determine not only a learner's specific aptitudes but also his or her general intelligence level. For this reason aptitude measures have been used in the past to predict intelligence. Currently, the relationship between the newly developed DAT-S and intelligence measures is unknown and therefore intelligence cannot be predicted from the aptitude tests.

Scholastic achievement is influenced by many factors. In order to provide support to the learner an understanding of the role played by different variables is necessary. Cognitive and affective variables, as well as study habits and attitudes, all have an influence on scholastic achievement. The specific contribution made by each factor when the newly developed Differential Aptitude Test is used and new methods of measuring achievement are implemented, is currently unknown. Therefore, the formal statement of the problem is based on the following three questions:

- How can individual tests or different combinations of the DAT-S tests be used to obtain a general intelligence score?

- How can the aptitude tests be used to predict achievement in the major subject areas?
- How can the aptitude tests in combination with other variables, such as self-concept, motivation and study orientation predict achievement?

### **1.3 AIM OF THE INVESTIGATION**

The aim of the investigation is to determine in what way aptitude, as measured by the DAT-S, can be used to predict intelligence and how these aptitude measures predict achievement in Grade 9 learners. The role of aptitude in combination with other variables such as motivation, self-concept and study orientation in scholastic achievement will also be investigated.

In the light of the abovementioned aim, a literature study will be carried out to:

- Analyse the constructs intelligence and aptitude, in order to determine the relationship between them.
- Establish the relationship between intelligence, aptitude and scholastic achievement.
- Analyse the constructs motivation, self-concept and study orientation and determine to what extent they relate to scholastic achievement in combination with aptitude scores.

An empirical investigation will be carried out in order to test hypotheses regarding the relationship between the constructs of general intelligence and aptitude, as well as their respective influence on scholastic achievement. Hypotheses regarding the influence of other variables such as affective factors and study orientation on scholastic achievement will also be put to the test.



#### **1.4 PROGRAMME OF THE RESEARCH**

Two cognitive factors are distinguished which are important in scholastic achievement, namely, general intelligence and aptitude. Both general problem-solving ability as well as more specific aptitudes, have an influence on a learner's performance at school. In chapter 2, these two cognitive constructs will be analysed in the light of established psychological theory and recent research findings.

When engaged in the educational process the learner is acting as a psychological whole and for this reason, the respective roles of affective factors and study orientation are also investigated. An explanation of the constructs of motivation, self-concept and study orientation will be provided in chapter 3. The main body of this chapter will deal with the relationships of the cognitive variables, affective factors and study orientation to scholastic achievement.

In chapter 4 the research design will be described and justified. At the beginning of the chapter hypotheses with regard to the formal statement of the problem will be given. A description of the sample, the measuring instruments used for each variable, and the research method will be provided.

The results of the empirical investigation will be given in chapter 5. The way in which the stated hypotheses are tested and the results obtained will be explained. Conclusions will be made regarding the relationship between intelligence and aptitude, as well as between certain independent variables and scholastic achievement.

Finally, in chapter 6, the educational implications of the research findings will be discussed. Guidelines will be provided to users of the DAT-S on how to predict an intelligence score from the aptitude test results. Recommendations regarding the optimal combination of cognitive and affective measures as well as study orientation scores to best predict scholastic achievement will be given.

## CHAPTER 2

### INTELLIGENCE AND APTITUDE

#### 2.1 INTRODUCTION

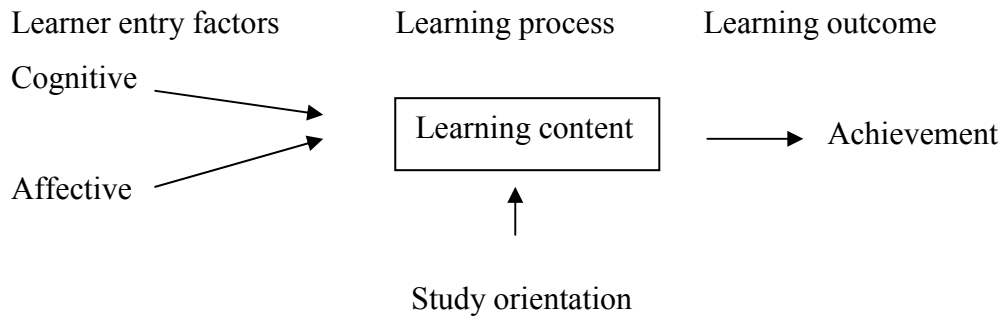
In order to predict scholastic achievement the most important variables involved in learning need to be measured. Benjamin Bloom (1976:10) developed a useful model to identify important factors involved in learning. He differentiated between three main variables that influence academic achievement, namely:

- Cognitive entry factors: these are variables such as intelligence, aptitude and thoughts which the learner brings to the learning task
- Affective entry factors: these are variables such as motivation and self-concept
- Quality of instruction: this includes aspects such as good explanations, participation in the learning events, application of the learning content and regular evaluation.

Cognitive and affective variables are entry factors that lie within the learner and precede the learning process. Quality of instruction is situated outside the learner and varies from teacher to teacher.

In a high school situation where different subjects are taught by different teachers, it is difficult to research a variable such as quality of instruction and because of this it is better to focus on a learner characteristic that is involved in the learning process. Instead of the instruction the learner receives, his or her study habits and study attitudes (study orientation) can be considered.

A representation of Bloom's model is given below:



The above model is used as a framework for this study. In this chapter the cognitive factors are analysed. Reference is made to prominent theories of intelligence, such as factor analytic theories, theories of cognitive development and new perspectives using information-processing models of intelligence. The concept, *aptitude* is described and the relationship between intelligence and aptitude is clarified.

## 2.2 INTELLIGENCE AND APTITUDE

Both intelligence and aptitude refer to cognitive abilities present in the individual (Cohen & Swerdlik 2002:257,301). Intelligence refers to those cognitive abilities, for example verbal reasoning and knowledge of the meanings of words, which are called upon in a person's general intellectual functioning across different areas of achievement (Berk 2000:316). Aptitudes, however, are specific abilities which are utilised in certain areas of achievement (Berk 2000:319), for example three dimensional spatial reasoning is used in architectural drawing.

Intelligence is considered to be a relative stable trait that does not fluctuate widely through the lifespan (Mussen, Conger, Kagan & Huston 1984:269), while aptitudes develop and change depending on individual characteristics and opportunities for learning. Cohen and Swerdlik (2002:301) explain that aptitudes are formed through the interaction between psychological factors (such as motivation) and the experiences the person encounters in everyday life. Aptitudes, therefore, represent a fund of information and skills acquired over time.

Aptitudes are used to predict variables such as future success in a given career which requires certain specific abilities (Vosloo, Coetzee & Claassen 2000:1). High aptitude scores, for example, in mechanical reasoning and nonverbal reasoning, may be interpreted as indicating that with further training, a person will markedly improve his or her performance in engineering-related skills. An important aspect of aptitude tests is therefore their predictive function. General intelligence is not usually used to predict success in a specific career but may be used to advise on the level of career to which a person may aspire. For example, a person who has a high aptitude for mechanical reasoning and an average level of intelligence may be advised to become a technician, while another person who has the same aptitude but an above average level of intelligence may be advised to become an engineer.

Research findings have revealed, however, that the level of *g* (general intelligence) is very high in tests of specific intellectual factors. Intelligence and aptitude, therefore appear to have more features in common than they have differences (De Bruin 1997:14).

### **2.3 WHAT IS INTELLIGENCE?**

Intelligence is a difficult construct to define. In a survey carried out by Snyderman and Rothman (in Li: 1996: 6-9), questioning social scientists and educators on the nature of intelligence, 99.3% indicated that abstract thinking or reasoning was an important element of intelligence; 97.7% indicated that the problem-solving ability was important, and 96% indicated that the capacity to acquire knowledge was important. This survey therefore emphasises the importance of thinking, learning and problem solving as elements of intelligence. In a study asking nearly 500 laypeople and 24 experts to define intelligence, Sternberg (2000: 316) found that their responses were surprisingly similar. Both groups viewed intelligence as a complex construct made up of verbal ability, practical problem solving and social competence. Intelligence is an important component of learning and academic achievement because it can be seen as the ability to gain knowledge, to think about abstract concepts, to reason as well as the ability to solve problems (Li 1996:10).

An important consideration which has been in existence since Alfred Binet constructed the first intelligence test, in 1905, is that while intelligence is relatively stable, it should not be seen as a fixed characteristic. Matarazzo (1972: 21) maintains that intelligence should not be studied in isolation but seen as a quality of the total person as he or she functions in everyday life. Changing conditions may increase or decrease the functional level of a person's intellectual resources.

In an effort to describe the nature of intelligence three basic approaches have been used: the factor analytic approach where underlying relationships between sets of intelligence variables are measured; the developmental approach where the increase in complexity of cognitive functioning is described, and the information-processing approach where the focus falls on how the effective intake, processing and output of information occurs.

### **2.3.1 Factor-analytic approaches**

A question pertinent to a factor-analytic explanation of intelligence is whether intelligence is a general ability or whether it consists of a number of specific abilities. If intelligence consists of several different abilities what are they, and what is the relationship between them?

#### **2.3.1.1 The two factor theory of Spearman**

Charles Spearman (Spearman & Jones 1950:9-10) regarded the high positive correlations between items designed to test aspects of intelligence, such as memory span, spatial ability and sequential reasoning, as an indication of the presence of a common factor. He named this the general intelligence factor (*g*) that is common to many abilities. At the same time, he saw that the items were not perfectly correlated with each other. This meant that there were other factors which were being tested. He consequently suggested that there are specific intelligence factors (*s*) that are specifically related to a single intellectual activity. This view of mental abilities came to be known as the "two factor theory of intelligence" (Berk 2000:317).

### 2.3.1.2 Thurstone's theory of primary mental abilities

Louis Thurstone (1938:80) disagreed with the idea that intelligence comprised an overarching, general factor. He analysed the results of 50 intelligence tests which he administered to college students and came to the conclusion that there are seven primary mental abilities that make up a person's intelligence. The abilities or factors are:

#### Spatial (S)

The ability to form spatial and visual images (Thurstone 1938:80).

#### Perceptual (P)

The ability to find or recognise particular items in a perceptual field (Thurstone 1938:81).

#### Numerical (N)

The ability to perform simple numerical calculations (Thurstone 1938:83).

#### Verbal relations (V)

The ability to conceptualise ideas and meanings in language (Thurstone 1938:84).

#### Word (W)

The ability to deal with single and isolated words in a fluent manner (Thurstone 1938:84-85).

#### Memory (M)

The ability to recognise and recall words, numbers and figures after having memorised them (Thurstone 1938:52-54).

#### Inductive Reasoning (I)

The ability to find a rule or principle and apply it. An example of an item requiring inductive reasoning requires the identification of figures that belong to a specified category even though they differ in other

properties. For example, if the category of shaded shapes is specified, the respondent must choose shaded shapes in his or her answer even though the shapes may be of different sizes or kinds (Thurstone 1938:25).

He also tentatively identified two further abilities as factors of intelligence:

#### Restrictive Reasoning (R)

The ability to successfully complete tasks that involve restriction in the solution. Arithmetical reasoning utilises restrictive reasoning as the answer to an arithmetical calculation is limited to one correct solution.

#### Deductive Reasoning (D)

The ability to draw a logical conclusion from a set of assumptions. For example, the ability to correctly identify that the following item uses faulty reasoning: *Some sports are dangerous, and football is a sport. Therefore, football is dangerous* (Thurstone 1938:47).

### 2.3.1.3 Guilford's structure of the intellect theory

Guilford identified many different factors which together make up the structure of the intellect or intelligence (1967:70, 1985:229-233). Intelligent functions are defined according to three different dimensions: operation, content and product. Intelligence, therefore is seen as comprising abilities which are grouped according to the different kinds of mental processes used, the type of information involved, and the form of the information processed.

The mental processes identified by Guilford are:

#### Cognition

The comprehension or understanding of information.

### Memory

The ability to recall and recognise information that has been memorised.

### Divergent Production

Creative thinking which involves fluency, flexibility and elaboration abilities (Guilford 1967:62).

### Convergent Production

This refers to thinking in which the one correct answer to a question is produced (Guilford 1967:62).

### Evaluation

Comparing a product of information with known information according to logical criteria and making a decision concerning criterion satisfaction is identified as evaluation by Guilford (1967:185). Comparing two pictures and deciding whether they are the same or different involves evaluative ability.

These mental *processes* are used when considering different types of information, therefore each mental process is discussed as it operates on different *types* of information called content categories. The content categories are:

### Visual

The visual category refers to information that is visually perceived, for example, the correct perception of words that have parts of the letters missing (Guilford 1967:72).

### Auditory

This category refers to information that is heard and therefore auditory discrimination is important, for example listening to and interpreting a radio code (Guilford 1967:72).



### Symbolic

Information that is in the form of tokens or signs and stands for something else, for example printed language (Guilford 1967:73).

### Semantic

Meanings of words comprise semantic content (Guilford 1967:75).

### Behavioural

Nonverbal information is involved in human interactions. Awareness of one's own and others' thoughts, emotions, intentions and actions are among the behavioural factors included here (Guilford 1967:77).

Abilities are not only classified according to the *processes* and *content* but also according to the *form* in which the information was processed. The form of information is classified into product categories. The products identified are:

### Units

The most basic form of information is units or parts of wholes. Units can be seen as chunks of information, for example single words (Guilford 1967:64).

### Classes

A class is a set of objects with one or more common properties, for example in number classification, the number 22 fits in with the class formed by the numbers 44, 55 and 33 (Guilford 1967:64).

### Relations

A relation is a connection between two things. An item testing the cognition of relations, for example, may require the identification of the relation as the movement of a line by 45 degrees in a clockwise direction. This relation is then applied to another set of figures.

### Systems

Complexes, patterns or organisations of interdependent or interacting parts form systems. In testing the cognition of systems, spatial orientation tasks may be used, where visual rotation and consideration of many different parts and their changing relationships to each other are involved.

### Transformations

Changes, revisions, redefinitions or modifications, by which any product of information in one state goes over into another state involves transformation (Guilford 1967:64). In testing cognition of semantic transformation, the respondent may have to explain the many different ways in which two common objects, such as an apple and an orange, are alike. This involves the redefinition of the objects by emphasising one attribute or another (Guilford 1967:102).

### Implications

An implication is something expected, anticipated or predicted from given information. In an item testing the cognition of symbolic implications, different words are placed in relation to each other in the manner of a crossword so that the words may be read down or across. Considering the position of the letters gives rise to the expectation that one of the other words would fit in a certain place (Guilford 1967:104-105).

The three different dimensions are used to describe different kinds of intelligent thinking. A learner who needs to give the word “femur” in response to the clue, “the thigh bone”, will be using the following structures of the intellect: *convergent production* (only one correct answer) of a *unit* (one word) that is *symbolic* (language) in nature. The type of thinking used in the above example is abbreviated as NSU.

#### 2.3.1.4 Gardner’s theory of multiple intelligences

Gardner (1993: 63) defined intelligence as comprising eight different kinds of processing operations that allow a person to achieve in one or more of eight culturally meaningful areas. A person who has a high level of linguistic intelligence and is able to understand and express ideas well in language may achieve in society as a journalist or a poet (Berk 2000:323). One who has a high level of spatial intelligence may become an accomplished cartographer. Gardner does not agree with the concept of a general intelligence factor (*g*) and holds that eight different intelligences are found to a greater or lesser extent in different individuals. The eight intelligences identified by Gardner are:

#### Linguistic

A sensitivity to the sounds, rhythms and meanings of words and the different functions of language.

#### Logico-mathematical

Sensitivity to and the capacity to detect logical or numerical patterns; ability to handle long chains of logical reasoning

#### Musical

Ability to produce and appreciate pitch, rhythm (or melody) and aesthetic-sounding tones; understanding of the forms of musical expressiveness

#### Spatial

To perceive the visual-spatial world accurately, to perform transformations on those perceptions, and to recreate aspects of visual experience in the absence of relevant stimuli

#### Bodily-kinaesthetic

Ability to use the body skilfully for expressive as well as goal-directed purposes; ability to handle objects skilfully

### Naturalist

To recognise and classify all varieties of animals, minerals and plants

### Interpersonal

The detection and appropriate responding to the moods, temperaments, motivations and intentions of others

### Intrapersonal

Ability to discriminate complex inner feelings and to use them to guide one's own behaviour; knowledge of one's own strengths, weaknesses, desires and intelligences

Gardner uses neurological evidence to support the existence of separate intelligences. Damage to a specific part of the brain affecting one ability, for example linguistic or spatial, while sparing others, suggests that the affected ability is independent. Prodigies who have an outstanding talent in one area of ability yet have average ability in other areas lend support to the theory of the independence of abilities. Only a few factor analytical studies support the existence of multiple intelligences as Gardner sees them.

Plucker, Callahan and Tomchin (1996:81-92) carried out a study to assess the reliability and validity of a battery of instruments based on multiple intelligence theory to identify talented children. The battery included performance-based assessments and teacher checklists of behaviour and performance. The four intelligences investigated were Linguistic intelligence, Logical-mathematical intelligence, Spatial intelligence and Interpersonal intelligence. The factor analysis confirmed only two of the four intelligences investigated. Evidence for the existence of Linguistic and Logico-Mathematical intelligences was found through establishing concurrent validity with the Iowa Test of Basic Skills, measuring language abilities (such as storytelling), mathematics, reading comprehension and vocabulary. All of the Interpersonal intelligence activities loaded on Linguistic intelligence,

presumably because many interpersonal activities require verbal-linguistic talent.

Several programmes based on Gardner's theory of multiple intelligences have been implemented in schools in the United States of America. Activities aimed at developing a specific intelligence or set of intelligences were provided. Evidence is still needed on how effectively this approach nurtures children's talents, but there are indications that they highlight the strengths of some learners who previously had been considered unexceptional or at risk of school failure (Berk 2000:353). These programmes may therefore be useful in identifying talented ethnic minority children who are underrepresented in schools for the gifted (Suzuki & Valencia 1997:1103-1114).

#### 2.3.1.5 Cattell and Horn's theory of fluid and crystallised intelligence

Cattell (in Cohen & Swerdlik 2002:231) proposed a theory that intelligence consists of two major types of cognitive abilities: crystallised intelligence and fluid intelligence. Crystallised intelligence (*Gc*) refers to acquired skills and knowledge that are dependent on exposure to a particular culture, as well as formal and informal education, for example, vocabulary. The abilities that make up fluid intelligence (*Gf*) are nonverbal, relatively culture-free, and independent of specific instruction, for example, memory for digits.

#### 2.3.1.6 Carroll's three-stratum theory of cognitive abilities

John Carroll (Berk 2000:319) developed a hierarchically arranged model of cognitive abilities. He used improved factor-analytic techniques to reanalyse many studies in which the relationships between mental abilities were determined. This model elaborates on the models proposed by Spearman, Thurstone and Cattell discussed above. Carroll represents the structure of intelligence as a pyramid, with 'g', or general intelligence as conceptualised by Spearman, at the

top. Eight broad abilities occupy the second stratum, arranged from left to right in terms of their decreasing correlation with 'g'. The eight abilities are Fluid Intelligence, Crystallised Intelligence, General Memory and Associative Learning, Broad Visual Perception, Broad Auditory Perception, Broad Retrieval Ability, Broad Cognitive Speediness and Processing Speed (Berk 2000:319). Examples of the above eight abilities are:

- Fluid Intelligence
  - Sequential reasoning
  - Induction
  - Quantitative reasoning
- Crystallised Intelligence
  - Printed language
  - Language comprehension
  - Vocabulary knowledge
- General Memory and Learning
  - Memory span
  - Associative memory
- Broad Visual Perception
  - Visualisation
  - Spatial relations
  - Closure speed
- Broad Auditory Perception
  - Speech sound discrimination
  - General sound discrimination
- Broad Retrieval Ability
  - Creativity
  - Ideational fluency
  - Naming facility
- Broad Cognitive Speediness
  - Rate of test taking
  - Numerical facility
  - Perceptual speed

- Processing Speed
  - Simple reaction time
  - Choice reaction time
  - Semantic processing speed

### 2.3.1.7 The Cattell-Horn Carroll Model

The Cattell-Horn theory of intelligence was combined with the Carroll model, initially by McGrew and later by McGrew and Flanagan (Cohen & Swerdlik 2002:232-233), in an effort to provide a comprehensive conceptualisation of human cognitive abilities that many scientists would agree on. This theory could be used in psychological assessment in education where a comprehensive assessment of a student's abilities is necessary. The Cattell-Horn Carroll (CHC) model holds that there is no general intelligence factor. According to this model, there are ten broad stratum abilities and over seventy narrow stratum abilities. Each broad stratum ability includes two or more narrow stratum abilities. The ten broad stratum abilities are: Fluid Intelligence (*Gf*), Crystallised Intelligence (*Gc*), Quantitative Knowledge (*Gq*), Reading/Writing Ability (*Grw*), Short-Term Memory (*Gsm*), Visual Processing (*Gv*), Auditory Processing (*Ga*), Long-term Storage and Retrieval (*Glr*), Processing Speed (*Gs*) and Decision/Reaction Time or Speed (*Gt*).

Recent studies show that the CHC model offers a better representation of the structure of intelligence compared to other selected models or theories. A study was carried out comparing the CHC model to a four-factor Wechsler intelligence test and an information-processing model (Mascolo 2002:1084). The Wechsler test measured four abilities, namely verbal comprehension, working memory, perceptual organisation and processing speed (Cohen & Swerdlik 2002:269-270). The study found that the CHC model accounted better for the factor loadings obtained, supporting the existence of the ten broad stratum abilities identified by the model. CHC theory can be used in

developing and assessing executive functioning, which has implications for the educational sphere (Sherman 2002:87-195).

### **2.3.2 Developmental approaches**

Human cognition refers to the inner processes and products of the mind that lead to “knowing” (Berk 2000:221). These abilities develop and become increasingly complex as a person grows from infancy into adulthood. Developmental researchers have shed light not only on the nature of cognition at different ages, but also on how children’s cognitive abilities develop. Two developmental theories will be discussed here: Jean Piaget’s cognitive-developmental stage theory and Lev Vygotsky’s sociocultural theory.

#### **2.3.2.1 Piaget’s cognitive-developmental theory**

Piaget conceptualised the child’s understanding of the world at any given developmental period as being represented by mental structures or schemes (Cohen & Swerdlik 2002:228). The child’s schemes are organised ways of making sense of experience. As the child moves into the different developmental phases and interacts with his or her environment, he or she adjusts and changes his or her schemes so that they are consistent with his or her environment. In this way the child constructs and reconstructs his or her understanding of the world and how it works. This understanding contributes to the child's intelligence.

Piaget defined intelligence as a cognitively driven process of assimilation and adaptation to the environment (Cohen & Swerdlik 2002:227). The child uses his or her current schemes or cognitive structures to interpret his or her environment. The infant who repeatedly moves a cushion out of the way to find the toy behind it, is assimilating that action into his or her object permanence scheme. A preschool girl who sees a wild bird through the window and calls it a “chicken”, has searched through her schemes until she found one that most closely resembles the new sight. In accommodation the child encounters information in his or her environment which is inconsistent with his or her view of the world, as dictated by his or her level of cognitive development. Through trial and error the child changes or creates new



schemes about the environment and how it works. The child's schemes then become consistent with what he or she perceives, and the child reaches a higher, more sophisticated level of cognitive development. The infant boy who points to the cupboard and calls for the biscuits that he knows are in there, is modifying his object permanence scheme. The preschool girl who describes the wild bird as a "small chicken" is changing her "chicken" scheme so that it is more consistent with her observations. This process of building schemes through direct interaction with the environment is called adaptation (Berk 2000:223).

Piaget described four different developmental phases that children go through, representing increasingly complex levels of cognitive understanding.

The first stage is the sensorimotor period which ranges from birth to two years of age and during which the infant uses his or her senses and movement to learn about the environment.

The second stage is the preoperational period ranging from 2 to 6 years, during which there is a great increase in the child's ability to represent the environment symbolically, as in language. However, thought is not yet logical.

The third stage is the concrete operational period which ranges from 6 to 12 years and is a major turning point in cognitive development. Concrete operational reasoning is far more logical, flexible and organised than cognition during the preschool period. According to Piaget children in this period are able to perform logical operations only when the subject matter is concrete and directly perceived by the child. Abstract thinking about ideas that are not apparent in the real world is not yet present. The child who is capable of operational thought is able to master the Piagetian tasks of conservation, hierarchical classification and seriation, including transitive inference.

- Conservation involves the ability to see that a quantity of matter has not changed even though its form has changed. There is conservation of number, length, weight and volume. The child is able, for example,

to see that a volume of water has not changed when it is poured from a short, wide glass into a tall, narrow glass. The child who understands that the volume stays the same, uses logical operations in a correct way (in this particular instance decentration). If the water is poured back into the original container, another logical operation is used, namely reversibility (Berk 2000:249).

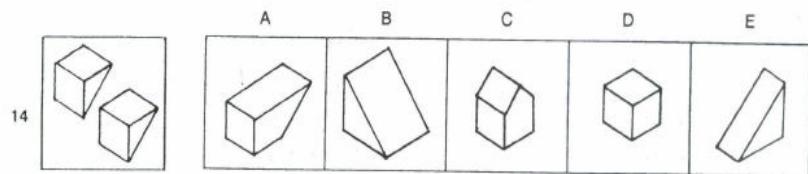
- Hierarchical classification involves the ability to classify objects using superordinate and subordinate categories. If a child is required to identify which word fits in least with a group of words in a list, the child will look for common characteristics which enable the classification of similar objects and the exclusion of one object. In the following list, “leaves, trunk, roots, branches, sunlight”, the word that fits in least with the others is the word “sunlight”, as the others refer to parts of a tree whereas “sunlight” does not (Owen & Vosloo 2000:8).
- The child in the concrete operational period is able to seriate, that is, order objects along a quantitative dimension, such as length or weight. Mentally the child can perform transitive inferences if he or she is able to infer that if stick A is longer than stick B and stick B is longer than stick C, then Stick A is longer than C. The child’s ability to seriate is tested in the DAT-S through nonverbal reasoning with figures, for example by showing him or her a sequence of pictures.



The child has to choose the correct option from a selection which includes the correct answer (the largest triangle below the smallest circle with a small part of intersection between the two shapes)

amongst other options such as a small circle and triangle next to each other or a circle featured below a triangle (Owen & Vosloo 1999:17).

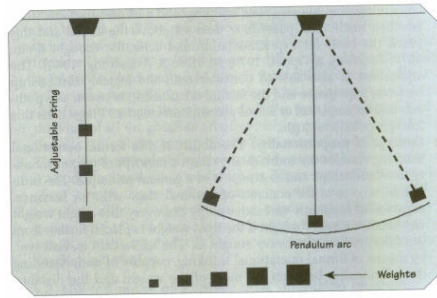
During the concrete operational period the child's understanding of spatial concepts improves since he or she has achieved conservation of distance. The child is able to give clear directions and form well-organised cognitive maps of large-scale spaces such as a school or neighbourhood (Berk 2000:251). The child's improved spatial abilities are tested in the DAT-S through spatial visualisation tasks such as the mental assembly of separate shapes to form a larger shape (Owen & Vosloo 1999:71).



The final cognitive developmental stage described by Piaget is the formal operational period, ranging from 12 years of age into adulthood. During this stage the individual becomes capable of abstract thinking and is able to generate new logical rules through internal reflection.

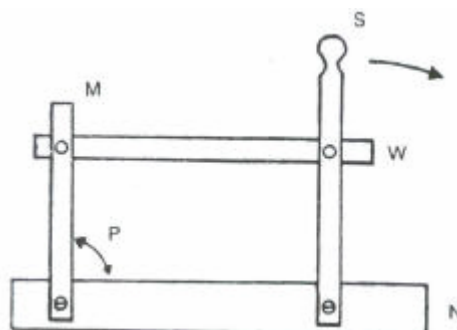
The first type of thinking that emerges is hypothetico-deductive reasoning. The adolescent, when faced with a problem, starts with a general theory of all possible factors that might affect an outcome, and deduces from it specific hypotheses (or predictions) about what might happen. He then tests these hypotheses in an orderly fashion to see which ones are correct or acceptable.

Piaget's famous pendulum problem illustrates this type of thinking. Several pendulums with strings of different lengths and objects of different weights attached to the strings are attached to a bar by means of the strings. The adolescent is asked what influences the speed of a pendulum as it swings through its arc.



The adolescent in the formal operational period will come up with four possible hypotheses: 1) the length of the string, 2) the weight of the object hung on it, 3) how high the object is raised before it is released and 4) how forcefully the object is pushed. Then by varying one factor at a time while holding all others constant, they try out each possibility. Eventually they discover that only string length makes a difference.

Test items included in the mechanical insight test of the DAT-S require hypothetico-deductive thinking. For example in an item which requires the adolescent to predict the consequences of the movement of levers attached to pivots, the adolescent will generate several possible hypotheses (or assess each multiple choice option given in the answer). He will then move the levers in the imagination keeping certain pivots stationary, allowing others to move in accordance with the mechanical principles explained, and thereby identify the consequences (Owen & Vosloo 1999:74). Each false hypothesis or multiple choice option is rejected until the correct one that matches the consequences as deduced by the adolescent, is found.



If lever S is pulled in the direction of the arrow, then ...

A. no movement will be possible

- B. W will move nearer to N
- C. W will move away from N
- D. M will move to the left
- E. Angle will become bigger

The second type of thinking that emerges during this stage is propositional thought, which enables adolescents to evaluate the logic of propositions or verbal statements without referring to real-world circumstances. For example if an adolescent is posed the following propositions about an object:

“*Either* the object in my hand is green *or* it is not green.”

“The object in my hand is green *and* it is not green.”

Adolescents understand that the *either-or* statement is always true and the *and* statement is always false, regardless of the object’s colour (Berk 2000:254).

Piaget’s theory has been criticised. Research carried out by Fahrmeier (Berk 2000:252) highlighted the fact that the development of cognition in children is heavily dependent on experience and education and is not a universal characteristic of all children everywhere as Piaget believed. Bjorklund (Berk 2000:257) and other researchers do not agree that cognitive development in children takes place in stages. New kinds of thinking seem to emerge sooner in areas where children have a lot of experience and knowledge and later in areas where they have little knowledge.

#### 2.3.2.2 Vygotsky’s sociocultural theory

Like Piaget, Vygotsky believed that children are active learners in their environment but he emphasised the importance of children’s social environment in their learning. Vygotsky believed that children construct knowledge as they interact with their environment, and saw the development of human cognition as predominantly social and language based (Berk 2000:259).

Vygotsky maintained that children use language in order to guide and direct their behaviour and course of action. He called the way young children speak aloud while playing, “private speech”. Vygotsky regarded private speech as the foundation for all higher cognitive processes (Berk 2000:260).

According to Vygotsky children learn to master activities and develop their cognitive abilities by engaging in joint activities with more mature members of society. He described the optimal situation for children’s learning to take place, as a situation in which the learning tasks cannot yet be managed alone but can be accomplished with the help of adults and more skilled peers. This is called the child’s “zone of proximal (or potential) development” (Berk 2000:261).

Vygotsky agrees with Piaget that the nature of thinking as the child enters the adolescent years changes (Rieber & Robinson 2004:423). He maintains that thinking becomes more abstract and complex. Acquired knowledge and the influence of speech are two basic factors that lead to the formation of abstract concepts in adolescent thinking. The younger, preadolescent child’s thinking is characterised by more concrete visual thinking which requires graphic representations. The younger child tries to explain abstract concepts by describing the concrete manifestations thereof. For example, when explaining the concept “love” the young child would say, “Love is someone who wants to get married”. The older adolescent may explain the concept “love” as an emotion characterised by a deep caring and committed attitude. The formation of concepts by the adolescent therefore reflects reality, but also organises it into a complex system of relationships.

Some theorists disagree with theories of cognitive development. They maintain that qualitative differences in a child’s thinking do not occur, but that thought processes are similar at all ages and are merely present to a greater or lesser extent. This forms the basis of the information-processing approach to intelligence (Berk 2000:257).

### **2.3.3 The information-processing approach**

Ways in which information is processed are studied in the information-processing approach. Two types of processing styles, namely simultaneous and successive processing, have been identified. In simultaneous or parallel processing information is integrated all at once. In successive or sequential processing each bit of information is individually processed in a sequential way (Cohen & Swerdlik 2002: 233). Sequential processing is logical and analytical in nature, putting new pieces of information successively together to reach a final conclusion, for example memorising a telephone number or spelling a word. Simultaneous processing involves the integration of information as a whole, for example looking at a painting or a map.

### **2.3.4 Recent approaches to intelligence**

Recently, researchers such as Ian Deary and Con Stough (Deary & Stough 1996:599-608) have begun combining psychometric and information-processing approaches. They conducted componential analyses of children's intelligence test scores by correlating them with laboratory measures, which assess the speed and effectiveness of information processing. In this way they hoped to isolate specific cognitive skills, such as inspection time, which underpin problem solving (Berk 2000: 321).

There is a distinction between speeded tasks involving only perception of information and those that require not only the intake of information but also a reaction within a certain amount of time. Perceptual tasks involving a speeded reaction by the participant have shown low correlations with intelligence measures, in the region of 0.2 or lower (Deary 1995:237-250). However, perceptual tasks involving only the rapid seeing or hearing of information and requiring a response that is not speeded, such as auditory inspection time (AIT) or visual inspection time (VIT) show moderate correlations with intelligence measures. Deary (1995:237-250) investigated the causal relationship between auditory inspection time and IQ measurements and found that auditory inspection time may cause late general cognitive ability in young adolescents. This finding suggests that

individuals whose nervous systems function more efficiently have an edge when it comes to intellectual skills. They can perceive and integrate information more quickly and they are therefore able to consolidate more information per unit of time. The rapid consolidation of information results in more attentional resources being available to solve problems.

Working memory is that part of the memory a person uses to temporarily store information so that it can be processed (Eysenck & Keane 2000:164). Different bits of information need to be held in the mind at one time in order to be able to reason and work out problems effectively. While working out whether a country has a democratic society or not a learner would have to consider the various ideas about democratic society in his or her mind, such as the individual's right to vote and the presence of a representative government. The learner would then have to compare those ideas to the specific aspects of the society in question. The activities of recall, comparison and logical reasoning make large demands on the learner's working memory capacity.

Working memory is thought to have much in common with general intelligence and can be predicted by *g* (Colom, Rebollo, Palacios, Juan-Espinosa & Kyllonen 2004: 277-296). It has been found that the larger the working memory the more attentional resources are available to comprehend language, and therefore to complete demanding cognitive tasks (Eysenck & Keane 2000: 342). Processing speed influences the efficiency with which higher cognitive functions are carried out thereby influencing children's school achievement (Rinderman & Nienaber 2004: 573-589).

Geary and Burlingham-Dubree (Berk 2000:321) found that strategy use, or the ability to decide how to solve a problem, is related to mental test scores. Children who apply strategies adaptively develop the capacity for fast, accurate retrieval of information stored in the memory, a skill which seems to carry over to performance on intelligence test items.



#### 2.3.4.1 Sternberg's triarchic theory

Robert Sternberg (1985:41-42) expanded the componential approach into a comprehensive theory which includes internal factors and external factors which affect a person's intelligence. Internal factors are factors within the individual such as inherent abilities or talents. External factors are factors such as a society that values and encourages the development of verbal abilities.

The triarchic theory (Sternberg 1985:41-42) consists of three subtheories: the contextual subtheory, the experiential subtheory and the componential subtheory.

The contextual subtheory refers to the context or culture of the individual and emphasises the importance of the individual's adaptation to his or her environment as a sign of intelligence. If individuals are unable to adapt to their environment they may have to select an alternative environment, or try to reshape their existing environment in order to improve the "fit" between themselves and their environment to meet their personal goals (Sternberg 1985: 45-46). An individual who is outgoing and extravert would be unsuited to a work environment where he or she would be required to work alone for long periods of time. Such an individual should select a work environment that requires interaction with other people.

The experiential subtheory explores the individual's ability to deal with novel tasks and the ability to automatise information processing as an aspect of intelligent behaviour (Sternberg 1985: 69,71). The child who learns efficiently from experience is, for example, able to rapidly learn a new method of solving a mathematical problem and thereafter to retrieve and use that strategy with ease.

The componential subtheory identifies different functions which underlie intelligent performance. One of these functions is metacognition or

executive processing, which monitors and regulates a person's thinking. Another function is combining and comparing information in order to carry out intelligent thinking. A further function is the selective encoding of information in the memory in order to increase knowledge (Sternberg 1985: 99,107).

Sternberg developed a test based on his triarchic theory. Recent research carried out by Koke and Vernon (2003:1803-1807) confirms that the Sternberg Triarchic Abilities Test (STAT) correlates significantly with a general intelligence test, the Wonderlic Personnel Test. This result indicates that the STAT is a valid measure of general intelligence.

## **2.4 MEASURING INTELLIGENCE**

The measurement of intelligence involves the comparison of a person's performance on a variety of subtests with the performances of others in that particular age group (Van Eeden 1997a:2).

The Senior South African Individual Scale – Revised (SSAIS-R) (Van Eeden 1997b:3) as well as the Afrikaans version of the test, are used most often in South Africa to test intelligence among English and Afrikaans speaking children. In South Africa where most learners do not speak English or Afrikaans as a home language the test may also be used. These learners must have spent at least five years in a school where either language was the medium of instruction. The test is then seen as an indication of the learners' abilities in an English or Afrikaans school environment.

The SSAIS-R measures different abilities. These abilities include knowledge of word meanings, verbal reasoning ability, short-term verbal memory, number ability, nonverbal reasoning ability, visual memory and the ability to visualise spatial relationships. The test also measures aspects of intelligence, such as concentration, long-term memory and acquired knowledge (Van Eeden 2000:6). The subtest scores can be grouped to provide a verbal and a nonverbal score. All the test scores may be added together to obtain a general intelligence factor.

One of the disadvantages of using the SSAIS-R is that it is a predominantly verbal test which means that it relies heavily on the language abilities of the child. In South Africa where many children do not speak English or Afrikaans, a nonverbal test, or a test in their home language may be a better indicator of their intelligence.

## **2.5 WHAT IS APTITUDE?**

Aptitude refers to a specific ability (Berk 2000:319), such as carrying out arithmetical calculations or recalling facts from information that has been read. Aptitudes form as a result of the interaction between individual characteristics and learning opportunities in the environment (Cohen & Swerdlik 2002:301). They, therefore, represent information and skills which are gradually acquired.

Aptitudes can be measured and are used to predict a person's potential for achievement in a defined area. If a person displays an aptitude for a type of activity by currently showing high specific ability in that field, one may predict that his or her performance will increase significantly with additional training in that area (Reber 1995:52).

## **2.6 MEASURING APTITUDE**

Aptitude is measured through the use of aptitude tests. Aptitude tests tap a combination of learning experiences and inborn potential that was obtained under uncontrolled and undefined conditions (Cohen & Swerdlik 2002:301). Test results obtained can then be used to predict a learner's probable success in a future course or career.

The Differential Aptitude Tests were recently developed as standardised aptitude tests for all population groups in South Africa (Vosloo, Coetzee & Claassen 2000:1, Owen 2000:1). Previously, the Junior Aptitude Test (Verwey & Wolmarans 1980:3) was used to test the aptitude of Grade 7, 8 and 9 learners and the Senior Aptitude Test (Fouché & Verwey 1994:1-82) was used to test Grade 10, 11 and 12 learners. An advantage of the Junior Aptitude Test

was that it could be used to estimate intelligence, making it an effective instrument to gain a lot of information about the respondent. The Junior Aptitude Test is, however, an old test, released in 1975. A new manual was published in 1980 with the addition of norms for Grade 10 learners but the test remained essentially the same as the previous one. The standardisation sample for this test consisted of Grade 7 to 10, male and female, English and Afrikaans speaking learners in South Africa and South-West Africa (currently Namibia). No indication of the population composition of the sample is given. Given the recent political and social changes in South Africa, it became necessary to develop tests that could be used with all population groups.

The Differential Aptitude Tests were developed to test learners in the General Education Training phase (GET) and in the Further Education and Training phase (FET). For each phase two tests were developed, a standard one for general use, and an advanced version for those learners who have had access to favourable educational opportunities. The full series comprises the following:

Differential Aptitude Tests Form R – (Grades 7 to 10: Standard form)

Differential Aptitude Tests Form S – (Grades 7 to 10: Advanced form)

Differential Aptitude Tests Form K – (Grades 10 to 12: Standard form)

Differential Aptitude Tests Form L – (Grades 10 to 12: Advanced form)

(Vosloo *et al.* 2000:1).

The Differential Aptitude Tests Form S (DAT-S) were standardised on English and Afrikaans speaking, Grade 7 and Grade 9 learners. The learners in the standardisation sample were drawn from four different population groups, namely black, coloured, Indian and white. The DAT-S was developed to measure the aptitudes of learners in Grades 7 to 10 who have had favourable educational opportunities (Vosloo *et al.* 2000:1). The DAT-S was used in this study to test the Grade 9 learners' aptitudes, as the learners had access to relatively good educational opportunities.

Aptitude tests such as the DAT-S draw on a broad spectrum of information and abilities (Cohen & Swerdlik 2002:301), such as knowledge of vocabulary,

verbal reasoning, nonverbal reasoning, arithmetical ability, reading comprehension, visual perceptual speed, three dimensional spatial visualisation, mechanical insight and memory (Vosloo *et al.* 2000:4,7). Measurement of these aptitudes enables us to predict broader characteristics such as whether a person will develop a high level of language ability or the ability to quickly and efficiently perceive similarities and differences in visual material (Cohen & Swerdlik 2002:301, Vosloo *et al.* 2000:4,7). Research carried out by the developers of the DAT-S shows that the aptitude for reading comprehension was the single aptitude in the test that correlated most highly with academic achievement (Vosloo *et al.* 2000:44). Measurement of the aptitude for Reading Comprehension could therefore be used to predict the broader variable of academic achievement through the use of a regression analysis. Combining the scores on different aptitude tests may be used to predict achievement in a specified area, for example the scores on the tests for vocabulary, verbal reasoning, reading comprehension and memory can be combined to predict a learner's general language achievement.

Nichols and Mittelholtz (1996:131) stated that aptitude tests measure mental abilities that are neither so stable that they cannot be changed, nor so easily changeable that they can be modified by a minor change in the situation where the aptitude is being used. Therefore, the arithmetical ability measured by the DAT-S should be an ability that can develop and improve with continued maturation of the learner and with continued learning and use of the ability. Arithmetical ability, on the other hand, should be stable enough so that it remains a true indication of the learner's ability and does not change too easily. For example, when a learner learns a new method of working out a particular kind of sum, this small, specific increase in ability should not result in a large increase in the measurement of his or her overall arithmetical aptitude.

Nichols and Mittelholtz (1996:131) point out that the prediction of achievement using a score on an aptitude test assumes that a specific aptitude is a necessary ability in that area. One could assume that visual perceptual speed is important to achieve at school level since much school work involves

the reading, scanning and comparing of information. However, research carried out by Vosloo, Coetzee and Claassen (2000:44) shows that visual perceptual speed has a low correlation with academic achievement and therefore would not accurately predict academic achievement.

At entry level an aptitude test is called a readiness test as the test is being used to measure the individual's readiness for learning (Cohen & Swerdlik 2002:301). The DAT-S, in assessing various aspects of intellectual functioning, such as abstract reasoning ability, memory and mechanical insight, can be used to assist the learner in deciding which subjects to take in Grade 10, the first year of the Further Education and Training Phase. The end of Grade 9 marks the end of the General Education and Training Phase when a learner may leave school and enter the workplace. The DAT-S can therefore also be used, together with information on interests and previous achievement, to assess potential success in a course or career.

## **2.7 THE RELATIONSHIP BETWEEN INTELLIGENCE AND APTITUDE**

Intelligence is usually seen as  $g$  – the general complex problem-solving ability common to many skills, while aptitude refers to  $s$  – specific abilities, each involved in a certain domain or skill. There is a close relationship between general and specific intelligences. As was shown by Carroll (Berk 2000:319), specific factors are related to general intelligence to a lesser or greater degree. Fouché and Verwey (1994: 55) maintain that aptitude tests do tap  $g$  because aptitude tests require the solution of complex problems. The high positive correlations between the different subtests on the Differential Aptitude Test indicate the presence of a common factor (Owen 2000:46-48).

While  $g$  appears to be closely related to  $s$ , it seems logical that certain specific abilities may be developed to a greater or lesser degree in different people, influencing their scholastic performance and making them more suited to certain occupations than others. Carroll (1982:29-120) states that while the general intelligence factor is the most important one in aptitude tests, some skills are specialised. He points out that certain skills in particular individuals have been developed to a point either above or below what could be expected

from the level of general intelligence in a person. This variation makes it important to consider specific abilities as separate skills, independent of general intelligence, which will predict aspects of scholastic performance or make a person suited to a particular occupation.

## 2.8 CONCLUSION

It was stated in section 2.1 that Bloom saw cognitive and affective factors to be important to scholastic achievement. This chapter dealt with two of the most important cognitive factors that play a role in academic achievement, that is intelligence and aptitude. Different perspectives on intelligence have been discussed. These perspectives have viewed intelligence as a single construct and alternatively, as many separate abilities related to each other in different ways. The basic speed of processing information and the consideration of a wider cultural context in the definition of intelligence were considered. The construct of aptitude was analysed and it was found to have much in common with intelligence, although there are also important differences between these constructs. One of the differences between intelligence and aptitude is that measures of aptitude are usually used to predict future academic and career performance, while intelligence measures are not commonly used in this way. The measurement of intelligence and aptitude in the South African context were considered. The importance of the measurement of cognitive factors with recently developed instruments was pointed out in the light of the political and social developments in the country.

General intelligence was shown to be a complex concept which involves cognitive abilities used in a person's intellectual functioning across contexts. These abilities are required in all learning situations to a greater or lesser degree and are therefore also tapped in tests measuring aptitude. For this reason it is possible to calculate the relationship between these two constructs so that one can be predicted from the other, in this case, intelligence from measures of aptitude. In section 2.6 it was pointed out that an advantage of the old Junior Aptitude Test was that it could also be used to estimate intelligence. The newly developed Differential Aptitude Test cannot be used to estimate intelligence, even though aptitude and intelligence have been found to be

similar constructs. For this reason, the current study aims to measure the relationships between the aptitude tests of the Differential Aptitude Test and the tests of the Senior South African Individual Scale – Revised, so that measures of aptitude can be used to estimate levels of intelligence in school learners.

The two cognitive factors discussed in this chapter, namely intelligence and aptitude, are closely related to a learner's academic achievement but they are not the only aspects involved in the learning situation. The learner brings his or her whole self to the classroom, and therefore non-cognitive aspects also influence his or her learning. Affective factors such as self-concept and motivation, as well as academic behaviour, such as study habits, affect academic achievement and will be the subject of the following chapter.



## CHAPTER 3

### FACTORS AFFECTING ACADEMIC ACHIEVEMENT AT HIGH SCHOOL LEVEL

#### 3.1 INTRODUCTION

Benjamin Bloom (1976:10) emphasised that both cognitive and affective factors are central to determining learning. The current chapter focuses on the relationship between cognitive and affective factors, and academic achievement.

Research has revealed that cognitive factors such as intelligence, aptitude and previous knowledge play an important role in academic achievement (Horn, Bruning, Schraw, Curry & Katkanant 1993:464-478). While these factors explain a great deal of the variance in classroom achievement, they do not account for all of it. Affective factors, such as the learner's self-concept and motivation, were identified by Bloom as important factors related to achievement. The learner, while participating in classroom events, develops an academic self-concept which in turn influences academic achievement. Motivational characteristics are important in influencing academic achievement as learners who are motivated are more likely to attempt, perform and persist in learning activities. Bloom considers quality of instruction as the most important instructional variable. Since it is difficult to measure quality, the concept of study orientation will be discussed in this chapter. The effective use of study habits and techniques, which students use to consolidate learning, are important in the learning process.

#### 3.2 COGNITIVE FACTORS

Intelligence, aptitude and prior learning experiences have been identified as important cognitive variables related to academic achievement (Horn *et al.* 1993:464-478).

### **3.2.1 Intelligence and academic achievement**

Academic achievement at school is the result of a learning process which consists of thinking, learning and problem solving (Bester 1998:9). Intelligence, as discussed in the previous chapter, is seen to be the ability to think and learn and is therefore considered to be fundamental to academic achievement.

In the literature, correlations between tests of general intelligence and measures of academic performance are reported as being usually close to 0.50 (Brody 1992:279; Neisser, Boodoo, Bouchard, Boykin, Brody, Ceci, Halpern, Loehlin, Perloff, Sternberg & Urbina 1996:81) but can be as much as 0.75 (Jensen 1998: 557-558). This means that 25% to 56% of the variance in academic performance can be attributed to intelligence.

Many empirical investigations have shown that intelligence is the best single predictor of academic success. Horn *et al.* (1993:464-478), in their study of undergraduate university students, developed a path model to show the relative influence of different variables on achievement. They found that when compared to other factors, such as previous knowledge and motivational factors, general intelligence was found to have a highly significant direct effect on achievement, independent of the other variables in the model. Intelligence showed a correlation of 0.55 with achievement, explaining 30% of the students' performance in this study.

Chen, Lee and Stevenson (1996:750-759) carried out a study investigating the relative contributions of intelligence, previous achievement and family factors to later school achievement in the Chinese, Japanese and American cultures. It was found that there were similar correlations between intelligence and academic achievement for each culture studied. Participants were administered intelligence tests in Grade 1 and their achievement was tested 10 years later in Grade 11. The single most predictive variable for Grade 11 achievement in mathematics, reading and general knowledge was general intelligence. The study found correlations of

between 0.48 and 0.53 for mathematics achievement, between 0.28 and 0.51 for reading and 0.35 and 0.44 for general knowledge. Gagné and St Père (2002:71-100), in a study comparing the predictive values of intelligence, motivation and persistence, similarly found that cognitive abilities were by far the best predictor of school achievement. In this test, it was found that intelligence correlates with an achievement of between 0.36 and 0.56, explaining 13% to 31% of the variance in achievement.

Verbal ability, as measured in intelligence tests, appears to contribute most to achievement in scholastic success. Marais (1992:184-191) carried out a study investigating the prediction of academic achievement in Grade 7, 8 and 9 learners. It was found that verbal intelligence, measured by the New South African Group Test, contributed the most to achievement in English, Afrikaans, Mathematics and Physical Science. Grade 7 learners' verbal intelligence scores were the strongest predictor of their achievement, explaining 62% of the variance in academic performance at school. Grade 8 and 9 learners' verbal intelligence was significantly positively correlated with their academic achievement. The highest correlation obtained for Grade 8 and 9 learners was 0.52 between verbal intelligence and Afrikaans (first language) achievement. A correlation of 0.43 was found between verbal intelligence and English (second language) achievement, and a correlation of 0.40 was found between verbal ability and Science achievement. It can be seen that for Grade 8 and 9 learners, between 16% and 27% of achievement in the above subjects can be accounted for by their verbal ability. Thompson, Detterman and Plomin (1991:158-165) conducted an investigation to ascertain the correlations between different measures of intelligence and achievement in reading, mathematics and general language tasks from Grades 1 to 6. The researchers found that the correlations between verbal ability and achievement were higher than correlations between other measures of intelligence, for example, spatial ability and achievement. Verbal intelligence was measured using the WISC-R Vocabulary test and a verbal fluency test. The correlation of verbal intelligence and achievement in reading was 0.40, in

mathematics 0.32 and in language achievement 0.34. Verbal ability therefore accounted for between 10% and 16% of the variance in achievement. The high correlations found between verbal intelligence and school achievement show that knowledge of the meanings of words, as well as the ability to access associated words in memory quickly, and articulate them fluently, are important in academic achievement at school.

Research carried out during the standardisation of the Senior South African Individual Scale – Revised (Van Eeden 1997a:121) shows significant correlations between the verbal scores and Grade 9 academic achievement. The verbal scale is an indication of verbal intelligence and comprises five subtests. The verbal subtests are:

- Vocabulary, which tests the respondent's knowledge of the meanings of words
- Comprehension, which tests the respondent's ability to understand and express himself or herself in language
- Similarities, which tests the ability to think abstractly
- Number Problems, which test the respondent's ability to solve numerical problems
- Story Memory, which tests short-term auditory memory

The verbal scale score, that is the combined scores of all the verbal subtests, shows significant correlations with the subjects taken at Grade 9 level. The verbal score shows the highest correlations with the language subjects and subjects with considerable language content. A correlation of 0.53 was obtained between the verbal score and English achievement, and a correlation of 0.51 was found between the verbal score and general science. Correlations of 0.48 were obtained in both Afrikaans and history achievement. A correlation of 0.44 was obtained between the verbal score and both geography and mathematics. A slightly lower correlational value of 0.41 was obtained between the verbal score and the subject

accountancy (Van Eeden 1997a:121). The SSAIS-R verbal scale therefore shows consistently significant correlations with academic achievement and predicts between 16% and 28% of the variance in Grade 9 academic achievement.

The abovementioned studies show the importance of verbal intelligence with regard to academic achievement, but the results reveal that other measures of intelligence are also important in predicting scholastic success. In the study carried out by Thompson *et al.* (1991:158-165), spatial intelligence, as measured by a spatial relations test and a hidden patterns test, was found to be a good predictor of scholastic success in reading and mathematics. Spatial intelligence was, however, a less powerful predictor than verbal ability of achievement in the general language area. Spatial ability was found to have a correlation with reading of 0.40, with mathematics of 0.32 and with language of 0.33. In the study carried out by Marais (1992:184-191) it was found that nonverbal factors were important in predicting achievement in mathematics. The total score on the intelligence test, that is, the combination of the verbal and nonverbal intelligence scores, was the strongest predictor for Mathematics in this study. A correlation of 0.36 was found between the total intelligence score and Mathematics, explaining 13% of the variance in achievement. Similarly, the full scale score on the Senior South African Individual Scale – Revised (Van Eeden 1997a:121) was found to have a higher correlation with Mathematics achievement than the verbal score (0.48 as opposed to 0.44). The subject of Accountancy also showed a higher correlation with the full scale score on the SSAIS-R than with the verbal scale score (0.43 as opposed to 0.41). General Science showed equal correlations of 0.51 between achievement and both the verbal scale score and the full scale score. A measurement of the total intelligence of a learner can therefore predict 23% of the variance in mathematics achievement, 18% of accountancy achievement and 26% of achievement in general science in Grade 9. The above results show that the ability to do mathematics, accountancy and general science appears to require the contribution of both verbal and nonverbal abilities.

Nonverbal intelligence alone does not appear to predict scholastic achievement better than either verbal intelligence on its own, or a combination of verbal and nonverbal intelligence. Research carried out using the SSAIS-R (Van Eeden 1997a:121) found that nonverbal scale scores showed correlations of between 0.30 and 0.43 with all the subjects taken at Grade 9 level, accounting for between 9% and 18% of academic achievement. The subject having the highest correlation with the nonverbal scale was found to be mathematics (0.43). This relationship possibly reflects the use of nonverbal intelligence in the high school mathematics syllabus, with its increased visual figural content in geometry, and the measurement of dimension, such as area and volume.

Information processing theories of intelligence emphasise the speed of processing information. The study carried out by Thompson *et al.* (1991:158-165) showed that cognitive processing speed is significantly positively correlated with achievement. Perceptual speed (measured by a test where a specific alphabet letter had to be found amongst other letters), showed correlations of 0.33 with Reading, 0.32 with Mathematics, and 0.36 with Language achievement. In the same study Thompson *et al.* (1991:158-165) found that memory abilities, as measured in tests of the recall of names and faces, as well as a picture memory test had positive, if low, correlations with achievement. The correlation of memory with reading was 0.26, with mathematics 0.22 and with language achievement, 0.22. The memory test was not as strongly related to academic achievement as were verbal intelligence, spatial intelligence and speed of processing. This implies that school learning does not rely that heavily on memorisation of information but rather on more complex language abilities, spatial abilities and the rapid processing of information.

One investigation emerged from the literature study which showed that intelligence is not the most important predictor of academic achievement in university students (Coté & Levine 2000:58-80). In this study, motivation, as measured by the Student Motivations for Attending University (SMAU) Scale,

appeared to be more important than intelligence, showing higher correlations with achievement than intelligence as measured by the Culture Fair Intelligence Test (CFIT). The researchers explain this unusual finding by suggesting that the university system in this study did not engage the brightest students to achieve well but rewarded less bright students who were highly motivated.

The implication of the above studies is that general intelligence can be used as a reliable predictor of academic achievement at school level. General intelligence, however, does not explain all the variance in academic achievement and other factors that play a role. One of these factors is aptitude, or specific intelligence.

### **3.2.2 Aptitude and academic achievement**

The concept of aptitude was described in the previous chapter. Aptitude refers to specific abilities and is tested with a view to the person's future performance should the person obtain additional training in a field (Reber 1995:52).

Specific abilities or aptitudes are related to academic achievement. In a study carried out by Kelly (1999:104), achievement in mathematics was significantly predicted by an arithmetic aptitude test. The Arithmetic Reasoning Test (ART), measuring learners' ability to understand basic arithmetic rules and the application of these rules to solve numerical problems, was found to significantly predict higher grade mathematics marks in secondary school. The ART showed a correlation of 0.29 to 0.65 with higher grade secondary school mathematics marks. The aptitude test, therefore, accounted for between 8% and 42% of the variance in mathematics achievement, with the highest prediction being for Grade 9, Grade 10 and Grade 11 higher grade mathematics achievement.

Aptitude tests administered at school level appear to predict future school performance as well as achievement in tertiary education. In a study carried out by Stumpf and Stanley (2002:1042-1052) it was found that learners' College Board Scholastic Assessment Test (SAT) scores correlated positively with their

graduation from college. The Verbal score on the SAT contributed approximately 40% to the likelihood of a learner graduating from college and the Mathematics score contributed 38%.

Marais (1992: 184-191) carried out an investigation into factors, such as intelligence, aptitude, interest and socio-economic factors, that predict academic achievement during the junior secondary phase of schooling (Grades 7 to 9). The Junior Aptitude subtests showing the highest contributions to achievement in the key subjects of Afrikaans, English, mathematics and science, were the Memory for Paragraphs and Synonyms subtests. The Memory for Paragraphs subtest accounted for between 2% and 8% of the variance in language achievement. Synonyms accounted for between 2% and 5% of the variance in language achievement. Memory for Paragraphs contributed 4% to the variance in achievement of mathematics, with Synonyms contributing 2%. Synonyms accounted for 3% of the variance in science achievement, and the Number Ability subtest contributed 2% to the variance in this subject. According to Marais, a contribution of 1% to the variance in academic achievement can be seen as educationally meaningful. It is therefore clear that the contributions of the aptitude subtests are both statistically and educationally meaningful.

Fouché and Verwey (1994:1-82), in the development of the Senior Aptitude Tests, obtained significant correlations between the aptitude subtests and academic achievement in higher grade subjects in Grades 10, 11 and 12. In Grade 10, the Verbal Comprehension subtest accounted for between 21% and 32% of the variance in first language achievement. The Calculations subtest explained between 21% and 25% of the variance in mathematics achievement. Verbal Comprehension accounted for between 24% and 27% of first language achievement in Grade 11. Mathematics achievement was best explained by the Writing Speed and Verbal Comprehension tests. These two tests accounted for between 9% and 24% of the variance in achievement. In Grade 12, first language achievement was best explained by the Disguised Words and Verbal



Comprehension subtests. These two tests accounted for between 24% and 29% of the variance in achievement. The Calculations and Pattern Completion subtests best explained performance in mathematics, accounting for between 20% and 30% of achievement. The above results show that language comprehension is the most important factor in predicting language achievement in the Further Education and Training phase. Mathematics prediction at this level appears more complex. The Calculations, Verbal Comprehension and Pattern Completion subtests were the most important predictors of mathematics achievement. It appears that mathematics at this level requires many different abilities such as number ability, comprehension of language and nonverbal reasoning.

Verwey and Wolmarans (1983:54-55), during the development of the Junior Aptitude Test, found significant correlations between the subtests and achievement in Grades 7, 8 and 9. In Grade 7, the Reasoning, and Memory for meaningful information, subtests explained between 32% and 39% of the variation in first language achievement. Mathematics achievement was best explained by the Number Ability and Reasoning subtests which accounted for between 40% and 42% of the variance in achievement. The Synonyms subtest accounted for between 40% and 52% of the variation in first language achievement in Grade 8. Mathematics achievement in Grade 8 was explained by the Number Ability and Synonyms subtests, which explained between 29% and 32% of the variation in performance. The highest correlations with first language achievement in Grade 9, were obtained in the Reasoning and Synonyms subtests. The two tests accounted for between 26% and 46% of first language achievement. Verbal reasoning abilities, as well as knowledge of words and their meanings are therefore considered to be important in Grade 9 language achievement. Mathematics achievement was best accounted for by the Number Ability and Memory for paragraph subtests, which explained between 6% and 27% of the variance. The ability to work quickly and accurately with numbers, and the ability to remember meaningful information, can therefore be regarded as important in mathematics achievement in Grade 9. Science achievement was best explained by

the General Reasoning and Number Ability tests of the JAT which explained between 20% and 31% of the variance.

In the development of the Differential Aptitude Test Form S (Vosloo, Coetzee & Claassen 2000:44), the relationship between the aptitude tests and academic achievement of Grade 7 learners only, was measured. The single test showing the highest correlation with overall academic achievement in Grade 7, was found to be the Reading Comprehension test. This test explained 50% of the variance in achievement. The emphasis on the ability to read, not only in the languages and the learning subjects such as History and Geography, but also to read instructions and understand explanations in mathematics and science, appears to be very important in the General Education phase of schooling. Reading Comprehension and Memory abilities each accounted for 43% of the variance in Afrikaans first language achievement. The ability to read with understanding, as well as to remember information is predictably important in first language achievement. English second language achievement variance was best accounted for by Reading Comprehension and the Verbal Reasoning subtest, each explaining 52% of the variance. Reading with understanding, as well as the ability to reason verbally in a relatively unfamiliar language where the learner does not know all the vocabulary and language constructions used, appears important in second language achievement. Mathematics achievement correlated highly with the Computations subtest, which accounted for 41% of the variance in Mathematics achievement. The ability to work quickly and accurately with numbers therefore had a predictable close relationship with mathematics achievement. Reading Comprehension accounted for 41% of the variance in history achievement, with memory abilities accounting for 36%, highlighting the importance of reading with understanding, as well as recalling large volumes of information in this subject. After Reading Comprehension, which accounted for 41% of the variance in geography achievement, verbal reasoning accounted for the greatest variation, 37%. The ability to reason is important in geography, where application of information and problem solving is often necessary. It appears that an

understanding of the figural content of geography, for example contour maps, draws on nonverbal abilities, as significant positive correlations were obtained with the tests for Spatial Visualisation (0.46) and Mechanical Insight (0.53). After Reading Comprehension, which accounted for 40% of the variation in Science achievement, the Nonverbal reasoning subtest accounted for the most variation, 38%. The Comparison subtest, measuring visual perceptual speed, showed the highest correlation with mathematics where the ability to see similarities and differences quickly is important. The Comparison subtest accounted for 6% of the variance in Mathematics. The correlations between the subtests of the Differential Aptitude Test Form S and academic achievement, range from low to high positive correlations. It should be borne in mind that the study was carried out on a selected sample of only 61 Afrikaans speaking learners. Further studies with a more representative sample, is necessary to more precisely predict academic achievement in South African learners.

#### 3.2.2.1 Factors affecting the predictive function of aptitude tests

Certain variables appear to influence the effectiveness of aptitude tests. The period of time that elapses between testing and the measurement of achievement, lower the prediction of students' later performance. In a study carried out by Kruger and Bester (1989: 693-699) only 17,7% of the variance in academic achievement in Afrikaans-Nederlands III at university, was explained by the Senior Aptitude Test and the final matriculation examination combined. The researchers explain that the reason for this may be due to the long period of time between the measurement of aptitude and the measurement of performance in Afrikaans-Nederlands III which took place three, or in some cases, four years later. A similarly low prediction of achievement was found in a study investigating variables contributing to the academic achievement of black Grade 12 students. Van der Westhuizen, Monteith and Steyn (1989:771) found that aptitude, as measured by the Academic Aptitude Test, explained only 15.3% of the variance in achievement in the

matriculation examinations. The researchers in this study maintain that it was difficult to make predictions of achievement in black populations at that time, due to the influence of non-test factors, such as educational disadvantages. Another factor that may play a role in lowering the predictive function of aptitude tests, is an inadequate command of the language in which the aptitude and achievement tests are administered (Huysamen 1999:132-137, Van Eeden, De Beer & Coetzee 2001:171-179).

### **3.2.3 Previous knowledge and achievement**

Meaningful learning, according to Ausubel (Woolfolk 1995:319), takes place when new information is linked to existing knowledge. The learner associates new and existing information, structures the information, and then classifies existing and new information according to rules, so that meaningful conceptual learning takes place (Prinsloo, Vorster & Sibaya 1996:240-241).

The existing conceptual structures that a person has are important, as Bereiter and Scardamalia (Horn *et al.* 1993:464-478) point out. A learner who has high quality previous knowledge in a given area, already possesses hierarchical cognitive structures that allow for the connection of general ideas with factual detail, and this allows for more efficient access at a later time. Bransford, Stein, Vye, Franks, Auble, Mezynski and Perfetto (Horn *et al.* 1993:464-478) maintain that the more knowledge a person has in a certain area, the more able the person is to make accurate, meaningful connections between different concepts, and to "flesh out" the information. If there is no existing conceptual framework into which new information can be classified and integrated, rote learning will take place, new information will be easily forgotten and poor academic achievement will result (Bester 1998:21).

Previous knowledge assists learning by allowing for the rapid assimilation of incoming information into existing conceptual structures. This frees up the

working memory, so that the learner is able to use the new information in, for example, reasoning activities.

Previous achievement can be viewed from a macro-level or a micro-level point of view. Macro-level studies assess achievement at the end of a relatively long period of time, for example, a term or a year of instruction (Bloom 1976: 39). Micro-level studies assess the learning of particular content and skills, which are necessary for the mastery of specific learning tasks. An example of micro-level learning, is the knowledge of how to measure angles with the aid of a protractor in order to calculate the sum of the angles in a geometric diagram. If achievement in general needs to be predicted, macro-level studies should rather be carried out, where achievement is assessed over a year of instruction. Mathematics achievement in Grade 10, therefore, will be predicted from a learner's mathematics achievement in Grade 9 (Bester 1998:21).

Previous knowledge and achievement appear to be strongly related. The correlation between previous achievement (or knowledge that has already been gained), and later achievement becomes higher as the learner progresses through school (Bloom 1976: 39). This shows the importance of an increasing body of knowledge to continued learning and achievement at school.

Bloom (1976:39) points out that learners who do not possess the required previous knowledge for a specific task, will show lower levels of achievement and slower rates of progress than learners who do possess the prerequisite knowledge. Learners who may have had an opportunity to gain the knowledge, but who cannot remember the information or lack the skills to apply the necessary information, will not be able to achieve as well, or as fast as more effective learners.

School learning tasks are often structured in such a way that simple, basic concepts are learnt first, and concepts that are introduced later, are related to and

build on the information learnt earlier. In this situation the most critical tasks are likely to be the early ones in the sequence, since if these are not learned adequately, the student is likely to have great difficulty with all the tasks that follow. As learners move from grade to grade, the deficit in knowledge will become greater, and their level of achievement will continually drop (Van der Lith 1991:74-81).

Knowledge of specific content areas appears to be important in later achievement in related areas of knowledge. Irandoust and Karlsson (2002: 41-48) found that studying Natural and Technical Sciences at high school, played a very important role in academic achievement in the areas of Economics, Statistics, Business Administration and Informatics, at tertiary level. They attribute the important role played by previous learning of these subjects, as being the result of students learning more mathematics, which formed an important part of the courses studied later.

Kelly (1999:100-108) found that mathematics knowledge acquired by the end of Grade 9, was strongly related to mathematics achievement in Grades 10, 11 and 12. Previous knowledge was assessed by measuring mathematics performance on an achievement test, the Initial Evaluation Test in Mathematics (IET), as well as noting the learners' marks in mathematics at school. Kelly found that learners' mathematics marks at the end of Grade 9, were the best predictors of later Higher Grade mathematics achievement at school, in Grades 10-12. Their marks showed high to very high positive correlations with later mathematics achievement, between 0.67 and 0.83. The IET also showed significantly high correlations with Higher Grade Mathematics, between 0.60 and 0.84.

Previous knowledge, when studied across countries, has been found to influence subsequent achievement. Children in Japan and China, for example, know a great deal more mathematics than American children and perform better in tests of mathematics knowledge than do American children (Neisser *et al.* 1996:77-101).

Across cultures, the importance of previous knowledge to later achievement seems clear. Chen *et al.* (1996:750-759) found that previous knowledge, assessed in Grade 1, accounted for between 27% and 47% of the variation in mathematics achievement in American, Chinese and Japanese learners when they were assessed 10 years later, in Grade 11. In this study, the variation in reading achievement seemed less dependent on previous reading performance. Reading in Grade 1 accounted for between 6% and 18% of the variation in later reading achievement. Overall, in this investigation, which assessed also learners' general knowledge, it was found that between 38% and 51% of the variability of achievement in Grade 11, could be accounted for by measures obtained when the learners were in Grade 1.

Van der Westhuizen *et al.* (1989:769-773) conducted a study of variables affecting the academic achievement of black students. They found that 22.9% of the variance in Grade 12 was accounted for by achievement in Grade 10. Previous achievement explained more of the variance in this study than did aptitude measurements.

Previous knowledge has been found to be important in predicting whether a student will be successful in tertiary study. Stumpf and Stanley (2002:1042-1052) carried out a study in which they found that high Grade Point Averages obtained at high school contributed 24% to the likelihood that a student would graduate from college. Kanoy, Wester and Latta (1989:65-70) found that high school achievement together with academic self concept predicted 56% of the variance in first year college achievement. Unfortunately the predictive values of the individual variables are not given. Kruger and Bester (1989:693-699), however, found that Grade 12 matriculation results contributed very little, only 3.96%, to the achievement of university students in Afrikaans-Nederlands III. They attributed this lack of predictive power to the long period of time which elapsed between the testing in Grade 12, and the testing at the end of the Afrikaans-Nederlands III course, some three or four years later.

Horn *et al.* (1993:464-478) found that domain knowledge was not significantly related to academic achievement even though it accounted for 11% of the variance in achievement in the sample. The researchers pointed out that the lack of predictive power of domain knowledge in this study may have been due to the small size of their sample which required the effects of the independent variable to be large to reach significance. Additionally, this finding may indicate that previous knowledge may not be necessary for academic achievement in certain types of courses, especially entry level courses. General experience may have been an adequate preparation for the tasks the students needed to learn in this study.

Previous knowledge can account for between 22.9% and 68% of the variance in later achievement. A high predictive value was obtained for mathematics achievement which by its nature is heavily sequenced and dependent on the establishment of previous knowledge, in order for further learning to take place. In some areas of achievement it appears that previous knowledge may not be a condition for later achievement.

### **3.3 AFFECTIVE FACTORS**

Psychological processes do not occur in isolation. When a person thinks, his or her physical body, emotions, expectations, will, attitudes, moral and spiritual beliefs as well as social influences contribute to those thoughts (Du Toit & Kruger 1993:28). The learner, therefore, who approaches a learning task, does so as a psychological whole, with many variables influencing his or her learning and ultimate level of success.

The learner characteristics which most influence academic achievement other than cognitive factors are affective or emotional characteristics (Bloom 1976:73-74). Bloom maintains that a psychological state of emotional preparedness is necessary for a learning task. He does not explicitly define this concept but it can be deduced,



that a state of emotional preparedness is present when a learner is interested in a subject, has a favourable attitude towards it, is motivated to learn and views himself or herself as being capable of completing work in that subject. If the student is emotionally prepared to learn, learning should be easier, quicker and a higher level of academic achievement will be attained. This emotional preparedness may vary from subject to subject.

Bloom identifies the following affective factors as having the most influence on learning: desire to learn (or motivation), fear, attitudes, self views and interest. The above factors have been extensively researched with regard to education and two of the most important will be discussed in this chapter, namely self-concept and motivation.

### **3.3.1 Self-concept**

Shavelson, Hubner and Stanton (1976:407-441) proposed the first comprehensive model of the self-concept. The model represents the self-concept as multifaceted and hierarchical. Perceptions of personal behaviour in specific situations are at the base, inferences about the self in broader domains (for example, social, physical and academic) in the middle of the hierarchy, with the global or general self-concept at the top. Byrne and Shavelson (1986:474-481) found empirical evidence for this model. According to them the self-concept comprises the totality of a person's self-perceptions. It shows stability but is open to change as one moves down the hierarchy (Marsh & Shavelson 1985:107-123). Lower in the hierarchy, the self-concepts formed, are more dependent on situation-specific experiences, and therefore the self-concepts at that level are less stable. The self-concept is both descriptive and evaluative, containing information describing the self (I am a girl, I have long hair) and information evaluating the self (I do well in Mathematics, I am a person of worth) (Schmidt & Padilla 2003:37-46).

### 3.3.1.1 Relative importance of specific and global self-concepts

The relative contribution of a specific component of the self-concept, to the global self-concept, is dependent on how important the component is to a particular individual. An adolescent, for example who considers his academic self-concept as being important, will experience an improvement in his global self-concept if he does well in a History test. His global self-concept will not be substantially lowered, however, if the physical ability component of the self-concept is not an important one to him and he is not selected for the rugby team.

### 3.3.1.2 Academic self-concept

Initially it was assumed that learners' experiences in different subjects at school combined to form one academic self-concept, which Bracken (1996:290) referred to as the view of the self with reference to scholastic competence. Later research has pointed to the verbal and mathematics self-concepts being nearly uncorrelated. It appears that the two self-concepts do not combine to form one academic self-concept, but rather two second-order academic factors, a verbal academic factor and a mathematics academic factor (Marsh & Shavelson 1985:107-123; Marsh 1990a:623-636). The term "academic self-concept" (or scholastic self-concept) is widely used in the literature, however, and when used, it can be seen to refer to both the verbal and mathematics self-concepts.

The internal/external reference model was developed to explain the relationship between different academic self-concepts (Marsh & Yeung 2001:389-420). Students base their self-concepts on two simultaneous comparison processes. An internal comparison occurs when an individual student appraises his or her ability in one academic domain, for example mathematics, in comparison to his or her ability in other academic areas. The external comparison is the student's evaluation of his or her competence in a specific academic domain, relative to the perceived

ability of peers. Therefore, a student's self-concept in mathematics is derived from his perceived mathematics competence relative to his or her competence in other subjects, as well as from an evaluation of his or her mathematics competence relative to that of his or her peers.

#### 3.3.1.3 Self-concept and achievement

The model proposed by Shavelson *et al.* (1976:407-441) discussed above holds that actual performances at the base lead to overall inferences about the self at the top of the hierarchy. For example, self-perceptions of mathematical ability "cause" positive self-views of mathematics academic competence, which in turn foster a positive global self-concept. Recent research does support the assertion that academic achievement causes the formation of the academic self-concept (Schmidt & Padilla 2003:37-46). However, it appears that the self-concept also influences subsequent achievement (Marsh 1990b: 646-656). In the study by Marsh, academic self-concept in Grade 10 was found to significantly affect later academic achievement and accounted for between 5% and 14% of the variance in achievement in Grades 11 and 12. In this study, prior achievement had no effect on subsequent measures of academic self-concept. Therefore it appears that a reciprocal interaction occurs between self-concept and achievement. In a recent study carried out by Marsh, Hau and Kong (2002:727-763) evidence was found for this relationship between self-concept and achievement. Among high school students, previous self-concept influenced subsequent achievement, while prior achievement had effects on subsequent self-concept as well. There was a correlation ranging from 0.22 to 0.25 between these two variables.

The more specific to an area of achievement a self-concept is, the more closely related it is to that achievement. General self-concept is positively related to academic achievement (Hansford & Hattie 1982:123-142; Coover & Murphy 2000:125-147) showing correlations ranging from 0.21

to 0.27. Global self-concept can therefore be seen to account for between 4% and 7% of the variance in scholastic achievement. Marsh (Bracken 1996:301) found that subject-specific self-concepts have a higher correlation with matching subjects than general self-concept and scholastic achievement. This finding is supported by recent research carried out by Koutsoulis and Campbell (2001:108-127). These studies show that English self-concept has a correlation with English subject achievement of between 0.39 and 0.42, explaining up to 18% of the variance in English achievement. The relationship between mathematics self-concept and mathematics achievement was found to be between 0.33 and 0.58, explaining up to 34% of the variation in achievement in that subject.

The inverse relationship between learners' English and mathematics self-concepts was shown in a study of Grade 11 girls carried out by Marsh and O'Niell (Marsh & Shavelson 1985:107-123). It was found that English achievement was negatively correlated with mathematics self-concept and mathematics achievement was negatively correlated with English self-concept. A recent study of gifted high school learners, who would be expected to have high self-concepts in all areas due to their general high achievement, supported this finding (Plucker & Stocking 2001:534-548).

### **3.3.2 Motivation**

Motivation refers to the inner state that arouses, directs and maintains behaviour (Woolfolk 1995:330). Motivation may be seen as a temporary state of having energy to move towards a specific goal, or it may be seen as an enduring trait which is necessary for the individual's continuing psychological development. Gouws and Kruger (1994:5) refer to motivation in the child as involvement which is characterised by an inherent, inner drive to attain maturity which involves perseverance and commitment. A motivated learner is one who shows an openness to learning, is willing to give attention, participate in the learning events and to complete learning tasks.

### 3.3.2.1 Motivation and personality theories

#### 3.3.2.1.1 Behavioural view of motivation

Behaviourists emphasise extrinsic reinforcement for behaviour in the form of reinforcers, rewards, incentives and punishment (Meyer, Moore & Viljoen 1993:187-188). The learner who is motivated extrinsically, will focus his or her attention, persist with the activity and reach goals because he or she seeks to obtain a good mark for his or her efforts, or to avoid being punished by teachers or parents for not completing school tasks. If the learner is praised or given other forms of positive recognition, such as stars or good work stamps for doing his or her schoolwork, he or she is more likely to develop a tendency or a habit of carrying out such behaviours in the future (Bester 1998:26).

#### 3.3.2.1.2 Humanistic view of motivation

According to the humanistic view motivation does not have an external source, but an intrinsic cause. According to this view, people are continually motivated to satisfy the needs that are situated within them (Bester 1998:27).

An example of the humanistic view, is the theory of Abraham Maslow. He maintained that people were driven by an inner need to fulfil their potential. An important aspect of his theory is the description of a need hierarchy, where physiological needs, such as the need for food and physical safety, are situated at the bottom of the hierarchy. "Growth" needs such as the need to understand the environment, and the need for personal growth are situated at the top of the hierarchy. Maslow is of the opinion that the lower needs have to be satisfied first, before needs at the top of the hierarchy can develop and be fulfilled (Woolfolk 1995:341). The learner who is motivated to do his or her schoolwork is seen as a person whose needs

lower in the hierarchy have been met, and who is then driven by a need to know and understand his or her environment.

The need to have control over the environment influences learners' scholastic achievement. Deci, Vallerand, Pelletier and Ryan (1991:28) and Ramseier (2001:421-439) state that people have a need to be in control of the environment in which they live. The more learners are able to determine for themselves, the course and type of learning they will do, the more motivated the learners will be.

#### 3.3.2.1.3 Cognitive view of motivation

The cognitive view sees motivated behaviour as resulting from a person's thoughts, plans, expectations and attributions (Woolfolk 1995:334). The learner is motivated not by responding to external events or internal needs, but by interpreting the stimuli around him or her, including what he or she learns at school (Bester 1998:28).

Attributions refer to the thoughts one has about the reasons for behaviour (Beck 2000:452). A learner's attributional style affects his or her motivation and achievement at school. A learner may attribute his or her success at school to high ability or effort, and is therefore more likely to expect that he or she will achieve future success, through continuing or greater expenditures of effort (Eccles & Wigfield 1995:215-225). Learners who attribute their achievement to an external cause, such as luck or an easy test, are not likely to believe that they can succeed in future, and will therefore be less motivated.

The expectation of success for an activity, identified as self-efficacy by Albert Bandura (Meyer, Moore & Viljoen 1993:232), may be an important precondition for a learner to take the risk to learn new information. If an individual feels confident in his or her ability to perform an activity, his or

her self-efficacy for that activity will be high and he or she will most likely carry out the activity. If the individual's self-efficacy for an activity is low, he or she will avoid carrying out that activity, and will be inclined to select another situation in which he or she expects to be successful.

Learners' beliefs influence the type of goals they have regarding their scholastic achievement. Three main types of goals that motivate student behaviour are learning or mastery goals, performance goals and avoidance goals (Martin & Marsh 2003:31-38). To improve learning or achieve mastery of a task, students pursue learning goals and can be described as having a task orientation. Learners pursue performance goals if their primary aim is to show evidence of their ability in comparison to other learners. Such learners can be described as having an ego orientation. Avoidance goals are chosen by students who do not believe that they have the competency to achieve, and they focus only on avoiding failure. They emphasise the minimum requirements needed to pass, and they limit their efforts to achieving only that minimum.

### 3.3.2.2 Motivation and achievement

The learner with high levels of intrinsic motivation, rather than the learner who is motivated by external rewards, is more likely to achieve well at school. Fortier, Vallerand and Guay (1995:257-274), Monteith (1988:23-34) and Ramseier (2001:421-439) found positive relationships between intrinsic motivation and scholastic achievement. Intrinsic motivation in these studies was found to account for between 3% and 28% of the variance in scholastic achievement.

An internal locus of control is significantly associated with academic achievement (Ross & Broh 2000:270-284; Elliot, Hufton, Illushin & Lauchlan 2001:38-68). In the study carried out by Ross and Broh, it was found that there

was a correlation of 0.07 between locus of control measured in Grade 10, and academic achievement in Grade 12.

Motivation to obtain high marks was found to play an important role in explaining student behaviour towards academic achievement. Sideridis (2001:277-288) as well as McCoach and Siegle (2003:144-154) found that a strong emphasis on gaining high grade point averages, was the main reason why learners achieved. It was found that the motivation to obtain high marks led to student behaviour such as complying with teachers' expectations and effective study behaviour.

Maata, Stattin and Nurmi (2002:31-46) carried out a study to identify the relationship between different attributional styles and achievement among learners aged 14 to 15. They identified two groups of students who achieved well at school and who showed the following motivational characteristics: high expectancies for success and low levels of task-avoidance. The students who did not achieve well at school had higher expectations of failure and avoided tasks.

Elliot, Hufton, Illushin and Lauchlan (2001:38-68) as well as Schultz (1997:193-102) found that the valuing of education as a goal in itself was associated with scholastic achievement. In an international study comparing motivational characteristics and achievement of school learners, these researchers found that obtaining an education was seen as valuable by Russian children, resulting in higher levels of motivation for scholastic achievement.

Students in Grades 10, 11 and 12 with strongly held educational goals, such as the intention to obtain their high school qualification, tended to be higher achievers than students who did not place a high value on this goal (Schultz 1997:193-102). A correlation of 0.31 between having educational goals and academic achievement was obtained in this study. The presence of educational



goals, therefore, accounted for approximately 10% of the variance in academic achievement.

Both a task and performance goal orientation, have been found to have a positive relationship to academic achievement (Tanaka & Yamauchi 2001:123-135; Bouffard, Boileau & Vezeau 2001:589-604). Mastery goals were found to explain 11% of the variance in academic achievement and performance goals were found to predict 1.3% of achievement. These results were confirmed by Vrugt, Oort and Zeeberg (2002:385-397). They found that task orientation led to beliefs of self-efficacy, which led to the setting of goals of marks to be achieved, which in turn, led to high achievement results. A study carried out by Leondari and Gialamas (2002:279-291) found a correlation of 0.52 between beliefs of self-efficacy and achievement, accounting for 27% of academic achievement.

Subject self-efficacy was found to better predict achievement in a particular subject than general beliefs of self-efficacy. Bong (2002:133-162) found that there was a correlation of 0.33 between English self-efficacy and English achievement, while mathematics self-efficacy showed a correlation of 0.27 with mathematics achievement. Self-efficacy beliefs for English therefore explained 11% of the variance in achievement, and mathematics self-efficacy explained 7% of the variation in mathematics achievement. Bouffard, Goileau and Vezeau (2001:589-604) found that self-efficacy beliefs for French predicted 10% of the variance in French achievement in Grade 6 and predicted 9.8% of the variance in the first year of secondary school.

An important study, given the many South African learners who come from disadvantaged backgrounds, was carried out by Gordon-Rouse (2001:461-472). He found that disadvantaged, but resilient, students who achieved well at high school, showed a positive "robust" motivational pattern. They had strong

positive beliefs about their cognitive abilities, and were highly confident that they would receive sufficient support from their environment.

Motivation also contributes indirectly to scholastic performance. An expectancy of success in a task encourages learners to select effective study strategies (Horn *et al.* 1993:464-478; Manstead & van Eekelen 1998:1375-1392). Study strategies or techniques form a part of a student's study orientation.

### **3.4 STUDY ORIENTATION**

A learner's study habits and study techniques influence how effectively he or she achieves academically (Bester 1998:36). The learner makes learning content understandable and useful by, for example asking questions in class, making sure that instructions to tasks are read and understood and completing homework timeously. At high school level learners are taught by different teachers and the quality of teaching from one teacher to another can differ substantially. Learners need to be able to compensate for a teacher's poor teaching, or the lack of adequate learning opportunities, in order to master the work. Learners do this by developing effective study habits and techniques to ensure that they are able to master the work despite the lack of teaching support given in class. Learners have different aptitudes for different subjects. They will therefore have to develop highly effective study habits in subjects in which they have less ability, in order to achieve a desired achievement level (Bester 1998:34).

Study habits refer to acquired behaviour patterns in a study environment. Time management is an important habit to aid study. Learners who are unable to settle down to study and who take opportunities to busy themselves with other activities, have underdeveloped study habits. This is in contrast to the learner who dutifully studies according to a set timetable (Coe & Sarbin 1984:6).

Study techniques refer to specific strategies that a learner applies to make learning content understandable and to improve the retention of the information. Eggen en

Kauchak (1994:385-386) identify underlining, note-taking, summaries and visual diagrams as typical study techniques which learners use. Underlining is effective, as highlighting learning content shows that the learner is actively deciding what is more or less important. Note-taking, in the form of making margin notes and identifying key words, helps the learner to structure his or her long-term memory. Summaries have the advantage that the learner attaches meaning to the content, identifies important aspects and formulates the content in his or her own words. The summing up of much of the information to be learnt is helpful as it allows the release of mental resources to integrate other incoming information. Hierarchical diagrams, network diagrams, sketches, maps and other diagrams help the learner to form a global picture of the content, and to entrench it in the long-term memory.

There are comprehensive study strategies which combine different study techniques. In this way, steps are identified which can be followed to master the learning content. Six steps can be identified in the SQ4R, one of the most well known study strategies:

- Survey (overview of the learning content)
- Question (pose questions about the learning content)
- Read (read the learning content with the questions in mind)
- Reflect (think about what has been read and link it with existing knowledge)
- Recite (try to answer the questions)
- Review (repeat the difficult parts)

(Eggen & Kauchak 1994:387)

The advantage of an effective study method lies in the fact that it often fits better with the cognitive and affective characteristics of the learner than teaching in the classroom situation (Bester 1998:35).

### **3.4.1 Study orientation and achievement**

Study habits and appropriate study techniques are important in high school students as they, more than primary school learners, are faced with increased

volumes of work to be mastered and an increased demand for independent study skills.

Thombs (1995:280-288) found that poor study habits made students more likely to drop out of college or to achieve poorly in their academic courses. Individuals who do drop out of school, but who subsequently graduate from high school through an alternative route, were found to be more likely to have good study habits, to complete their homework timeously and to watch little television on weekdays (Suh & Suh 2006:11-20).

The research literature shows that the following study habits and techniques are positively associated with achievement at school:

- selecting important concepts
- organising and summarising information
- finding definitions
- using examples and diagrams
- using headings
- reading skills
- rehearsal of important information
- sticking to a study schedule
- using facts learnt at school to help understand events outside of school

(Mäkinen & Olkinuora 2004:477-491; Jakubowski, Terrance & Dembo 2002:1-53; Wilhite 1990:696-700, Lammers, Onwuegbuzie & Slate 2001:71-81; Elliot, Godshall, ShROUT and Witty 1990:203-207; Yip and Chung 2005:61-70; Kovach, Fleming and Wilgosh 2001:39-49; Horn *et al.* 1993:464-478).

The above studies found that study habits and techniques accounted for between 4% and 13% of the variance in scholastic achievement. The study by Lammers,

Onwuegbuzie and Slate (2001:71-81) explained the greatest variance in achievement by using a standardised study habits inventory. Note-taking, good time-management, and study techniques, such as applying information to other subjects and events outside the school environment, were measured by this instrument.

Rau and Durand (2000:19-38) found that students who spent considerable time on their studies and who studied consistently throughout the year achieved well academically. These students studied on weekends and in the evenings, and did not cram before tests and exams in an effort to raise their marks. The researchers found a correlation of 0.24 between this way of studying and the achievement of college students, explaining 6% of the variation in achievement.

Cooper, Lindsay, Nye and Greathouse (1998:70-83) found that students from Grade 6 to 12 who regularly completed their homework, achieved higher grades than those who did not. Their completion of homework explained between 2% and 10% of the variance in their performance on standardised and teacher administered tests.

The above research illustrates that good study habits and study techniques can account for up to 13% of the variation in academic achievement. An effective study orientation was found also to have beneficial effects on learners remaining in school and ultimately graduating from school. Study orientation is, therefore a significant variable when considering academic achievement, although it is not one of the most important variables. It cannot be ignored, however, and should be taken into account in a model which attempts to predict academic achievement.

### **3.5 CONCLUSIONS**

This chapter dealt with factors which are related to academic achievement. In section 3.2.1 it was stated that academic achievement is the result of activities such as

thinking, learning and problem solving. The predominance of these cognitive activities in school work points to intelligence, specific aptitudes and previous knowledge as being the most important variables affecting academic achievement. General intelligence, and especially verbal ability, was found to be the most significant variable affecting academic achievement. The reason why language abilities are important becomes clear when the great extent of language usage in the classroom is considered. Specific aptitudes appear to contribute significantly to scholastic achievement, with tests of reading comprehension showing the highest correlations with the many different subjects at school level. Previous knowledge and scholastic achievement are shown to be strongly related in subjects that are strictly sequenced, and where prior learning contains basic concepts essential for later learning.

A state of emotional, or affective, preparedness was referred to in section 3.3 as being important in the learning process, in addition to cognitive factors. Affective factors and academic achievement have been the subject of a considerable amount of research carried out recently. The most important affective variables appear to be the learner's subject-specific self-concepts, and his or her motivations for learning. Study habits and techniques were found to additionally explain a portion of the learner's academic achievement.

It is clear from the literature that one variable does not adequately explain the variation in achievement. A combination of variables explains a greater proportion of the variation in achievement than a single variable can do. In addition, the combination of variables can differ from subject area to subject area and from grade to grade, which makes a uniform prediction model an impossibility. For this reason this study focuses on Grade 9 school learners and achievement.

An empirical investigation was carried out, firstly to establish the relationships between intelligence and aptitude. Secondly, the relationships between scholastic

achievement and certain cognitive variables, affective variables and study orientation were determined. The empirical investigation will be discussed next.

## **CHAPTER 4**

### **EMPIRICAL INVESTIGATION**

#### **4.1 INTRODUCTION**

In this chapter the course of the empirical investigation will be described. As was stated in Chapter 1 (section 1.3), the purpose of the empirical investigation was firstly, to determine the relationship between intelligence and aptitude and secondly, to determine the relationships between academic achievement at Grade 9 level and certain cognitive variables, affective variables and study orientation. These variables were measured in order to use aptitude scores to predict intelligence and scholastic achievement.

In order to achieve the research aim as stated above, a representative sample was selected of typical Grade 9 learners. Information about the final sample, as well as the way in which the sample selection was carried out, will be discussed in this chapter.

Appropriate instruments were chosen to measure the variables that affect academic achievement at school level. A discussion of these instruments will be undertaken in this chapter as well as an explanation of the reasons for choosing them.

Hypotheses regarding the relationship between the variables were formulated which will be discussed in the next section.

#### **4.2 HYPOTHESES**

The purpose of the empirical investigation is to, amongst other things, statistically test the hypotheses regarding the use of measures of aptitude to predict intelligence and academic achievement at school level. In the light of the completed literature study it is possible to formulate the following hypotheses:



## Hypothesis 1

*There is a significant positive correlation between intelligence and aptitude, as measured with the Differential Aptitude Test Form S (DAT-S).*

### Rationale

Intelligence, or *g*, is a factor common to all tests of complex problem solving (Fouché & Verwey 1994: 55). The construct, general intelligence usually refers to those cognitive abilities used in a person's intellectual functioning across different contexts, while specific abilities are required only in a certain context. The relationships between specific abilities and general intelligence were described by Carroll (in Berk 2000:319) using psychometric analysis. He developed a three-stratum, pyramid structure of intelligence which shows that some specific abilities are strongly related to general intelligence, such as sequential reasoning, while others are less strongly related to *g*, for example perceptual speed.

In section 2.7 it was stated that there is strong evidence for the presence of a general cognitive ability in the different subtests on the Differential Aptitude Test (Owen 2000:46-48). It is therefore likely that the Differential Aptitude Test measures general intelligence as well as specific abilities. When two variables are strongly related, it becomes possible to use one to predict the other. In this study aptitude measures were used to predict intelligence. Both of the previously developed aptitude tests, the Junior Aptitude Test (Verwey & Wolmarans 1983:71) and the Senior Aptitude Test (Fouché & Verwey 1994: 55), made use of the relationship between aptitude and intelligence to estimate intelligence from aptitude measures. The correlation of the estimated intelligence score obtained from the Junior Aptitude test with the New South African Group Test intelligence score is 0.80, indicating a very high positive relationship between the two constructs (Verwey & Wolmarans 1983:71).

## Hypothesis 2

*There is a significant positive correlation between the aptitude subtests of the DAT-S and achievement in different school subjects.*

### Rationale

The literature study revealed that significant positive correlations have been found between aptitude tests and achievement in the key subjects of English, Afrikaans, Mathematics and Science, as well as in learning subjects. First language achievement at Grade 9 level showed moderate to high positive correlations of between 0.53 and 0.68, with the Synonyms and Reasoning Junior Aptitude subtests (Verwey & Wolmarans 1983:54-55). Achievement in a second language had moderate positive correlations of between 0.47 and 0.55 with the Reasoning subtest. Correlations ranging from 0.51 to 0.52 were obtained between the Number Ability subtests of the JAT and Mathematics achievement (Verwey & Wolmarans 1983:54-55). Science achievement showed moderate correlations with the Reasoning and Number Ability subtests (0.46 and 0.56 respectively). The Reasoning and Number Ability subtests, as well as the 3D Spatial Ability subtest, revealed moderate positive correlations ranging from 0.45 to 0.57 with History and Geography achievement. Marais (1992:184-190) also investigated the relationship between the Junior Aptitude subtests and academic achievement at Grade 9 level. The Synonyms subtest showed moderate to high correlations not only with language achievement in English (0.60) and Afrikaans (0.54), but also with Science achievement (0.51). A study carried out by Kelly (1999:104) focusing only on Mathematics achievement, showed that the Arithmetic Reasoning test (a Mathematical aptitude test) had a correlation of between 0.29 and 0.65 with higher grade secondary school Mathematics marks.

## Hypothesis 3

*There is a positive correlation between affective variables and scholastic achievement.*

## Rationale

Affective variables, such as self-concept and motivation, were found to have a relationship with learners' achievement. General self-concept shows positive correlations ranging from 0.21 to 0.27 with academic achievement (Hansford & Hattie 1982:123-142; Coover & Murphy 2000:125-147). The more specific academic self-concept shows higher correlations with scholastic achievement than general self-concept (between 0.22 and 0.38) (Marsh 1990: 646-656; Marsh, Hau & Kong 2002:727-763). Subject-specific self-concepts have the highest correlations with achievement in matching subjects. Koutsoulis and Campbell (2001:108-127) found that English self-concept had a correlation with English subject achievement of between 0.39 and 0.42. The relationship between Mathematics self-concept and Mathematics achievement was revealed to be between 0.33 and 0.58.

Motivation has a positive relationship with scholastic achievement (Monteith 1988:23-34). Fortier, Vallerand & Guay (1995:257-274) and Ramseier (2001:421-439) found positive relationships between intrinsic motivation and scholastic achievement ranging from 0.13 to 0.40. Extrinsic motivation also plays a role in academic achievement. Sideridis (2001:277-288) as well as McCoach and Siegle (2003:144-154) found that a strong emphasis on gaining high marks led to student behaviour such as complying with teachers' expectations and effective study behaviour which in turn led to high school achievement. A correlation of 0.31 was found between holding educational goals, such as the intention to obtain a high school qualification, and academic achievement (Schultz 1997:193-102). The motivational variable of subject self-efficacy was found to predict achievement in a particular subject. Bong (2002:133-162) established that there was a correlation of 0.33 between English self-efficacy and English achievement, while Mathematics self-efficacy showed a correlation of 0.27 with Mathematics achievement. Bouffard, Goileau & Vezeau (2001:589-604) determined that self-efficacy beliefs for French predicted 10% of the variance in French achievement in Grade 6 and predicted 9.8% of the variance in the first year of secondary school. Both a task and performance goal

orientation, have been found to have a positive relationship with academic achievement (Tanaka & Yamauchi 2001:123-135; Bouffard, Boileau & Vezeau 2001:589-604). Mastery goals explained 11% of the variance in academic achievement and performance goals predicted 1.3% of achievement. A study carried out by Leondari and Gialamas (2002:279-291) found a correlation of 0.52 between beliefs of self-efficacy and achievement, accounting for 27% of academic achievement.

#### Hypothesis 4

*There is a positive correlation between study orientation and scholastic achievement.*

#### Rationale

A survey of the literature revealed that effective study habits and techniques are positively related to academic achievement. Research has shown that study habits and attitudes account for between 4% and 13% of the variance in scholastic achievement (Lammers, Onwuegbuzie & Slate 2001:71-81; Kovach, Fleming & Wilgosh 2001:39-49). The study by Lammers, Onwuegbuzie and Slate (2001:71-81) revealed a correlation of 0.36 between good study habits and academic achievement and explained the greatest variance in achievement, using a standardised study habits inventory. Note-taking, good time-management, and study techniques such as the application of information to other subjects and events outside of school were important in predicting high achievement. Rau and Durand (2000:19-38) found that students who spent considerable time on their studies and who studied consistently, achieved well academically. The researchers reported a correlation of 0.24 between this way of studying and academic achievement. Regular completion of homework accounted for between 2% and 10% of the variance in scholastic performance of Grade 6 to 12 learners (Cooper, Lindsay, Nye & Greathouse 1998:70-83).

## Hypothesis 5

*A combination of variables explains more of the variance in achievement than any variable on its own.*

### Rationale

A combination of different variables will explain more of the variance in scholastic achievement than any one variable on its own (Marais 1992:184-191). Studies measuring the effects of not only cognitive factors but also affective factors and other variables, such as study habits and attitudes, have accounted for a greater amount of variance in achievement than any variable on its own (Horn, Bruning, Schraw, Curry & Katkanant 1993:464-478). These researchers developed a path model to establish the contributions made by intelligence, previous knowledge, motivation and study habits to academic achievement. They found that 21% of the variance was explained by intelligence, while a further 11% was explained by previous knowledge. The researchers suggest that an additional 3% of the variance in achievement can be ascribed to motivation variables and effective study strategies. The above variables taken together, accounted for a total of approximately 35% of the variance in achievement.

Chen, Lee and Stevenson (1996:750-759) conducted a long-term study to predict achievement at school. They measured learners' intelligence and previous performance. Included in the study were demographic factors and the effects of home environment as predictive variables. The researchers found that intelligence accounted for between 8% and 28% of the variance in school achievement in Grade 11. The combination of intelligence with previous knowledge, however, accounted for up to 47% of the variance in Grade 11 achievement. Previous knowledge may be influenced by a whole range of factors, such as specific aptitudes for a subject, affective factors, study habits and quality of instruction on the part of the teacher. Demographic factors and the influence of home environment did not have direct effects on achievement.

### **4.3 RESEARCH DESIGN**

The research design that was used to test the stated hypotheses will be discussed below. The discussion includes a description of the sample, the measuring instruments and the research procedure.

#### **4.3.1 Sample**

Grade 9 learners were selected for the study for the following reasons:

- a) The completion of Grade 9 marks the end of the General Education and Training Band when learners are legally allowed to leave school. The possibility of estimating further academic achievement from measures obtained in Grade 9 will enable learners and their parents to decide whether it would be advantageous for the learner to remain in school, to enter another training institution or to enter the job market.
- b) The use of an aptitude test in Grade 9 can provide guidelines regarding the selection of subjects for Grade 10.
- c) Grade 9 learners have had a year's experience of the secondary school environment. Factors, such as excessive anxiety due to learning new rules and routines, might not affect the research process.

Learners were selected in the province of Mpumalanga. Two circuits within the Middelburg area were randomly chosen and one school from each circuit was selected. The learners are representative of the diverse cultural population of South Africa, including European, African, Indian and Coloured learners. Girls comprised sixty percent of the sample and boys, forty percent. Table 4.1 shows the composition of the sample according to gender and language.

TABLE 4.1: COMPOSITION OF SAMPLE ACCORDING TO GENDER AND LANGUAGE

	English	Afrikaans	African	Other	Total
Boys	16	2	5	1	24
Girls	22	4	10	0	36
Total	38	6	15	1	60

A selection process had to be carried out to identify learners whose English language proficiency was good enough for the aptitude test results to be valid. The test developers state that learners have to score in the average range or higher on the Vocabulary test (Test 1) of the Differential Aptitude Test for the results of the DAT to be valid (Vosloo, Coetzee & Claassen 2000:39). This proved to be a challenge as many learners who completed the test obtained a stanine of 3 or lower in Test 1, showing a below average level of English vocabulary development.

A total of 60 learners met the requirements of the Vocabulary test and were, therefore selected for the study.

The size of the sample satisfies statistical requirements which allow for the results of the study to be applied to the population of Grade 9 learners. Howell (1992:498) states that in order to obtain a relatively unbiased estimate of the relationships of the variables in the total population, it is necessary for the number of individuals in the sample to exceed the number of independent variables in the study by 40 to 50. In the current study, there are 13 independent variables: the 9 aptitude subtests of the DAT-S, self-concept, motivation, study orientation and age (calculated in months). According to the above guideline, the number of learners in the sample

should not have been fewer than 53. Therefore the sample size of 60 learners is satisfactory.

The sample contains some learners who are older than the normal age of a learner in Grade 9, which is 14 years turning 15. The reason for this is that in South Africa learners are retained in a grade if they have not sufficiently mastered the academic content of a year. The oldest learners, however, were not older than 16 years 11 months as this is the maximum age provided for by the norm tables of the Senior South African Individual Scale – Revised.

#### **4.3.2 Measuring instruments**

A range of tests were used in this study as several different variables had to be measured.

##### **4.3.2.1 Intelligence**

The Senior South African Individual Scale – Revised (SSAIS-R) (Van Eeden 1997b:1) was used to measure intelligence. It is a deviation IQ scale where the individual's scores are compared with the test performance of others in the same age group. The aim of the SSAIS-R is to obtain an indication of a learner's general intelligence as well as to determine relative strengths and weaknesses in cognitive functioning. As was shown in Chapter 3 (section 3.2.1), the level of a learner's general intelligence accounts for the largest proportion of the variability in scholastic achievement. Verbal and nonverbal factors were also shown to predict performance in certain subjects. The SSAIS-R was released in 1997 and is standardised for South African pupils from the ages of 7 years 0 months to 16 years 11 months.

The standardisation of the English version of the SSAIS-R was carried out with a sample of learners who had English as their



mother tongue. Some of the learners in the current study do not speak English as a home language, but since the learners receive their education in English, it was decided to use the SSAIS-R. The measurement of a learners' intelligence in English, gives an indication of their intellectual ability in an English school environment. This variable is important when the learner's achievement in English is being measured, as is the case in the current study. A certain level of English proficiency was ensured, however, as learners were only selected if they had an average score or higher, on the Vocabulary test of the aptitude measure used. It was therefore likely that the learners in this study had at least an average level of English language proficiency.

The SSAIS-R comprises eleven subtests. Nine subtests form the composite scale necessary to calculate the verbal scale, the nonverbal scale and the full scale scores. Two additional tests, Test 10: Memory for Digits, and Test 11: Coding, are included if further diagnostic information is required, but are not included in the composite scales. The nine composite scale subtests are:

#### Verbal Scale

1) Test 1: Vocabulary

The test measures the individual's verbal intelligence and verbal learning ability. An indication of the individual's language development is also obtained.

2) Test 2: Comprehension

An understanding of a variety of social situations and the ability to use the information in a meaningful and emotionally relevant way is evaluated in this test.

3) Test 3: Similarities

Logical, abstract reasoning, verbal concept formation and long-term memory are evaluated in this test.

4) Test 4: Number Problems

This test measures numerical reasoning which involves logical thinking, abstract thought and mental alertness.

5) Test 5: Story Memory

In this test short-term auditory memory for meaningful material is evaluated.

Nonverbal Scale

6) Test 6: Pattern Completion

Nonverbal sequential reasoning and the ability to use analogies is tested.

7) Test 7: Block Designs

This test measures nonverbal intelligence and nonverbal problem-solving skills. Spatial abilities are evaluated.

8) Test 8: Missing Parts

In this test comprehension of familiar situations, visual perception and visual memory are evaluated.

9) Test 9: Form Board

Visual perception and visual-motor coordination are tested.

4.3.2.1.1 Reliability of the SSAIS-R

The reliability of the subtests and scales of the SSAIS-R, is an indication of the extent to which they consistently measure the respective cognitive abilities. The reliability coefficients of the subtests of the nine composite subtests of SSAIS-R for the ages 14, 15 and 16, relevant to the current study, are provided in Table 4.2.

TABLE 4.2: RELIABILITY OF THE SSAIS-R

<b>SUBTESTS/ SCALES</b>	<b>14 YEARS</b> N = 295	<b>15 YEARS</b> N = 296	<b>16 YEARS</b> N = 289
Test 1: Vocabulary English	N = 135 0.87	N = 124 0.88	N = 122 0.85
Test 2: Comprehension	0.71	0.69	0.63
Test 3: Similarities	0.76	0.75	0.76
Test 4: Number Problems	0.83	0.86	0.86
Test 5: Story Memory	0.83	0.84	0.83
Test 6: Pattern Completion	0.73	0.76	0.79
Test 7: Block Designs	0.90	0.88	0.89
Test 8: Missing Parts	0.59	0.66	0.60
Test 9: Form Board	0.73	0.75	0.73
Verbal Scale	0.93	0.93	0.92
Nonverbal Scale	0.88	0.89	0.88
Full Scale	0.94	0.95	0.94

(Van Eeden 1997a:13)

The reliability coefficients range from 0.59 to 0.90 on the subtests. In general, the subtests appear to be reliable with the possible exceptions of Test 2: Comprehension for 15 year olds and 16 year olds, and Test 8: Missing Parts for all three age groups. These coefficients are below the accepted minimum of 0.70 (Bester 2003:38).

#### 4.3.2.1.2 Validity of the SSAIS-R

The validity of a test refers to the extent to which it measures that which it is supposed to measure (Cohen & Swerdlik 2002:154). In most cases three types of validity are investigated: content validity, criterion validity and construct validity.

Content validity refers to the extent to which items in a test are representative of the area that the test is designed to measure (Cohen & Swerdlik 2002:156). The content validity of the SSAIS-R was established by a description of the cognitive abilities that are measured in each subtest and which are widely accepted measures of intelligence. For example, in Test 1: Vocabulary, the individual's verbal intelligence and verbal learning ability are measured. Sternberg (2000: 316) maintains that verbal intelligence and verbal learning ability are widely accepted as valid measures of intelligence.

Construct validity refers to the extent to which a construct explains the variance in test behaviour (Van Eeden 1997a:34). The construct validity of the SSAIS-R, as an intelligence test, was established through factor analysis, as well as using comparisons with other intelligence tests. In order to establish validity in the standardisation process, factor analysis was carried out. The factor analysis revealed that there were significant loadings, of 0.30 or higher, on one main factor. This factor was taken to be *g*, or general intelligence (Van Eeden 1997a:98). The general intelligence factor explained 44% of the variance in scores obtained on the different subtests. Two further factors were

identified which had sufficient specific variance to be distinguished from each other (Van Eeden 1997a:35). These factors were verbal and nonverbal intelligence.

Criterion-related validity refers to the extent to which scores obtained on a test can predict scores of a specific criterion. The test developer mentions that the SSAIS-R is used in the educational context, to predict future scholastic achievement and to obtain diagnostic and prognostic information (Van Eeden 1997a:34) but does not provide evidence for this aspect of validity. As stated in Chapter 3 (section 3.2.1), however many studies show that intelligence measures predict academic achievement. It can be said that the SSAIS-R has content and construct validity which indicate that it is a valid intelligence test. On this basis it would be probable that the test would be able to predict academic achievement.

#### 4.3.2.2 Aptitude

Aptitude was measured using the newly developed Differential Aptitude Tests Form S (Advanced Form) (Vosloo *et al.* 2000:1). The DAT-S was developed in 2000, with the purpose of measuring different aptitudes which could be used to help make decisions regarding subject choices and choice of school type. The DAT-S is one of a series of aptitude tests for different grades. The other aptitude tests in the series have been described in more detail in chapter 2 (section 2.6). The DAT-S was developed for use with learners in Grades 7, 8, 9 and 10 who have received favourable learning opportunities. The learners in the current study have received favourable educational opportunities so it was decided to use the DAT-S.

The DAT-S comprises nine different aptitude tests:

Test 1: Vocabulary

This test measures the Verbal Comprehension Factor (V), which is the knowledge of word meanings, as well as the application of this knowledge in spoken and written language.

Test 2: Verbal reasoning

General reasoning (R) with verbal material is measured in this test.

Test 3: Nonverbal reasoning: Figures

General reasoning (R) on the basis of nonverbal material is measured in this test.

Test 4: Computations

The arithmetical ability of learners is measured in this test.

Test 5: Reading Comprehension

This test measures the ability of the learner to comprehend what he is reading.

Test 6: Comparison

Visual Perceptual Speed (P) is measured in this test as an aspect of clerical ability. The learner is required to perceive differences and similarities between visual configurations quickly and accurately.

Test 7: Spatial Visualisation 3 D

The three-dimensional spatial ability of a learner is measured in this test.

Test 8: Mechanical Insight

This test measures Mechanical Insight through evaluating the ability of the learner to make correct visual representations of the result of the operation of a mechanical apparatus, or a physical principle depicted in a drawing.

#### Test 9: Memory (Paragraph)

The Memory Factor (M) is measured in this test where the learner is required to memorise written paragraphs, and to correctly answer questions on the content of the paragraphs.

The DAT-S was standardised on a sample of Grade 7 and Grade 9 learners. In total there were 2 250 learners. Learners from all population groups were included. About half were boys and half were girls. The researchers state that good quality education was provided in most of the schools.

#### 4.3.2.2.1 Reliability of the DAT-S

The reliability coefficients are given only for a Grade 7 group in the manual and are provided in Table 4.3.

TABLE 4.3: RELIABILITY COEFFICIENTS FOR A GRADE 7 GROUP TESTED IN 4 SCHOOLS

TEST	Reliability
1. Vocabulary English	0.84
2. Verbal reasoning	0.78
3. Nonverbal reasoning	0.78
4. Computations	0.81
5. Reading comprehension English	0.87
7. Spatial visualisation Boys	0.80
Girls	0.80
8. Mechanical insight Boys	0.82
Girls	0.77
9. Memory	0.89

(Vosloo *et al.* 2000: 41)

The reliability of Test 6: Comparison was not given as the researchers maintain that the test is a speeded one and therefore highly reliant on the pace at which the learner works rather than his or her ability to complete items correctly. Seeing as the reliability coefficients are all above 0.70 the tests appear to be reliable measures of aptitude (Vosloo *et al.* 2000:41).

#### 4.3.2.2.2 Validity of the DAT-S

The test developers state that an indication of the content validity of the DAT-S was obtained by a consideration of the items by a team of experts in the field of aptitude testing. Construct validity, that is, the degree to which the test measures a theoretical construct, was evaluated by



looking at the correlations of the tests with each other. The tests that should theoretically correlate with each other, show significant correlations, because of their relation with the same construct (Vosloo *et al.* 2000:42-43). The intercorrelations of the tests are given in Table 4.4.

TABLE 4.4: INTERCORRELATIONS OF DAT-S SUBTESTS

Test	1	2	3	4	5	6	7	8
1. Vocabulary								
2. Verbal reasoning	0.70							
3. Nonverbal reasoning	0.59	0.64						
4. Computations	0.62	0.66	0.65					
5. Reading comprehension	0.75	0.66	0.56	0.60				
6. Comparison	0.39	0.37	0.39	0.42	0.44			
7. Spatial visualisation	0.60	0.63	0.64	0.57	0.55	0.34		
8. Mechanical insight	0.60	0.59	0.61	0.59	0.63	0.42	0.65	
9. Memory	0.75	0.69	0.55	0.59	0.79	0.39	0.53	0.59

(Vosloo *et al.* 2000: 43)

Some of the highest correlations occur between Test 1: Vocabulary, Test 2: Verbal reasoning, Test 5: Reading comprehension and Test 10: Memory. These tests have the factor, verbal ability, in common.

The predictive validity of the DAT-S was established by correlating the test results with achievement in school subjects. Only 61 Grade 7 learners were involved in this study. All correlations, except for Test 6: Comparison, are

significant at the 5% level. The correlations are given in Table 4.5.

TABLE 4.5: CORRELATIONS OF DAT-S TESTS WITH SUBJECT PERCENTAGES FOR 61 AFRIKAANS-SPEAKING GRADE 7 LEARNERS TESTED IN ONE SCHOOL

<b>Test</b>	<b>Afr</b>	<b>Eng</b>	<b>Math</b>	<b>Hist</b>	<b>Geog</b>	<b>Sci</b>	<b>Art</b>	<b>Total</b>
1. Vocabulary	0.58	0.68	0.55	0.50	0.52	0.61	0.47	0.65
2. Verbal reasoning	0.60	0.72	0.49	0.51	0.61	0.61	0.52	0.68
3. Nonverbal reasoning	0.56	0.62	0.53	0.44	0.56	0.62	0.49	0.65
4. Computations	0.56	0.57	0.64	0.41	0.51	0.51	0.48	0.61
5. Reading comprehension	0.66	0.72	0.57	0.64	0.64	0.63	0.60	0.71
6. Comparison	0.14	0.23	0.25	0.06	0.23	0.18	0.23	0.21
7. Spatial visualisation	0.34	0.49	0.51	0.28	0.46	0.36	0.29	0.46
8. Mechanical insight	0.47	0.48	0.55	0.26	0.53	0.54	0.51	0.55
9. Memory	0.66	0.67	0.44	0.60	0.55	0.57	0.47	0.65

(Vosloo *et al.* 2000:44)

#### 4.3.2.3 Self-concept and Motivation

A questionnaire developed for measuring affective factors in learners participating in the performing arts in secondary school, was used (Bester 2003:186). The questionnaire measured the levels of anxiety, motivation, self-concept and stress in these learners. Their relationships with their teacher and peers were also assessed. Only the motivation and self-concept items were selected from this questionnaire and the wording translated and adapted to be used in a general school context. For example, one of the original items was

“As musiekleerder, is ek die meeste van die tyd teleurgesteld in myself.”

The item was translated into English and changed to:

“As a learner, I am disappointed in myself most of the time.”

The questionnaire contains 40 items, 20 items measuring motivation and 20 measuring self-concept. The sequence of the items is mixed so that the respondents do not know which construct is being measured as this knowledge may affect their responses. The items are answered on a six-point scale so that a greater range of scores can be obtained, thus increasing the reliability of the questionnaire. A high score on the questionnaire indicates high motivation while a low score indicates low motivation. The same applies to self-concept. Some of the items are reversed to prevent respondents from answering “yes”, in a uniform way.

#### 4.3.2.3.1 Reliability of the self-concept and motivation questionnaire

The reliability of the questionnaire was established by calculating the Alpha reliability coefficient for the items dealing with each construct. The reliability coefficients are provided in Table 4.6.

TABLE 4.6: RELIABILITY COEFFICIENTS OF THE MOTIVATION AND SELF-CONCEPT SECTIONS OF THE QUESTIONNAIRE

Variable	Reliability coefficient
Motivation	0.86
Self-concept	0.89

The reliability coefficients are higher than 0.70 and the questionnaire can therefore be considered as a reliable measure.

#### 4.3.2.3.2 Validity of the self-concept and motivation questionnaire

Content validity was addressed by using some items from existing tests, such as Mellet's motivation questionnaire (Bester 2003:187), and some were developed on the basis of the definition used for motivation. The researcher defined motivation in a similar way to that used in the current study in Chapter 3 (section 3.3.2). Motivation is seen as a state of having energy to move towards a specific goal. Motivation therefore leads a person to take action, to become involved in an issue and to be determined to persevere until the goal is achieved. A motivated learner is, therefore someone who sets a certain standard for himself, is determined to maintain that standard, who learns conscientiously and is proud of the work he does (Bester 2003:187). The self-concept items were based on existing tests such as Waetjen's *Self-concept as Learner Scale* (Burns 1979:141). The definition of the self-concept used in developing the items is similar to that used in the current study in Chapter 3 (section 3.3.1). The self-concept is defined as a comprehensive construct which includes a person's behaviour as well as his or her thoughts and feelings. The self-concept is seen as both descriptive and evaluative (Bester 2003:190). Content validity was also addressed by having experts in the relevant fields evaluate whether the items measure what they are supposed to measure.

Correlations obtained between the constructs measured in this questionnaire show its construct validity. According to theory, learners obtaining a high motivation score can be expected to obtain a high self-concept score. Negative correlations were obtained for constructs that should, theoretically, be negatively correlated with each other. For example, anxiety is negatively correlated with motivation and self-concept. The intercorrelations of the constructs are given in Table 4.7.

TABLE 4.7: CORRELATION COEFFICIENTS BETWEEN THE AFFECTIVE FACTORS

	Motivation	Stress	Anxiety	Self-concept
Motivation		-0.30	-0.20	0.59
Stress			0.34	-0.46
Anxiety				-0.64

(Bester 2003:219)

There was evidence of predictive validity since motivation and self-concept had significant positive correlations with performance. Through a regression analysis it was found that self-concept and, to a lesser extent, motivation, accounted for up to 9% of the variation in performance in the different grades (Bester 2003:231).

#### 4.3.2.4 Study orientation

In Chapter 3 (section 3.4), study orientation was analysed and recent research on study habits and techniques was presented. On the strength of this research it was decided that the learner's study

orientation be assessed using the Survey of Study Habits and Attitudes developed by Brown and Holtzman (1997:1).

The questionnaire may be administered to learners from Grade 8 to Grade 12. It consists of 100 statements to which the learner responds on a five-point scale. The learner indicates how often each statement is true for him or her, either “rarely” (0-15% of the time), “sometimes” (16-35% of the time), “frequently” (36-65% of the time), “generally” (66-85% of the time) or “always” (86-100% of the time). An example of an item is “It takes a long time before I really start working” (Brown & Holtzman 1997:3).

The scores on the questionnaire are grouped into four different scales, which are further grouped into higher order descriptions of study habits and study attitudes. The scores on the “Delay avoidance” and “Work methods” scales are grouped into a “Study habits” scale. The “Teacher approval” and “Education acceptance” scales are grouped into the “Study attitudes” scale. The combination of the study habits and study attitudes scales forms a global picture of the learner’s study orientation (Du Toit 1995:7).

The Delay avoidance scale indicates to what extent the learner promptly completes his assignments. An indication of the learner’s use of effective study methods is provided by the Work methods scale. The Teacher approval scale provides a measure of the learner’s attitude towards the teacher’s classroom behaviour and methods. The Education acceptance scale determines the extent of the learner’s acceptance of educational ideals, objectives, practices and requirements.

The questionnaire was adapted and standardised for use in South Africa by the Health Sciences Research Council (Du Toit 1995:8). A group of 354 learners, comprising 184 girls and 170 boys, were involved in the sample for standardisation for Grade 9.

4.3.2.4.1 Reliability of the Survey of Study Habits and Attitudes

The reliability of the questionnaire was determined through the calculation of split-half coefficients shown in Table 4.8.

TABLE 4.8: CORRECTED SPLIT-HALF RELIABILITY FOR THE FOUR PRIMARY SCALES OF THE SSHA (N=2790)

Scale	Delay Avoidance	Work Methods	Teacher Approval	Education Acceptance
	0.83	0.84	0.87	0.81

(Du Toit 1995:9)

Test-retest reliability was also used to assess the reliability of the questionnaire. Four groups of learners were tested and then retested after 14 days. The results of the test-retest reliability are provided in Table 4.9.

TABLE 4.9: RETEST RELIABILITY FOR THE SSHA SCALES

Group	N	DA	WM	TA	EA	SH	SA	SO
Boys	229	0.89	0.86	0.87	0.87	0.90	0.90	0.92
Girls	223	0.88	0.81	0.86	0.88	0.88	0.90	0.90
Afrikaans	210	0.86	0.86	0.88	0.87	0.89	0.90	0.91
English	242	0.90	0.82	0.85	0.88	0.89	0.90	0.91

(Du Toit 1995:9)

The reliability coefficients using both methods are above 0.70, therefore the questionnaire can be taken as a reliable measure of all the scales.

#### 4.3.2.4.2 Predictive validity of the Survey of Study Habits and Attitudes

The SSHA questionnaire has a significant, positive relationship with scholastic achievement. The correlations between SSHA scores on the seven scales and school achievement in Grade 9 are provided in Table 4.10



TABLE 4.10: CORRELATIONS BETWEEN SSHA SCORES  
AND SCHOLASTIC ACHIEVEMENT AS AN AVERAGE  
PERCENTAGE IN GRADE 9 (N=332)

Scale	Grade 9 achievement
Delay avoidance	0.36
Work methods	0.40
Teacher approval	0.35
Education acceptance	0.44
Study habits	0.44
Study attitudes	0.42
Study orientation	0.45

(Du Toit 1995:10)

#### 4.3.2.5 Scholastic achievement

Marks obtained at the end of the second term in both schools were taken as measures of academic achievement. Half of the second term percentage comprised a term mark, and the other half the formal midyear examination mark. The term mark in Grade 9 is made up of different kinds of assessments which are weighted more or less equally. The kinds of assessments used differ from subject to subject but usually included the following:

- An *investigation* – the learners carry out real-life research, for example in Mathematics, they find out how hamburger sales at Steers compares with hamburger sales at McDonalds. The learners collect the data and report on their findings.
- A *project* – information on a topic has to be presented in written or other form. The topic does not form part of the syllabus and is therefore enrichment work.

- *Formal tests* – the usual controlled, supervised tests that take place in the classroom.
- *Assignments* – written exercises done as homework.
- *Informal tests* – small tests completed in class. The subject matter is decided on by the teacher. In Mathematics, aspects of theory may be tested in the informal test.

In obtaining the final term mark, the above five kinds of assessment may each be represented as a mark out of 10. A mark out of 50 would then be obtained. The learner's term mark would then be added to the midyear examination mark and the total percentage for the subject would then be obtained.

Performance in the following subjects was seen as representative of Grade 9 achievement in the current study:

First language (English)

Second language (Afrikaans)

Mathematics

Natural sciences

Social sciences

Economic and Management sciences

#### 4.3.2.6 Previous knowledge

Previous performance was not taken into account as previous knowledge is not a pure variable. It is influenced by many factors. Additionally, in cases where learners have performed badly in the past it is psychologically-speaking better not to take previous performance into account in a prediction model. Learners may feel that they will be disadvantaged by their previous weak performance. If previous performance is not taken into account, it is possible to

predict performance for a learner even if he does not take the relevant subject.

#### **4.4 RESEARCH METHOD**

The aptitude tests were administered to the 60 learners in groups of no more than 12 at a time. The learners completed the tests during the school morning to avoid fatigue due to the long testing time required. The administration procedures were strictly followed according to the instructions in the DAT-S manual.

The Self-concept and Motivation Questionnaires, as well as the Survey of Study Habits and Attitudes questionnaires, were completed by the learners on the same day they completed the aptitude tests. The instructions were read aloud to the class and the learners were allowed to complete these at their individual pace.

The Senior South African Individual Scale IQ tests were administered individually to learners, in the weeks following their completion of the aptitude tests and questionnaires. The IQ tests were carried out at a time suitable for the learner considering their school time table and extra mural commitments. Most of the IQ tests were administered during the morning to avoid fatigue. The instructions as stated in the manual for the SSAIS-R were strictly followed.

The school results were obtained after the June reports had been compiled at the respective schools. All the information was entered on coded sheets and the information was processed using a computer.

Ethical considerations were addressed in the study. Learners were informed that the test results would be used in a research study at the University of South Africa. The aims of the study were explained. They were assured of the confidentiality of their results and they were offered the opportunity to obtain feedback regarding their tests.

The tests were carefully selected and the research method developed in order to provide reliable and valid answers to the research questions posed in Chapter 1 (section 1.2). The results of the investigation are presented and discussed in the following chapter.

## CHAPTER 5

### RESULTS OF THE EMPIRICAL INVESTIGATION

#### 5.1 INTRODUCTION

The purpose of the empirical investigation is to test the hypotheses which were stated in chapter 4 (section 4.2). These hypotheses deal mainly with the relationships between aptitude, intelligence, affective factors and scholastic achievement.

#### 5.2 TESTING OF THE HYPOTHESES

##### 5.2.1 Hypothesis 1

With regard to hypothesis 1 in section 4.2, the following null hypothesis is stated:

*There is no significant positive correlation between intelligence and aptitude.*

In order to test the null hypothesis, the Pearson correlation coefficients between each of the aptitude tests and the Verbal scale, Nonverbal scale and Total scale of the intelligence test were calculated. The results are given in Table 5.1.

TABLE 5.1: CORRELATIONS BETWEEN DAT-S APTITUDE TESTS AND SCALES OF SENIOR SOUTH AFRICAN INDIVIDUAL SCALE – REVISED (SSAIS-R)

APTITUDE TEST	VERBAL SCALE	NONVERBAL SCALE	TOTAL SCALE
1.VOCABULARY	0.63	0.37	0.58
2.VERBAL REASONING	0.57	0.48	0.62
3.NONVERBAL REASONING	0.45	0.54	0.60
4.COMPUTATIONS	0.44	0.48	0.55
5.READING COMPREHENSION	0.50	0.39	0.52
6.COMPARISON	0.10*	0.19*	0.16*
7.SPATIAL VISUALISATION	0.40	0.60	0.58
8.MECHANICAL INSIGHT	0.50	0.47	0.58
9. MEMORY	0.37	0.20*	0.33

\*  $p > 0.05$

For all the other correlations  $p < 0.01$

From the results it appears that the null hypothesis can be rejected as all of the aptitude subtests show significant, positive correlations with the intelligence scales. The correlations between most of the aptitude subtests and the different scales of the Senior South African Individual Scale – Revised (SSAIS-R) are moderate to high positive correlations. These correlations indicate that the aptitude scores are related to intelligence scores. Persons with a high aptitude score will also obtain a high general intelligence score. These findings are in agreement with De Bruin (1997:14) as well as Fouché and Verwey (1994:55) who

maintain that specific aptitudes have much in common with general intelligence. Owen (2000:46-48), in the development of the Differential Aptitude Test, found that there was evidence of a common factor. This factor is probably general intelligence.

The subtest showing the highest correlation with the Total Intelligence Scale is Test 2 (Verbal Reasoning) (0.62). The last mentioned result is in agreement with the interpretation made by the developers of the DAT-S, that Test 2 (Verbal Reasoning) gives the best indication of the learner's general intelligence level (Vosloo, Coetzee & Claassen 2000:36).

Five of the nine aptitude subtests correlate more with the Total Scale of the SSAIS-R than with either of the two subscales. These tests are Test 2 (Verbal Reasoning) (0.62), Test 3 (Nonverbal Reasoning) (0.60), Test 4 (Computations) (0.55), Test 5 (Reading Comprehension) (0.52) and Test 8 (Mechanical Insight) (0.58). Therefore, these tests appear to be measuring both verbal and nonverbal factors and give an indication of the learner's general intelligence. These results are in agreement with the relationships between general and specific intelligences illustrated by Carroll (in Berk 2000:319) and described in Chapter 2 (section 2.3.1.6). The Nonverbal Reasoning, Computations and Mechanical Insight subtests measure abilities such as sequential reasoning and quantitative reasoning. The Verbal Reasoning and Reading Comprehension subtests measure language abilities. Sequential reasoning, quantitative reasoning as well as language comprehension are closely related to general intelligence according to Carroll.

The SSAIS-R comprises two subscales, verbal intelligence and nonverbal intelligence. An analysis of the relationship between each aptitude subtest and the two subscales will give an indication of common factors measured. The aptitude subtests that were expected to show higher correlations with the Verbal scale rather than the Nonverbal scale generally do show this relationship (except for Test 8: Mechanical Insight which shows a higher relationship with the Verbal

scale despite measuring nonverbal content. Further discussion of the possible reasons for this is undertaken later in this chapter). The tests are Test 1 (Vocabulary) (0.63), Test 2 (Verbal Reasoning) (0.57), Test 5 (Reading Comprehension) (0.50) and Test 9 (Memory) (0.37). The higher correlations of these subtests with the Verbal scale are probably as a result of their measurement of a common Verbal factor (V).

The subtests that show higher correlations with the Nonverbal scale are the ones that would be expected to do so. These tests are Test 7 (Spatial Visualisation) (0.60) and Test 3 (Nonverbal Reasoning) (0.54). It appears therefore that these two subtests primarily measure nonverbal intelligence. Both the Nonverbal Reasoning subtest and the Spatial Visualisation subtest measure the general reasoning factor (R) according to Vosloo *et al.* (2000:5,8). General reasoning includes reasoning on the basis of nonverbal material.

Test 4 (Computations) and Test 8 (Mechanical Insight), correlate similarly with both the Verbal and Nonverbal scales indicating that they require the use of both verbal and nonverbal abilities. The Computations subtest shows moderate correlations of 0.44 with the Verbal scale and 0.48 with the Nonverbal scale. Mechanical Insight has moderate correlations of 0.50 with the Verbal Scale and 0.47 with the Nonverbal scale. It appears therefore that these two subtests measure general intelligence. This interpretation is supported by the higher correlations of these subtests with the Total scale of the SSAIS-R compared to that of the subscales.

A discussion of the relationship of each aptitude subtest with the different scales of the Senior South African Individual Scale (SSAIS-R) follows. Test 1 (Vocabulary), as shown above, has the highest correlation with the Verbal scale of the SSAIS-R (0.63). This would be expected as knowledge and understanding of the meaning of words are primarily verbal abilities. The test appears to discriminate well between verbal and nonverbal abilities as it shows a high



correlation with the Verbal scale and a conversely low correlation with the nonverbal scale (0.37). The Vocabulary subtest has a correlation of 0.58 with the Total scale.

The correlation of Test 2 (Verbal Reasoning) with the Total scale of the SSAIS-R (0.62) is higher than the correlations of this subtest with either of the subscales. This may indicate that the Verbal Reasoning subtest measures many verbal as well as nonverbal factors. The test shows a higher correlation with the Verbal Scale (0.57), than with the Nonverbal scale (0.48), probably due to the verbal content of the test.

Test 3 (Nonverbal Reasoning) shows a higher correlation with the Total scale (0.60) than with either of the subscales. This means that it measures verbal as well as nonverbal factors. It has, however a higher correlation with the Nonverbal scale (0.54) than with the Verbal scale (0.45) indicating that it measures more nonverbal than verbal factors.

Test 4 (Computations) shows similar correlations with both the Nonverbal scale (0.48) and the Verbal Scale (0.44). This finding appears to be in agreement with van Eeden (1997a:36) who found that the Number Problems subtest of the SSAIS-R, which also measures arithmetic ability, loads on both verbal and nonverbal factors. The Computations subtest shows the highest correlation with the Total scale (0.60) indicating the measurement of both verbal and nonverbal factors by this test.

Test 5 (Reading Comprehension) has a considerable higher correlation with the Verbal scale (0.50) than with the Nonverbal scale (0.39). This is probably due to its measurement of primarily verbal factors. Again, this subtest shows the highest correlation with the Total scale (0.52) indicating some measurement of nonverbal factors.

Test 7 (Spatial Visualisation) has the highest correlation with the Nonverbal scale (0.60) and a lower correlation with the Verbal scale (0.40). This is probably due to the nonverbal content of the test which comprises mostly drawings and diagrams. The Spatial Visualisation subtest appears to be measuring a nonverbal visualisation factor, Vz (Vosloo *et al.* 2000:8). This test shows a correlation of 0.58 with the Total scale.

Interestingly, Test 8 (Mechanical Insight) shows a slightly higher correlation with the Verbal scale (0.50) than with the Nonverbal scale (0.47). This is unexpected as the test is meant to measure Mechanical Ability on the basis of nonverbal pictures (Vosloo *et al.* 2000:8). Many of the multiple choice items in the test have lengthy, verbal descriptions of mechanical movement in the stems of the answers, as well as in the different answers available for selection. This relatively complex verbal content probably requires a good standard of language ability, and explains the strong positive relationship of this test with measures of verbal intelligence.

Test 9 (Memory) has a higher correlation with the Verbal scale (0.37) than with the Total scale (0.33). It has a non-significant relationship of 0.20 ( $p>0.05$ ) with the Nonverbal scale. The Memory subtest therefore appears to measure verbal factors rather than nonverbal factors. However, the correlation between the Memory test and the Verbal scale is a low one indicating that the factors measured in the Memory subtest do not have much in common with measures of verbal or general intelligence. If one looks at the insignificant relationship between the Memory test and the Nonverbal scale as discussed above, together with a consideration of the low correlation between the test and both the Verbal and Total scales, it appears that Memory aptitude does not have a strong relationship with any of the measures of intelligence included in this study.

The Comparison subtest shows statistically insignificant relationships with the Verbal, Nonverbal and Full scale scores of the SSAIS-R (respectively,  $r = 0.10$ ,  $r = 0.19$ ,  $r = 0.16$ ;  $p>0.05$  in all three cases). These results appear to be in

agreement with the literature on the relationship between intelligence and timed reaction tasks. The Comparison test measures Visual Perceptual Speed (P) where the learner is required to perceive visual information and to make a speeded reaction by marking the correct choice on the response sheet (Vosloo *et al.* 2000:7). Deary (1995:237-250) states that the correlation between cognitive test scores and reaction time tasks is around 0.2 or lower. In addition, Carroll (in Berk 2000:319) in his three-stratum theory of intelligence describes choice reaction time tasks as having the weakest relationship with *g*.

#### 5.2.1.1 Explanation of the variance in intelligence

As stated in the previous section, the correlation between aptitude subtests and general intelligence varies. For example the higher the score for verbal reasoning aptitude, the higher the score for verbal intelligence will be. The variance (or amount of change) shared by the variables is represented by the coefficient of determination. The coefficient of determination is obtained by squaring the Pearson correlation coefficient. It is then a measure of the variance of the dependent variable which can be explained by the independent variable (Bester 2003:26). More of the variance in intelligence can be explained by calculating the correlation between many of the aptitude tests and an intelligence score and squaring the correlations. The measurement of the amount of variance explained by the different aptitude tests as the independent variables can then be used in a regression analysis to predict the dependent variable, that is intelligence (Cohen & Swerdlik 2002:121).

In order to predict intelligence using aptitude scores in the current study, a number of regression analyses were carried out. The different aptitude tests and the learner's age (in months) were used as predictive variables and the criterion variables were verbal intelligence, nonverbal intelligence and general intelligence. The learner's age was found to be in a negative relationship with his or her level of intelligence. This may be because learners are kept back in a grade if they do not cope with the schoolwork. Learners who are kept back a year, or fail in a

grade, may have a lower level of intelligence than other learners who progress in the normal way. They are also necessarily older than the other learners in the same grade.

#### 5.2.1.1.1 Explanation of the variance in verbal intelligence

In Table 5.2  $R^2$  indicates the proportion of the variance in verbal intelligence which can be explained by each of the variables. It appears that Vocabulary aptitude explains 40% of the variance in verbal intelligence. The learner's age explains a further 12% of the variance which was not explained by the Vocabulary score. Mechanical Reasoning explains 7% more of the variance not explained by the previous two variables while Verbal Reasoning contributes a further 3% to the explanation of the variance in intelligence. In total, 62% of the variance in verbal intelligence is explained. No other variable adds to the explanation of the variance.

Table 5.2: EXPLANATION OF THE VARIANCE IN VERBAL INTELLIGENCE

Variable	$R^2$	*F	df
Vocabulary (VOCAB)	0.40	38.86	(1.58)
Age in Months (AGEM)	0.52	30.95	(2.57)
Mechanical Reasoning (MEC)	0.59	27.57	(3.56)
Verbal Reasoning (VERBAL)	0.62	22.50	(4.55)

\*In all cases  $p < 0.05$

The regression equation for verbal intelligence can be calculated as follows:

$$Y = 153.121 + 1.822 (\text{VOCAB}) + 0.822 (\text{VERBAL}) + 0.992 (\text{MEC}) - 0.719 (\text{AGEM})$$

#### 5.2.1.1.2 Explanation of the variance in nonverbal intelligence

It appears that Three-dimensional Spatial Visualisation explains 37% of the variance in nonverbal intelligence. The learner's age explains a further 5% of the variance which is not explained by the Spatial Visualisation score. Reading Comprehension explains 2% more of the variance not explained by the previous two variables while Mechanical Reasoning and Computations contribute a further 1% each to the explanation of the variance. In total 46% of the variance in nonverbal intelligence could be explained. No other variable added to the explanation of the variance.

Table 5.3: EXPLANATION OF THE VARIANCE IN NONVERBAL INTELLIGENCE

Variable	R <sup>2</sup>	*F	df
Spatial Visualisation (V3D)	0.37	34.06	(1.58)
Age in Months (AGEM)	0.42	21.22	(2.57)
Reading Comprehension (READ)	0.44	15.14	(3.56)
Mechanical Reasoning (MEC)	0.45	11.64	(4.55)
Computations (COM)	0.46	9.40	(5.54)

\*In all cases  $p < 0.05$

The regression equation for nonverbal intelligence can be calculated as follows:

$$Y = 120.411 + 0.326 (\text{COM}) + 0.49 (\text{READ}) + 1.463 (\text{V3D}) + 0.507 (\text{MEC}) - 0.371 (\text{AGEM})$$

#### 5.2.1.1.3 Explanation of the variance in general intelligence

Verbal Reasoning aptitude appears to explain 38% of the variance in general intelligence. The learner's age explains a further 12% of the variance which was not explained by the Verbal Reasoning score. Spatial Visualisation (3D)

explains 9% more of the variance not explained by the previous two variables while vocabulary and mechanical reasoning contribute a further 4% and 3% respectively to the explanation of the variance. Reading Comprehension explains approximately a further ½ %, while Memory and Computations explain an additional 1% each. In total 68% of the variance in general intelligence could be explained. This high amount of variance in intelligence explained by the aptitude test implies a multiple correlation of at least 0.80 which is very high. The very high correlation between aptitude and intelligence indicates that the two variables are measuring similar factors. No other variable added to the explanation of the variance.

Table 5.4: EXPLANATION OF THE VARIANCE IN GENERAL INTELLIGENCE

Variable	R <sup>2</sup>	*F	df
Verbal Reasoning (VERBAL)	0.38	36.31	(1.58)
Age in Months (AGEM)	0.50	29.25	(2.57)
Spatial Visualisation 3 D (V3D)	0.59	27.44	(3.56)
Vocabulary (VOCAB)	0.63	23.65	(4.55)
Mechanical Reasoning (MEC)	0.66	21.31	(5.54)
Reading Comprehension (READ)	0.66	17.91	(6.53)
Memory (MEM)	0.67	15.59	(7.52)
Computations (COM)	0.68	13.61	(8.51)

\*In all cases  $p < 0.05$

The regression equation for general intelligence can be calculated as follows:

$$Y = 136.758 + 0.934 (\text{VOCAB}) + 0.525 (\text{VERBAL}) + 0.244 (\text{COM}) + 0.494 (\text{READ}) + 0.746 (\text{V3D}) + 0.896 (\text{MEC}) - 0.268 (\text{MEM}) - 0.579 (\text{AGEM})$$

### 5.2.2 Hypothesis 2

With regard to hypothesis 2 in section 4.2 the following null hypothesis is stated:

*There is no significant positive correlation between aptitude subtests and achievement in different school subjects.*

In order to test the null hypothesis, the correlations between each of the aptitude tests and achievement in the key subjects, namely English (first language), Afrikaans (second language), Mathematics and Natural Sciences were calculated. Correlations between the aptitude tests and the learning subjects, Economic and Management Sciences (EMS) and Human and Social Sciences (HSS) were also obtained. The results are given in Tables 5.5 to 5.10.

TABLE 5.5: CORRELATIONS BETWEEN APTITUDE AND FIRST LANGUAGE ACHIEVEMENT (ENGLISH)

APTITUDE	CORRELATION WITH ACHIEVEMENT IN ENGLISH
1.VOCABULARY (VOCAB)	0.32*
2.VERBAL REASONING (VERBAL)	0.26*
3.NONVERBAL REASONING (NONV)	0.12
4.COMPUTATIONS (COM)	0.11
5.READING COMPREHENSION (READ)	0.05
6.COMPARISON (COMPAR)	-0.003
7.SPATIAL VISUALISATION (V3D)	0.06
8.MECHANICAL INSIGHT (MEC)	0.12
9. MEMORY (MEM)	-0.02

\* $p < 0.05$

In all other cases  $p > 0.05$

The results indicate that in the case of English achievement the null hypothesis can be rejected as Test 1 (Vocabulary) and Test 2 (Verbal Reasoning) show significant positive correlations with achievement. While the Vocabulary and Verbal Reasoning aptitude subtests show positive relationships with English achievement they are low correlations, indicating that the vocabulary and verbal reasoning aptitudes do not explain a great amount of the variance in English first language achievement. The remainder of the aptitude subtests do not show significant relationships with English achievement. The Comparison test appears to be unrelated to English achievement at school.

The correlations between the aptitude tests and second language (Afrikaans) achievement are provided in Table 5.6.



TABLE 5.6: CORRELATIONS BETWEEN APTITUDE AND SECOND LANGUAGE ACHIEVEMENT (AFRIKAANS)

APTITUDE	CORRELATION WITH ACHIEVEMENT IN AFRIKAANS
1.VOCABULARY (VOCAB)	0.07
2.VERBAL REASONING (VERBAL)	0.14
3.NONVERBAL REASONING (NONV)	0.11
4.COMPUTATIONS (COM)	0.08
5.READING COMPREHENSION (READ)	-0.03
6.COMPARISON (COMPAR)	0.05
7.SPATIAL VISUALISATION (V3D)	0.05
8.MECHANICAL INSIGHT (MEC)	0.04
9. MEMORY (MEM)	0.13

For all correlations  $p > 0.05$

In the case of Afrikaans achievement the null hypothesis can be accepted as none of the aptitude tests show significant relationships with Afrikaans achievement.

The correlations between the aptitude tests and Mathematics achievement are provided in Table 5.7.

TABLE 5.7: CORRELATIONS BETWEEN APTITUDE AND MATHEMATICS ACHIEVEMENT

APTITUDE	CORRELATION WITH ACHIEVEMENT IN MATHEMATICS
1.VOCABULARY (VOCAB)	0.15
2.VERBAL REASONING (VERBAL)	0.25
3.NONVERBAL REASONING (NONV)	0.35*
4.COMPUTATIONS (COM)	0.36*
5.READING COMPREHENSION (READ)	0.08
6.COMPARISON (COMPAR)	0.06
7.SPATIAL VISUALISATION (V3D)	0.17
8.MECHANICAL INSIGHT (MEC)	0.13
9. MEMORY (MEM)	0.02

\* $p < 0.01$

For all other correlations  $p > 0.05$

In the case of Mathematics the null hypothesis may be rejected for Test 3 (Nonverbal Reasoning) and Test 4 (Computations). Both show significant, positive relationships with Mathematics achievement. However, the relationships with Mathematics achievement seem to be low.

The correlations between the aptitude tests and Natural Sciences achievement are provided in Table 5.8.

TABLE 5.8: CORRELATIONS BETWEEN APTITUDE AND NATURAL SCIENCES ACHIEVEMENT

APTITUDE	CORRELATION WITH ACHIEVEMENT IN NATURAL SCIENCES
1.VOCABULARY (VOCAB)	0.23
2.VERBAL REASONING (VERBAL)	0.26**
3.NONVERBAL REASONING (NONV)	0.39*
4.COMPUTATIONS (COM)	0.32**
5.READING COMPREHENSION (READ)	0.21
6.COMPARISON (COMPAR)	0.07
7.SPATIAL VISUALISATION (V3D)	0.17
8.MECHANICAL INSIGHT (MEC)	0.19
9. MEMORY (MEM)	0.19

\* $p < 0.01$

\*\* $p < 0.05$

For all other correlations  $p > 0.05$

In the case of Natural Sciences achievement the null hypothesis may be rejected for Test 2 (Verbal Reasoning), Test 3 (Nonverbal Reasoning) and Test 4 (Computations). These tests show significant, positive relationships with Science achievement. However, the correlations seem to be low. No other aptitude test showed a significant relationship with achievement in this subject area.

The correlations between the aptitude tests and Economic and Management Sciences (EMS) achievement are provided in Table 5.9.

TABLE 5.9: CORRELATIONS BETWEEN APTITUDE AND EMS ACHIEVEMENT

APTITUDE	CORRELATION WITH ACHIEVEMENT IN EMS
1.VOCABULARY (VOCAB)	0.18
2.VERBAL REASONING (VERBAL)	0.11
3.NONVERBAL REASONING (NONV)	0.18
4.COMPUTATIONS (COM)	0.19
5.READING COMPREHENSION (READ)	0.18
6.COMPARISON (COMPAR)	0.10
7.SPATIAL VISUALISATION (V3D)	-0.00
8.MECHANICAL INSIGHT (MEC)	-0.07
9. MEMORY (MEM)	0.08

For all correlations  $p > 0.05$

In the case of Economics and Management Sciences the null hypothesis can be accepted as none of the aptitude subtests showed significant relationships with achievement in this subject.

The correlations between the aptitude subtests and Human and Social Sciences (HSS) achievement are provided below.

TABLE 5.10: CORRELATIONS BETWEEN APTITUDE AND HSS ACHIEVEMENT

APTITUDE	CORRELATION WITH ACHIEVEMENT IN HSS
1.VOCABULARY (VOCAB)	0.32*
2.VERBAL REASONING (VERBAL)	0.25*
3.NONVERBAL REASONING (NONV)	0.26*
4.COMPUTATIONS (COM)	0.22
5.READING COMPREHENSION (READ)	0.24
6.COMPARISON (COMPAR)	0.04
7.SPATIAL VISUALISATION (V3D)	0.17
8.MECHANICAL INSIGHT (MEC)	0.13
9. MEMORY (MEM)	0.16

\* $p < 0.05$

For all other correlations  $p > 0.05$

In the case of Human and Social Sciences the null hypothesis may be rejected for Test 1 (Vocabulary), Test 2 (Verbal Reasoning) and Test 3 (Nonverbal Reasoning). These tests show significant, positive relationships with achievement in this subject. However, the correlations seem to be low.

### 5.2.3 Hypothesis 3

With regard to hypothesis 3 in section 4.2 the following null hypothesis is stated:

*There is no positive correlation between affective variables and scholastic achievement.*

In order to test the null hypothesis, the correlations between motivation and self-concept as affective variables, and scholastic achievement were calculated. The results are provided in Table 5.11:

TABLE 5.11: CORRELATIONS BETWEEN AFFECTIVE FACTORS AND SCHOLASTIC ACHIEVEMENT

<b>AFFECTIVE FACTORS</b>	<b>ENG</b>	<b>AFRIK</b>	<b>MATH</b>	<b>NAT. SCIENCE</b>	<b>EMS</b>	<b>HSS</b>
MOTIVATION (MOT)	0.36	0.26**	0.29**	0.42	0.49	0.53
SELF-CONCEPT (SELF)	0.39	0.36	0.39	0.48	0.48	0.47

\*\*  $p < 0.05$

For all other correlations  $p < 0.01$

As the above results show, Hypothesis 3 can be rejected as there are positive correlations between both affective variables and achievement in all subjects represented in this study. Both motivation and self-concept show low to moderate, significant correlations with school achievement.

#### 5.2.4 Hypothesis 4

With regard to hypothesis 4 in section 4.2 the following null hypothesis is stated:

*There is no positive correlation between study orientation and scholastic achievement.*

In order to test the null hypothesis, the correlations between study orientation and scholastic achievement were calculated. The results are provided in Table 5.12:

TABLE 5.12: CORRELATIONS BETWEEN STUDY ORIENTATION AND SCHOLASTIC ACHIEVEMENT

<b>STUDY ORIENTATION</b>	<b>ENG</b>	<b>AFRIK</b>	<b>MATH</b>	<b>SCIENCE</b>	<b>EMS</b>	<b>HSS</b>
DELAY AVOIDANCE (DELAY)	0.37*	0.28**	0.39*	0.41*	0.42*	0.52*
WORK METHODS (WORK)	0.35*	0.15	0.27**	0.31**	0.36*	0.47*
STUDY HABITS (STUDY)	0.38*	0.22	0.34*	0.37*	0.41*	0.53*
TEACHER APPROVAL (TAPPRO)	0.18	0.21	0.10	0.12	0.17	0.28**
EDUCATION ACCEPTANCE (EDACC)	0.34*	0.30**	0.34*	0.35*	0.40*	0.51*
STUDY ATTITUDES (SATT)	0.26**	0.26**	0.22	0.24	0.29**	0.40*
STUDY ORIENTATION (SO)	0.35*	0.26**	0.30**	0.33*	0.37*	0.50*

\* $p < 0.01$

\*\* $p < 0.05$

For all other correlations  $p > 0.05$

The above results show that the null hypothesis can be rejected as there are positive correlations between study orientation and all subjects included in the current study. Study Habits appear to be most important in the learning subjects of EMS and HSS showing moderate positive correlations of 0.41 and 0.53. Study Attitudes shows the highest correlation with HSS achievement. Teacher approval does not correlate significantly with five of the six subjects. It only correlates significantly in HSS achievement. Indeed, Study Orientation correlates higher with achievement in the Human Sciences compared to achievement in the other subject areas. All correlations between HSS and the different aspects of study orientation appear to be moderate positive correlations, except for that with Teacher Approval which is a low positive correlation. Afrikaans achievement does not appear to relate strongly with study orientation as two aspects fail to correlate significantly with achievement in this subject, namely Work Methods and Teacher Approval. The variable, Study Habits, does not correlate significantly with achievement in Afrikaans.

#### 5.2.4.1 Explanation of the variance in scholastic achievement using aptitude variables

Overall the aptitude tests did not contribute greatly to the variance in scholastic achievement, and did not explain any of the variance in achievement in Afrikaans, and Economic and Management Sciences.

The lack of a contribution to the variance in Afrikaans is in contrast to the findings of Verwey and Wolmarans (1980:54-55) where the ten Junior Aptitude tests were found to account for between 5% and 30% of the variance in achievement in Grade 9 Afrikaans as a second language. The aptitude test that showed the highest correlation with Afrikaans achievement was the reasoning test



which measures general reasoning aptitude based on verbal and numerical material (Verwey & Wolmarans 1980:7).

An explanation for the difference in predictive validity between the abovementioned results of the JAT and the current findings of the DAT-S may be that the way in which achievement is measured in education has changed from measures based primarily on summative tests and examinations (which measure primarily cognitive variables) to the Outcomes Based Education (OBE) system where the learner is also assessed using creative and practical forms of assessment, such as projects and real-life investigations. OBE assessment takes place continually throughout the year, unlike tests and examinations in the previous system which were held after a relatively long period of learning. The kind of assessment in the OBE system may therefore reward the learner who is creative, practical and motivated rather than one who has high intelligence, but is not necessarily creative or practical, and who does not work consistently through the year.

In the same test as that used in the current study, the DAT-S, Vosloo *et al.* (2000:44) found that eight of the nine aptitude subtests explained between 23% and 51% of the variance in achievement in a second language in Grade 7 (albeit in English). The discrepancy between the amount of variance explained by that study compared to the current investigation may be attributed to differences in grade, language and assessment methods used.

None of the variance in achievement of the Economic and Management Sciences (EMS) could be accounted for by the aptitude variables of the DAT-S. No comparative information about achievement in EMS can be obtained from the literature as this is a new subject introduced to the schools. The closest subject included in the old syllabus would be Accounting but Accounting forms only a part of the EMS syllabus. This fact together with the differences in assessing achievement make it difficult to compare research results.

#### 5.2.4.1.1 Explanation of the variance in first language (English) achievement

In the case of achievement in English as a first language, it appears that Vocabulary knowledge contributes 10% to the variance. An additional 1% in achievement which is not explained by vocabulary is accounted for by verbal reasoning. In total 11% of the variance in English achievement could be explained by aptitude factors. No other aptitude tests contributed to the explanation of the variance. These results correspond with the findings of Verwey and Wolmarans (1983:54-55) which show that the Reasoning and Synonyms subtests of the JAT explain the greatest amount of variance in first language achievement. The abovementioned tests of the JAT measure general reasoning aptitudes as well as knowledge of words and their meanings, aptitudes which are similar to those measured by the Vocabulary and Verbal Reasoning tests of the DAT (Vosloo *et al.* 2000:4-5).

TABLE 5.13: EXPLANATION OF THE VARIANCE IN FIRST LANGUAGE (ENGLISH) ACHIEVEMENT

Variable	R <sup>2</sup>	*F	df
Vocabulary (VOCAB)	0.10	6.74	(1.58)
Verbal Reasoning (VERBAL)	0.11	3.69	(2.57)

\*In all cases  $p < 0.05$

The regression equation for first language achievement in English using aptitude variables can be calculated as follows:

$$Y = 43.420 + 0.874 (\text{VOCAB}) + 0.359 (\text{VERBAL})$$

#### 5.2.4.1.2 Explanation of the variance in Mathematics achievement

With regard to Mathematics achievement, it appears that Computations contributes 13% to the variance and nonverbal reasoning explains a further 2% which is not explained by Computations. A total of 15% of the variance in

Mathematics achievement was accounted for by aptitude variables. No other aptitude tests contributed to the explanation of variance. The importance of a test measuring arithmetic aptitude in order to explain the variance in Mathematics achievement is supported by the studies carried out by Kelly (1999:104) and by Verwey and Wolmarans (1983:54-55). In these two studies, tests of arithmetic aptitude explain between 8% and 42% of the variance in Mathematics achievement. The current finding is supported also by the study of Vosloo *et al.* (2000:44) where the Computations aptitude test has the highest correlation with Mathematics achievement in Grade 7.

TABLE 5.14: EXPLANATION OF THE VARIANCE IN MATHEMATICS ACHIEVEMENT

Variable	R <sup>2</sup>	*F	df
Computations (COM)	0.13	8.82	(1.58)
Nonverbal Reasoning (NONV)	0.15	5.05	(2.57)

\*In all cases  $p < 0.05$

The regression equation for Mathematics achievement can be calculated as follows:

$$Y = 33.662 + 0.935 (\text{NONV}) + 0.973 (\text{COM})$$

#### 5.2.4.1.3 Explanation of the variance in Natural Sciences (NS) achievement

Variance in achievement in Natural Sciences is accounted for by nonverbal reasoning aptitude only. This subtest explains 15% of the variance. No other aptitude variable contributes to the explanation of the variance in NS achievement. The importance of reasoning aptitudes is supported by Verwey and Wolmarans (1983:54-55) whose research reveals that general reasoning aptitudes explain between 20% and 21% of the variance in Science achievement. The current finding is supported also by the study of Vosloo *et al.* (2000:44), which identifies nonverbal reasoning aptitudes as important in

Science achievement. In the study by Vosloo *et al.* (2000:44) 38% of the variance in achievement in Grade 7 is explained by nonverbal reasoning.

TABLE 5.15: EXPLANATION OF THE VARIANCE IN NATURAL SCIENCES ACHIEVEMENT

Variable	R <sup>2</sup>	*F	df
Nonverbal Reasoning (NONV)	0.15	10.80	(1.58)

\*p<0.05

The regression equation for Science achievement can be calculated as follows:

$$Y = 37.869 + 1.613 (\text{NONV})$$

#### 5.2.4.1.4 Explanation of the variance in Human and Social Sciences (HSS) achievement

In the case of HSS two aptitude variables account for the variance in achievement. Vocabulary explains 10% of the variance and Nonverbal reasoning accounts for a further 2% that is not explained by Vocabulary. No other aptitude variables contribute to the explanation of the variance. A total of 12% of the variance is explained. To interpret current findings, previous research regarding achievement in History and Geography will be analysed since both of these subjects are typical examples of the Human Sciences. The importance of vocabulary knowledge and reasoning aptitudes in HSS achievement is supported by the findings of Verwey and Wolmarans (1983:54-55). In their study vocabulary knowledge explains between 13% and 29% of the variance of History and Geography achievement and general reasoning aptitude explains between 11% and 32% of the variance. In the study by Vosloo *et al.* (2000:44), vocabulary aptitude accounts for between 25% and 27% of the variance in History and Geography achievement. Nonverbal reasoning aptitude accounts for between 19% and 31% of the variance in History and Geography achievement (Vosloo *et al.* 2000:44).

TABLE 5.16: EXPLANATION OF THE VARIANCE IN HUMAN AND SOCIAL SCIENCES ACHIEVEMENT

Variable	R <sup>2</sup>	*F	df
Vocabulary (VOCAB)	0.10	6.97	(1.58)
Nonverbal Reasoning (NONV)	0.12	4.02	(2.57)

\*For all cases  $p < 0.05$

The regression equation for HSS achievement can be calculated as follows:

$$Y = 13.400 + 1.647 (\text{VOCAB}) + 0.606 (\text{NONV})$$

### 5.3 EXPLANATION OF THE VARIANCE IN SCHOLASTIC ACHIEVEMENT USING APTITUDE VARIABLES, AFFECTIVE FACTORS AND STUDY ORIENTATION

Affective factors were found to explain more of the variance in certain subjects than aptitude factors. Affective factors accounted for up to 34% of the variance in achievement while aptitude factors could only explain a maximum of 18% of the variance in achievement (see Tables 5.17 to 5.20).

It was found that affective variables, as well as learners' study habits and attitudes in the case of Natural Sciences, account for a greater amount of the variance in achievement than aptitude factors alone (see Tables 5.17 to 5.20). In consideration of this, regression equations are given for predicting achievement using not only aptitude variables but also motivation, self-concept and study orientation factors.

#### 5.3.1 Explanation of the variance in achievement in a first language (English)

Self-concept accounts for 15% of the variance in English achievement. Vocabulary aptitude accounts for a further 16% of the variance that is not explained by self-concept. Verbal reasoning accounts for 1% of the variance not explained by the previous two variables. A total of 32% of the variance is accounted for in English first language achievement when all the predictive variables are used, as opposed to the use of aptitude factors alone which explain

only 11% of the variance (section 5.2.5.1.1). Correlations between English self-concept and English achievement were found by Koutsoulis and Campbell (2001:108-127) to be between 0.39 and 0.42 explaining between 15% and 17% of the variance. This finding supports the results obtained in the current study.

TABLE 5.17: EXPLANATION OF THE VARIANCE IN FIRST LANGUAGE ACHIEVEMENT (ENGLISH)

Variable	R <sup>2</sup>	*F	df
Self-concept (SELF)	0.15	10.92	(1.58)
Vocabulary (VOCAB)	0.31	13.30	(2.57)
Verbal Reasoning (VERBAL)	0.32	9.17	(3.56)

\*In all cases  $p < 0.05$

The regression equation for first language achievement in English can be calculated as follows:

$$Y = 10.871 + 1.156 (\text{VOCAB}) + 0.372 (\text{VERBAL}) + 0.462 (\text{SELF})$$

### 5.3.2 Explanation of the variance in Mathematics achievement

Four variables contribute significantly to the variance in Mathematics achievement. Both nonverbal reasoning and self-concept variables account for 15% of the variance. Computations accounts for a further 1% of the variance not explained by the first two variables. Motivation factors explain a further 1% of the variance. A total of 32% of the variance in Mathematics achievement is explained. These factors explain more of the variance than aptitude variables alone which account for only 15% of the variance (section 5.2.5.1.2).

The correlations between self-concept and Mathematics reported in the literature lie between 0.33 and 0.58 (Koutsoulis & Campbell 2001:108-127) explaining 10% to 33% of the variance in Mathematics achievement. The correlation

between self-concept and Mathematics achievement obtained in the current study is therefore in agreement with the abovementioned research.

TABLE 5.18: EXPLANATION OF THE VARIANCE IN MATHEMATICS ACHIEVEMENT

Variable	R <sup>2</sup>	*F	df
Self-concept (SELF)	0.15	10.82	(1.58)
Nonverbal Reasoning (NONV)	0.30	12.24	(2.57)
Computations (COM)	0.31	8.60	(3.56)
Motivation (MOT)	0.32	6.66	(4.55)

\* In all cases  $p < 0.05$

The regression equation for Mathematics can be calculated as follows:

$$Y = -11.516 + 1.140 (\text{NONV}) + 0.846 (\text{COM}) - 0.318 (\text{MOT}) + 1.134 (\text{SELF})$$

### 5.3.3 Explanation of the variance in Natural Sciences achievement

The use of affective factors and study orientation variables greatly increase the explanation of the variance in Natural Sciences. Self-concept contributes 23% the explanation of the variance in Natural Sciences achievement and nonverbal reasoning accounts for a further 18%. Study orientation explains a further 2% of the variance that is not accounted for by the first two variables. Natural Sciences is the only subject where study orientation contributed significantly to achievement. A total of 43% of the variance in achievement in Natural Sciences is explained by the variables used. This combination of factors accounts for more than the 15% variance explained by aptitude factors alone (section 5.2.5.1.3).

The correlation of 0.48 between self-concept and Science achievement in the current study is higher than those correlations found between the variables in the literature of between 0.21 and 0.27 (Hansford & Hattie 1982:123-142; Coover &

Murphy 2000:125-147; Marsh, Hau and Kong 2002:727-763). This may be attributable to the fact that assessment in the Outcomes Based Education system suits the Science learner who has a positive self-concept regarding his schoolwork.

TABLE 5.19: EXPLANATION OF THE VARIANCE IN NATURAL SCIENCES ACHIEVEMENT

Variable	R <sup>2</sup>	*F	df
Self-concept (SELF)	0.23	17.80	(1.58)
Nonverbal reasoning (NONV)	0.41	19.90	(2.57)
Study Orientation (SO)	0.43	14.42	(3.56)

\*In all cases  $p < 0.05$

The regression equation for Natural Sciences achievement can be calculated as follows:

$$Y = -21.099 + 1.832 (\text{NONV}) + 1.212 (\text{SELF}) - 0.143 (\text{SO})$$

#### 5.3.4 Explanation of the variance in Human and Social Sciences achievement

Four variables contributed significantly in explaining the variance in HSS achievement. Motivation variables account for 28% of the variance, while Vocabulary explains a further 14% not already explained by Motivation. A further 1% of the variance is accounted for by nonverbal reasoning and Self-concept explains 2% of the variance not accounted for by the first three variables. A total of 45% of the variance in HSS is explained which is greater than the 12% variance explained by aptitude factors alone (section 5.2.5.1.4).

The correlation obtained between motivation and HSS achievement in the current study is 0.53 explaining 28% of the variance. This result is in line with the



findings of Leondari and Gialamas (2002:279-291) who identified a correlation of 0.52 between the motivational variable of self-efficacy and achievement. Motivation, in the last mentioned study, explains 27% of the variance in HSS achievement.

The correlation between self-concept and HSS achievement in the current study is 0.47. This correlation is higher than the correlations found between self-concept and scholastic achievement in the literature (from 0.21 to 0.27). This may be attributable to the fact that assessment in the OBE system suits the learner who has a positive self-concept regarding his schoolwork.

TABLE 5.20: EXPLANATION OF THE VARIANCE IN HUMAN AND SOCIAL SCIENCES ACHIEVEMENT

Variable	R <sup>2</sup>	*F	Df
Motivation (MOT)	0.28	23.48	(1.58)
Vocabulary (VOCAB)	0.42	21.02	(2.57)
Nonverbal Reasoning (NONV)	0.43	14.62	(3.56)
Self-concept (SELF)	0.45	11.35	(4.55)

\*In all cases  $p < 0.05$

The regression equation for Human and Social Sciences achievement can be calculated as follows:

$$Y = -51.755 + 2.11 (\text{VOCAB}) + 0.548 (\text{NONV}) + 0.541 (\text{MOT}) + 0.393 (\text{SELF})$$

## 5.4 CONCLUSIONS

In chapter 1 (section 1.2) three questions were stated which comprised the formal problem statement of the study. After the completion of the empirical investigation these questions can be answered as follows:

1. How can individual tests or different combinations of the DAT-S tests be used to obtain a general intelligence score?

A statistical analysis of the relationships between the aptitude tests and the intelligence test scores was carried out. The correlations between most of the aptitude tests and the different scales of the Senior South African Individual Scale – Revised (SSAIS-R) were found to be moderate to high positive correlations. These correlations were used to develop regression equations using the aptitude tests as predictive variables and intelligence as the dependent variable. Age is negatively related to intelligence, that is, the older the learner in Grade 9, the lower the level of intelligence tends to be.

The following aptitude tests are important in predicting verbal intelligence:

- Vocabulary
- Verbal reasoning
- Mechanical Insight

The regression equation for verbal intelligence using the aptitude tests can be calculated as follows:

$$Y = 153.121 + 1.822 (\text{VOCAB}) + 0.822 (\text{VERBAL}) + 0.992 (\text{MEC}) - 0.719 (\text{AGEM})$$

When a rough prediction of verbal intelligence is required, the values may be rounded off. The above equation may then read:

$$Y = 153 + 2 (\text{VOCAB}) + (\text{VERBAL}) + (\text{MEC}) - (\text{AGEM})$$

The following aptitude tests are important in predicting nonverbal intelligence:

- Computations
- Reading Comprehension
- Spatial Visualisation 3D
- Mechanical Insight

The regression equation for nonverbal intelligence using the aptitude tests can be calculated as follows:

$$Y = 120.411 + 0.326 (\text{COM}) + 0.49 (\text{READ}) + 1.463 (\text{V3D}) + 0.507 (\text{MEC}) - 0.371 (\text{AGEM})$$

When a rough prediction of nonverbal intelligence is required, the values may be rounded off. The above equation may then read:

$$Y = 120 + 0.5 (\text{COM}) + 0.5 (\text{READ}) + 1.5 (\text{V3D}) + 0.5 (\text{MEC}) - 0.5 (\text{AGEM})$$

Seven aptitude tests predict general intelligence:

- Vocabulary
- Verbal Reasoning
- Computations
- Reading comprehension
- Spatial Visualisation 3D
- Mechanical Reasoning

The regression equation for general intelligence using the aptitude tests can be calculated as follows:

$$Y = 136.758 + 0.934 (\text{VOCAB}) + 0.525 (\text{VERBAL}) + 0.244 (\text{COM}) + 0.494 (\text{READ}) + 0.746 (\text{V3D}) + 0.896 (\text{MEC}) - 0.268 (\text{MEM}) - 0.579 (\text{AGEM})$$

When a rough prediction of general intelligence is required, the values may be rounded off. The above equation may then read:

$$Y = 136 + \text{VOCAB} + 0.5 (\text{VERBAL}) + 0.5 (\text{COM}) + 0.5 (\text{READ}) + \text{V3D} + \text{MEC} - 0.5 (\text{MEM}) - 0.5 (\text{AGEM})$$

2. How can the aptitude tests be used to predict achievement in the major subject areas?

Statistical analyses of the relationships between the aptitude tests and the main subjects in Grade 9 were carried out.

Two aptitude tests have significant correlations (at the 0.05% level) with achievement in a first language (English):

- Vocabulary (0.32)
- Verbal Reasoning (0.26)

The regression equation for first language achievement in English using aptitude variables is:

$$Y = 43.420 + 0.874 (\text{VOCAB}) + 0.359 (\text{VERBAL})$$

When a rough prediction of first language achievement in English is required, the values may be rounded off. The above equation may then read:

$$Y = 43 + \text{VOCAB} + 0.5 (\text{VERBAL})$$

Two aptitude tests have significant correlations (at the 0.01 level) with Mathematics achievement. They are:

- Computations (0.36)
- Nonverbal Reasoning (0.35)

The regression equation for Mathematics achievement is:

$$Y = 33.662 + 0.935 (\text{NONV}) + 0.973 (\text{COM})$$

When a rough prediction of Mathematics achievement is required, the values may be rounded off. The above equation may then read:

$$Y = 33 + \text{NONV} + \text{COM}$$

Three aptitude tests showed significant correlations with achievement in Natural Sciences. They were:

- Verbal Reasoning (0.26,  $p < 0.05$ )
- Nonverbal Reasoning (0.39,  $p < 0.01$ )
- Computations (0.32,  $p < 0.05$ )

Only the Nonverbal Reasoning test shows sufficient predictive power to be used in the regression equation. The regression equation for Natural Sciences achievement is:

$$Y = 37.869 + 1.613 (\text{NONV})$$

When a rough prediction of Science achievement is required, the values may be rounded off. The above equation may then read:

$$Y = 37 + 1.5 (\text{NONV})$$

Three aptitude tests show significant correlations (at the 0.05 level) with Human and Social Sciences. They are:

- Vocabulary (0.32)
- Verbal Reasoning (0.25)
- Nonverbal Reasoning (0.26)

Only the Vocabulary and Nonverbal reasoning tests have enough predictive power to be used in the regression equation. The regression equation for HSS achievement is:

$$Y = 13.400 + 1.647 (\text{VOCAB}) + 0.606 (\text{NONV})$$

When a rough prediction of HSS achievement is required, the values may be rounded off. The above equation may then read:

$$Y = 13 + 1.5 (\text{VOCAB}) + 0.5 (\text{NONV})$$

No aptitude test correlates significantly with achievement in Afrikaans as a second language or with Economic and Management Sciences. Therefore, no regression equation could be developed for achievement in these subjects.

3. How can the aptitude tests in combination with other variables, such as self-concept, motivation and study orientation predict achievement?

Correlations between the aptitude tests, affective factors, study orientation and achievement in the major subjects in Grade 9 were calculated. Motivation, Self-concept, as well as Study Orientation show low to moderate significant correlations with scholastic achievement. Statistical analyses were carried out using the affective variables and Study Orientation as predictive variables and scholastic achievement in the different subjects as dependent variables. Only those variables with sufficient predictive power are included in the regression equations. The regression equations using the predictive variables are:

First language achievement in English:

$$Y = 10.871 + 1.156 (\text{VOCAB}) + 0.372 (\text{VERBAL}) + 0.462 (\text{SELF})$$

When a rough prediction of first language achievement in English is required, the values may be rounded off. The above equation may then read:

$$Y = 10 + \text{VOCAB} + 0.5 (\text{VERBAL}) + 0.5 (\text{SELF})$$

Mathematics:

$$Y = -11.516 + 1.140 (\text{NONV}) + 0.846 (\text{COM}) - 0.318 (\text{MOT}) + 1.134 (\text{SELF})$$

When a rough prediction of Mathematics achievement is required, the values may be rounded off. The above equation may then read:

$$Y = 11 + \text{NONV} + \text{COM} - 0.5 (\text{MOT}) + \text{SELF}$$

Natural Sciences:

$$Y = -21.099 + 1.832 (\text{NONV}) + 1.212 (\text{SELF}) - 0.143 (\text{SO})$$

When a rough prediction of Natural Sciences achievement is required, the values may be rounded off. The above equation may then read:

$$Y = -21 + 2 (\text{NONV}) + \text{SELF} - 0.1 (\text{SO})$$

Human and Social Sciences:

$$Y = -51.755 + 2.11 (\text{VOCAB}) + 0.548 (\text{NONV}) + 0.541 (\text{MOT}) + 0.393 (\text{SELF})$$

When a rough prediction of Human and Social Sciences achievement is required, the values may be rounded off. The above equation may then read:

$$Y = -51 + 2 (\text{VOCAB}) + 0.5 (\text{NONV}) + 0.5 (\text{MOT}) + 0.5 (\text{SELF})$$

## CHAPTER 6

### EDUCATIONAL IMPLICATIONS AND RECOMMENDATIONS

#### 6.1 INTRODUCTION

The purpose of the investigation was to determine in what way aptitude, as measured by the Differential Aptitude Test Form S, could be used to predict intelligence and scholastic achievement in Grade 9. The prediction value of aptitude in combination with other variables such as motivation, self-concept and study orientation was also investigated.

In the light of the abovementioned aim a literature study was carried out to:

- Analyse the constructs, intelligence and aptitude.
- Establish the relationship between intelligence, aptitude and scholastic achievement.
- Analyse the constructs motivation, self-concept and study orientation and to determine to what extent they relate to scholastic achievement in combination with aptitude scores.

An empirical investigation was carried out in order to test hypotheses regarding the:

- Relationship between general intelligence and aptitude.
- Use of aptitude measures to predict intelligence.
- Prediction of scholastic achievement by combining aptitude scores with affective factors and study orientation.



Reliable instruments were used to measure the different variables. The scores were used to determine how the variables correlate with one another. The scores were also used to obtain regression equations to predict intelligence as well as scholastic achievement in Grade 9 subjects.

The findings indicated that the aptitude subtests predict a significant proportion of intelligence. However, many of the aptitude subtests do not predict a significant proportion of scholastic achievement in Grade 9. It was found that motivation and especially self-concept scores, accounted for more of the variance in most subjects compared to aptitude scores alone.

The implications of these results will be discussed under the following headings:

- Subject choice
- Learning problems and poor performance
- Differentiation of the difficulty level of schoolwork
- Emotional and behavioural problems

In the discussion of the implications, recommendations will be made for parents, the class teacher, the life orientation teacher and the educational psychologist.

## **6.2 RECOMMENDATIONS**

### **6.2.1 Subject choice**

One of the most important reasons for administering an aptitude test in Grade 9 is to determine which subjects should be chosen for Grade 10 to Grade 12. Since the DAT does not explain a great deal of the variance in scholastic performance (section 5.2.4.1) it is recommended that the educational psychologist will not use the DAT on its own, but rather in conjunction with motivation, self-concept and study orientation measures (Vosloo *et al.* 2000:2). It is further advised that other tests, for example

achievement tests, be added to the assessment process to determine which subjects the learner should study in Grade 10.

## **6.2.2 Learning problems and poor performance**

### 6.2.2.1 Identification of the presence of learning problems

It was stated in Chapter 1 (section 1.1) that the presence of learning problems is often inferred when there is a discrepancy between a learner's general intelligence level and their scholastic achievement. The DAT can be administered to obtain an estimated level of intelligence which can then be compared to the learner's school performance. If the learner's level of school achievement is below what would be expected of the learner considering his level of intelligence, this could be a warning of the presence of learning problems and would indicate the need for further testing and exploration. Interventions to assist the learner, for example with remedial help can then be planned.

### 6.2.2.2 Diagnosis and remediation of learning problems

The DAT, together with the motivation and self-concept questionnaire as well as the study orientation questionnaire, can be used as diagnostic tests to identify the presence of learning problems. The current study indicates that poor scholastic performance can be attributed to a low aptitude for the subject, an unsatisfactory scholastic self-concept, lack of motivation or inadequate study orientation regarding schoolwork.

When all the variables were analysed, self-concept and motivation factors were found to relate more strongly than aptitude variables to achievement in Natural Sciences and Human and Social Sciences. In other subjects, self-concept, motivation and study orientation were significantly related to achievement. If a learner is not progressing

satisfactorily he can be assessed using the DAT, the self-concept and motivation questionnaire as well as the study orientation questionnaire. While little can be done to improve intelligence or aptitude, parents, teachers and psychologists can contribute to the improvement of a learner's self-concept, motivation and study orientation.

Self-concept appears to be strongly related to achievement in Natural Sciences achievement. Both self-concept and aptitude show equally strong relationships with Mathematics achievement. Self-concept shows a slightly weaker relationship with English first language achievement compared to aptitude, and is significantly related to Human and Social Sciences achievement. If a learner is not performing well in these subjects his or her self-concept scores could be affected.

If the learner's self-concept is poor, it can be improved through intervention by parents, the class teacher, the life orientation teacher and the educational psychologist. The following guidelines for improving the learner's self-concept are provided based on information obtained in the literature study.

- Since high achievement raises the academic self-concept (Schmidt & Padilla 2003:37-46) and intervention at the lowest (behavioural) level of the self-concept hierarchy is most effective (Marsh & Shavelson 1985:107-123), teachers should make sure that the everyday activities in the classroom are geared to provide opportunities for success. Learners who perceive themselves as being able, for example to correctly observe and note down the results of an experiment, is likely to develop a positive science self-concept.

- Learners form their self-concepts by comparing their performance with the performances of others (Marsh & Yeung 2001:389-420). In the classroom, learners who perform poorly can be paired with weaker or younger learners so that they have opportunities to perceive their achievement in a more positive way. This may lead to an improved academic self-concept. A high academic self-concept, in turn leads to increased achievement (Marsh 1990:646-656).

Motivation appears more strongly related to Human and Social Sciences achievement than aptitude. It is significantly related to Mathematics achievement. The following suggestions based on the literature study are provided to improve a learner's motivation regarding his or her school work.

- While intrinsic motivation is the best type of motivation, external reinforcement of behaviour should not be discounted. Motivation in the classroom can be improved through positively reinforcing effort and progress made by the learner. Positive reinforcement can take the form of praise by the teacher. Other means of recognition such as the allocation of marks can also be used.
- Teachers need to remember that what motivates one learner may not motivate another. They therefore need to know their learners well in order to motivate them effectively. Contact with parents in this regard is helpful.
- Parents, as well as the class teacher, life orientation teacher and educational psychologist can help the learner to set attainable achievement goals. Learners who are able to meet their academic goals will be more motivated to undertake future tasks and persevere until they attain success.

- According to Abraham Maslow's hierarchy of needs, learners must have their lower needs satisfied, for example for food and safety, before they can satisfy their need to know and understand the environment (Woolfolk 1995:341). Parents should, therefore make sure that their children eat before they go to school, and teachers must create a classroom atmosphere in which pupils feel safe.
- Deci and Ryan (Bester 1998:28) as well as Ramseier (2001:421-439) state that learners are more motivated if they have a feeling of control over the learning process. Teachers can, therefore give learners choices. For example, they can assign a project but give different options regarding the content and method of presentation.
- The life orientation teacher and the educational psychologist need to determine a learner's attributions regarding his schoolwork. A learner who attributes his performance in a test to luck, may not have a high expectation of future success. The anticipation of probable failure may result in a decrease in motivation, because the learner may think that there is little to be gained by trying. If the learner attributes his good mark to effort, he may have higher levels of motivation and feel that he can achieve success if he tries hard enough (Eccles & Wigfield 1995:215-225).
- The life orientation teacher and the educational psychologist need to help the learner identify motivational goals for school achievement. The learner who is focused on mastering his school work (mastery goals) or who wants to perform better than others (performance goals) is more likely to achieve well (Tanaka & Yamauchi 2001:123-135; Bouffard, Boileau & Vezeau 2001:589-604). A learner may have avoidance goals and avoid or neglect

academic tasks. The learner with avoidance goals often does the minimum amount of work in class, rarely attempts or completes homework, and usually fails tests with very low marks. The learner who has avoidance goals needs to formulate mastery and performance goals. Mastery goals can be encouraged by teachers, through, for example the clear description of requirements and standard of work expected. Performance goals can be established by encouraging competition between learners.

- Children whose parents bring them up to value education as a goal in itself, are more motivated to achieve scholastically (Elliot, Hufton, Illushin and Lauchlan 2001:38-68; Schultz 1997:193-102). Therefore, in homes where there is an emphasis on being well-educated and well-informed, learners are more likely to identify with the goals of the school.

Study orientation significantly relates with achievement in Natural Sciences. The current study showed that the following specific study habits and attitudes which form part of the learner's study orientation, are related to Natural Sciences achievement:

- ability to complete tasks timeously
- application of appropriate work methods
- acceptance of the goals of education

The Natural Sciences teacher should emphasise the importance of completing work timeously, for example to instruct learners to complete a task on the day it is assigned, and not to wait until the day before it is due. Parents can play an important role in this regard by monitoring the completion of homework, and limiting television viewing time which has been shown to be detrimental to academic achievement (Suh & Suh

2006:11-20). The Natural Sciences teacher should inform learners of specific study methods appropriate for learning the Natural Sciences, for example summarising information using keywords.

The following additional guidelines based on information in the literature study can help learners to achieve at school.

- All subject teachers have a responsibility to educate learners about the most effective study techniques for their subjects. For example, Mathematics is not primarily a learning subject, but one in which the application of methods and rules must be practised. Teachers need to inform learners of this and explain or model how to master the work.
- Teaching students how to identify and underline important information, take notes, make summaries and use visual diagrams should be done by subject teachers, life orientation teachers and educational psychologists. The use of the above study techniques helps learners to attach meaning to the content, actively decide what information is important and to structure information in their long-term memory (Eggen & Kauchak 1994:385-386).
- Comprehensive strategies which combine different study techniques into a multi-step approach make learning easier. The life orientation teacher can show learners how to use, for example the SQ4R method (Survey, Question, Read, Reflect, Recite, Review) to master their school work (Eggen & Kauchak 1994:387).
- Learners who are aware of a variety of study techniques and methods are able to choose those that best fit their needs.

- Parents can help their children to achieve by ensuring that they study consistently throughout the year and do not merely cram before tests and exams. Encouraging children to study not only during the week, but also on weekends and in the evenings raises academic achievement (Rau & Durand 2000:19-38).
- Regular completion of homework is an important requirement at school (Cooper, Lindsay, Nye & Greathouse 1998:70-83). Parents and teachers, therefore need to constantly check that homework has been correctly done.

### **6.2.3 Differentiation of the difficulty level of schoolwork**

It was stated in Chapter 1 (section 1.1) that determination of a learner's general intelligence score is important when differentiation of schoolwork in the mainstream classroom is considered. The DAT can be used to obtain a general intelligence score so that it can be decided whether, for example a learner needs enrichment activities to stimulate a gifted intellect, or whether the learner could benefit from a slow pace and extra practice when new concepts are introduced.

### **6.2.4 Emotional and behavioural problems**

Emotional or behavioural problems often develop as a result of difficulties with schoolwork and require the combined efforts of parents, the class teacher and the educational psychologist. Signs that indicate that a learner is experiencing serious difficulty in coping emotionally may manifest in several ways. The learner may show overt anger towards the teacher, peers and towards the school in general. Depression and anxiety can also result if learners cannot succeed with their schoolwork. The strong relationship between affective factors and school achievement has been highlighted in the current study.



In this section the focus will be on emotional and behavioural problems with specific reference to the self-concept and motivational factors.

The aggressive learner may feel that he is never going to succeed. He may perceive his continual failure as a threat to his self-concept and his sense of capability. In response the learner may react with aggression towards people who are connected with the school. The learner may talk back to the teacher, neglect his school books, be aggressive towards his peers or damage school property.

Bester (2003:256) states that the social relationship between the teacher and the learner is important in the formation of the affective aspects of a learner. The teacher therefore, needs to cultivate a warm and supportive relationship with the aggressive learner so that he feels that someone believes in his ability to succeed, and that he is not alone in his difficulties.

The educational psychologist plays an important role in helping the aggressive learner. Person-centred therapy can be used to establish an empathic relationship between the psychologist and the learner. Here, the learner experiences a safe space in order to identify and work through his feelings of, for example hurt and inadequacy. Later, action therapies, for example Reality Therapy, aimed at helping the learner to work constructively towards his academic goals, can be used.

A depressed learner often has a negative academic self-concept and lacks motivation for schoolwork. He may feel that he is “useless at schoolwork” and that trying for future success at school is “hopeless”. The educational psychologist can assist the learner by providing therapy aimed at improving his academic self-concept and motivation for schoolwork. Cognitive Behavioural Therapy and Reality Therapy may be particularly

helpful. Therapeutic techniques developed by Beck (Corey 2005:289) such as challenging the tendency of the depressed learner to focus on his academic inadequacies, disputing the learner's negative interpretations of scholastic events and his feelings of helplessness, would be helpful. Glasser's Reality Therapy can be used to help the learner through application of the WDEP system (Corey 2005:325-328). This approach helps the learner to:

- Become conscious of his wants and needs regarding school achievement
- Become aware of what he is currently doing regarding his schoolwork
- Evaluate whether his actions are bringing him closer to what he wants regarding achievement
- Take action to attain what he wants to achieve academically

Anxious learners may have a poor self-concept due to unrealistic expectations of their abilities, often believing that they have to improve their performance no matter how well they achieve. They may become so anxious that they are unable to complete tasks or perform in test situations. Setting realistically obtainable goals is necessary to avoid the development of a low self-concept and lack of motivation for schoolwork (Bester 1998:3). Therapy, such as Cognitive Behavioural Therapy, aimed at identifying unrealistic expectations and bringing those expectations in line with current and previous achievement at school, may be carried out by the educational psychologist. Use of Rational Emotive Behaviour Therapy (REBT) developed by Albert Ellis (Corey 2005:271-272), may help the anxious learner to deal with situations in more positive and less anxiety-provoking ways. In REBT the following components need to be identified, and ways in which these components interact should be understood by the learner:

- A – Activating event (event that arouses anxiety, for example a test)
- B – Belief (beliefs related to the activating event, such as “I will be disgraced if I do not get at least 80%”)
- C – Emotional and Behavioural consequence (experience of panic and “freezing up” in the test situation)
- D – Disputing intervention (“it is not a disgrace to get less than 80% on a test”, “I am worthy of respect even if I get less than 80%”)
- E – Effect (healthy thoughts, such as “I will do my best in this test”, “I will not expect more of myself than what I can realistically do”)
- F – New Feeling (instead of feeling overwhelmingly anxious, the learner feels a healthy tension associated with taking a test)

### **6.3 EVALUATION OF THE INVESTIGATION**

The current study has made contributions to the literature regarding the uses of the Differential Aptitude Test, as well as the influence of various factors on school achievement in Grade 9.

- 1) In the past aptitude tests have been used not only to obtain information about aptitudes, but also to estimate a learner’s level of general intelligence. In Chapter 1 (section 1.1) it was stated the relationship between the DAT (as an aptitude test) and general intelligence had not been established in previous studies. The current study has filled this gap and the relationship between the general intelligence and aptitude has been determined. In addition, the relationship between aptitudes as measured by the DAT, and achievement in Grade 9 had not been determined. The current study has identified and described these relationships.

- 2) In Chapter 2 it was stated that aptitude and intelligence were closely related to each other. The current study supports that assertion because the Differential Aptitude Test and the Senior South African Individual Scale – Revised correlate very highly with each other. As a result of this study it is clear that the DAT measures both specific aptitudes and general intelligence. Furthermore, the high correlations between the DAT and the SSAIS-R established in this study make it possible to predict intelligence from the DAT scores through the use of regression analyses. This makes the DAT a more useful and time-effective test to use.
  
- 3) In Chapter 1 (section 1.1) it was stated that both cognitive and affective factors contribute to scholastic achievement. According to Bloom (1976:10) the most important factors are cognitive variables such as aptitudes, while other variables, such as affective factors, explain a lesser amount of scholastic achievement. In contrast to this viewpoint the current study shows that affective factors may be more important than aptitude variables (measured by the DAT) in achievement. It appears that affective factors account for more of the variance in achievement in Natural Sciences as well as in Human and Social Sciences. Both self-concept and aptitude show equally strong relationships with Mathematics achievement. Self-concept shows a slightly weaker relationship with English first language achievement compared to aptitude. The importance of affective factors in Grade 9 achievement may be due to changes in measuring achievement under the Outcomes Based Education system in the schools. It may be possible that Outcomes Based Education is measuring a kind of emotional intelligence as well as cognitive intelligence.

The predictive validity of the current study may be compromised by the small sample size of 60 learners. However, the administration of 60 intelligence tests which are individual tests and take between 75 and 90 minutes each, is a time

consuming task. A larger sample size would have taken a greater amount of time which would have made the study excessive for a dissertation of limited scope.

#### **6.4 POSSIBILITIES FOR FUTURE RESEARCH**

In the current study the relationship between aptitude, as measured by the DAT-S, and Grade 9 scholastic achievement was investigated. It was found that many aptitudes did not correlate significantly with achievement in the school subjects. The correlations that did reach significance fell into the low range (0.25 to 0.39). Affective factors, however showed significant relationships with all of the subjects, the strength of correlation ranging from low to moderate (0.26 to 0.53). In future research, therefore it would be important to investigate the reasons for the higher correlations between affective variables and achievement compared to cognitive variables. In addition, other variables, such as previous achievement, could be added to aptitude and affective factors to increase the accuracy in predicting achievement.

Grade 9 achievement scores on their own or in combination with aptitude and affective variables, could be used to predict Grade 11 scores. These scores could also be used to predict Grade 12 achievement, assisting in the identification of possible matriculation failure. Grade 11 achievement scores may be used on their own or in combination with aptitude and affective factors for Career Guidance purposes. The scores may be used to predict achievement in different subjects at tertiary level.

In section 6.2.3.2, suggestions regarding the diagnosis and remediation of learning problems are made. In future research, the outcome of these recommendations could be empirically established.

In the current study a random sample of learners was selected and the relationship between affective factors and their achievement became clear. In future research specific samples of learners who experience learning problems, emotional

difficulties or behavioural problems may be selected to study the relationship between their problems, affective factors and school achievement.

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# **APPENDIX**

## **MOTIVATION AND SELF-CONCEPT QUESTIONNAIRE**

## SECTION B

### INSTRUCTIONS

Answer the following questions by giving yourself a number between 1 and 6. Write this number in the block next to the question.

This is **exactly** how  
I experience it

6 5 4 3 2 1

This is **not at all** how  
I experience it

Remember this is about what **you** think about **yourself**, not how others evaluate you.

1. I am always motivated to go to class.   
c12
2. In a learning situation I sometimes feel unsure of myself.   
c13
3. If a task is hard to learn I give up easily.   
c14
4. I hate to study.   
c15
5. I have hope for myself as a learner.   
c16
6. If I do not meet my study obligations, it bothers me.   
c17
7. I feel that I am achieving something with my studies.   
c18
8. As a learner, I am disappointed in myself most of the time.   
c19
9. When it comes to studying I put work before pleasure.   
c20
10. I am usually enthusiastic when I begin to study but later I  
become less enthusiastic.   
c21
11. I feel proud of what I have already achieved in my studies.   
c22
12. I always look for excuses not to do my schoolwork.   
c23

13. I have confidence in myself when I have to perform a task or write an examination.   
c24
14. I set goals for my studies and try to reach them.   
c25
15. I catch up work that I have missed.   
c26
16. I fail most learning tasks which I attempt.   
c27
17. Where my schoolwork is concerned I use my time productively.   
c28
18. I am ashamed of my shortcomings in schoolwork.   
c29
19. It bothers me if my work for the day is not finished.   
c30
20. I do not have enough self-confidence to do a presentation before an audience.   
c31
21. I can overcome obstacles in my studies because I believe in myself.   
c32
22. I study when I feel like it.   
c33
23. If a task is too difficult I do not even try to learn it.   
c34
24. I have my schoolwork under control – I know where I am going to.   
c35
25. I am reluctant to learn new, challenging tasks.   
c36
26. I like to learn new work and extend my skills.   
c37
27. I sometimes feel that I will never produce good work.   
c38



28. I sometimes feel that I will never get anywhere with my schoolwork.   
c39

29. Where my schoolwork is concerned, I see myself as a hard worker.   
c40

30. My school performance is acceptable to me.   
c41

31. As a learner I sometimes doubt myself and what I can achieve.   
c42

32. I am determined to do my schoolwork to a high standard.   
c43

33. I am ashamed of the standard of my schoolwork.   
c44

34. I do not have to be told to do my schoolwork.   
c45

35. Where my schoolwork is concerned I do what I am meant to do but nothing extra.   
c46

36. To do my schoolwork gives meaning to my life.   
c47

37. As a school learner I am a struggler.   
c48

38. I am motivated to learn difficult, challenging work.   
c49

39. I always postpone doing my homework.   
c50

40. I would like to change many things about myself as a school learner if I could.   
c51

c52  
For office use