Investigating the Impact of a Psychometric Assessment Technique in the South African Automotive Industry

By

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"Building a new and prosperous nation is itself our own humble contribution to the well-being of humanity as a whole".

Thabo Mbeki,
South African president,
State of the Nation Address,
14 February 2003.

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ABSTRACT

This research takes place in a South African multinational automotive industry, which needs to be on the forefront for being globally competitive and sustainable to remain viable in the country. A strategic initiative was embarked upon to identify talent within their staff population, through the psychometric assessment of learning potential. The objective was to identify high potential employees and provide them with the requisite training and development to meet the demands of the rapidly advancing technology.

The primary purpose of this study is to investigate the usefulness of the Ability, Process of Information and Learning Battery (APIL) as a psychometric assessment tool for identifying talent, within a heterogeneous workforce. This research adopts a cross-cultural approach as it is comparative in nature and addresses the adequacy of a psychometric instrument in a multicultural context. The Employment Equity Act has transformed the landscape of the use of psychological measurement in South Africa, in that it stipulates that no psychological test that is biased against any cultural group can be used.

A sample of 841 heterogeneous staff employees was assessed with three major research objectives: (a) to ensure that the instrument could stand scientific scrutiny thereby complying with the Employment Equity Act; (b) to recommend ways the organisation can identify and understand employees' talent more holistically; and (c) to manage talent more effectively.

The heterogeneous sample was divided into six homogeneous subsets for statistical analysis. This research attempted to answer the first objective through the examination of internal consistency, bias and equivalence of the APIL. Results showed good internal consistency, very good construct equivalence and low item bias, demonstrating the APIL can be applied fairly in a multicultural industrial setting. The second objective was determined by investigating whether

significant difference in mean learning potential scores occur among the identified subsets in the sample. Statistical analyses provide clear trend lines indicating that sociopolitical and socioeconomic factors of advantagement and disadvantagement, age and education influence learning potential. However it is also evident that there are individuals across all subsets that demonstrate strong cognitive potential. This supports the rationale on which the APIL was developed, in that it distinguishes people with high learning potential despite the fact that there may be gaps or limitations in skill repertoire due to past disadvantagement. Recommendations to address the third objective is provided by aligning learning potential with the performance management system to provide a holistic overview of the talent composition. This will assist in the identifying of strategic training and development interventions needed at the individual, functional and organisational level, which is key for the South African automotive industry to remain competitive and viable.

CHAPTER 1
THE RESEARCH PROBLEM AND ITS SETTING

1.1 Introduction

South African industry leaders believe that the shortage of skilled workers is the biggest constraint to business growth for the third consecutive year and the greatest impediment to growth in South Africa, necessitating them to develop strategies that enable them to respond quickly to changes in the market place (Grant Thornton report, 2009). Joubert (2007) believes that the solution to South Africa's social and economic turnaround lies in creating an environment for talent and nurturing this talent.

In this chapter, an overview of the research problem is given. Orientation to the research of learning potential to identify talent in multicultural industrial settings is provided. The importance of the study and the main research aims are also presented, including the identification and definition of core concepts.

1.2 The Research Problem

In the emerging competitive business world, South African organisations have to find different and innovative ways to stay ahead against a backdrop of a shortage of skilled workers (Veldsman, 2007). An organisation's market value and financial success rely increasingly, *inter alia*, on employees' competence and knowledge (McLagan, 1997). In South Africa, the need for skills training and upgrading of people is a prerequisite for enduring world-class competitiveness, organisational excellence and appropriate levels of labour productivity (Khumalo, 1999; Van Zyl, 1999).

Groenewald and Schurink (2003) argue that the apartheid heritage presents major challenges for developmental opportunities of talented people in South Africa. Economic integration of the previously disadvantaged majority is now one of the highest priorities of the ruling African National Congress administration. To afford everyone an equal opportunity to secure a position in industry psychological testing in South Africa needs to take into account the country's political, economic, and social history (Claassen, 1997).

The South African context is both unique and complex, which creates challenges in the field of psychological assessment and the development of psychological tests (Claassen, 1997; Foxcroft, 1997; Owen, 1998; De Beer, 2000). All psychometric tests are not necessarily fair in a selection process for people from different cultures, different socio-economic or educational backgrounds. People from a low socio-economic group and/or educational disadvantaged background usually score lower marks on achievement and aptitude tests (Jensen, 1980; Claassen, 1990; Owen, 1998). It is for this reason why psychological tests in South Africa have been viewed with considerable skepticism, in particular by previously disadvantaged groups. However recently there has been a renewed appreciation for the contribution that these instruments can make in terms of fair and equitable decision making; providing that the tests comply with legislative requirements (Van der Merwe, 2002; De Beer, 2003). Since the first democratic elections, held in 1994, South Africa has had a new constitution which placed stronger demands on the cultural appropriateness of psychological tests. This culminated in the promulgation of the Employment Equity Act 55 of 1998, Section 8 (Government Gazette, 1998, p.9). This legislation stipulates "Psychological testing and other similar assessments are prohibited unless the test or assessment being used (a) has been scientifically shown to be valid and reliable, (b) can be applied fairly to all employees; and (c) is not biased against any employees or group."

The automotive industry is a key driver of the global economy and hence needs to be on the forefront for being competitive and sustainable. Most existing factories of the Original Equipment Manufacturers (OEMs) (e.g., Toyota, Mercedes Benz, Volkswagen, etc) have to be periodically renewed, retooled, refurbished and replaced to remain competitive, with “nowhere for the inefficient to hide” (Cokayne, 2005). The South African automotive industry requires a highly skilled workforce to operate in an increasingly technologically advanced environment where economic pressures demand a lean, cost-effective operating structure. The only way the South African automotive industry can protect its investments, including the hundreds of thousands of people (450 000 direct and indirect workers are reliant on the industry for employment) is to become and remain globally competitive on all fronts (Cokayne, 2005; Dlamini, 2009). Such competitiveness requires competent performers who can lead the organisation through environmental pressures to change. McCauley and Wakefield (2006) stress that organisations must have the ability to identify the most talented individuals, provide them with the necessary training and experiences, and retain them in the long term for future performance sustainability. From the above argument, it is clear that the quality of the South African workforce will, to a large extent, determine the country’s future economic growth and global competitiveness.

Many organisations rely solely on their performance management system to monitor performance, and an organisation may lose employees with potential if only one method of assessment is utilised (Grote, 1996). By relying on a single instrument or process to assess likely work performance as well as to identify future leaders may also be risky in terms of the current South African legislation framework. Foxcroft and Roodt (2006) recommend that organisations utilise a multidimensional assessment framework, which includes more than one assessment instrument, ensuring that assessment processes are less susceptible to criticism and to counteract legislative challenges.

In South Africa's post-apartheid society it is still acknowledged that enormous social and economic inequality still exists. There is recognition that social and economic conditions shape people's experiences, which can also be the causes of individual intellectual differences, as well as their consequences (Cole, 2010).

The Society for Industrial Psychology (1998) defines psychological assessment as ''including psychometric testing plus any other procedure used to assess human performance or potential''. Intelligence is measured distinctly as either an intelligence test score or as a learning potential test score (Hamers & Resing, 1993), which essentially refers to traditional static tests and dynamic tests respectively. Murphy (2006) believes that if static assessments continue to be used in South Africa, such as conventional intelligent quotient (IQ) tests, from which inferences are made about who will receive special treatment and thereby stigmatising other candidates, some candidates may be put at a disadvantage in terms of not being able to develop their full potential. According to De Beer (2006), learning potential is concerned with an overall cognitive capacity, including current and projected performance, which implies that intelligence is changeable when mediated. De Beer (2003) argues that there is a need in South African industry for psychological tests that can be used for all cultural groups without discriminating against subgroups. Cross-cultural use of tests can be discriminatory if they are not standardised for use across all cultural groups on representative samples (Van de Vijver & Rothmann, 2004).

The Employment Equity Act (EEA) stipulates that an applicant's suitability for a job depends, amongst others, on the "capacity to acquire, within a reasonable time, the ability to do the job" (Government Gazette, 1998). The EEA also states that in making decisions on job suitability an employer may not unfairly discriminate against a person solely on the grounds of lack of relevant experience. Sternberg and Grigorenko (2002) state that the ability to assess and identify employees who have the potential to learn new tasks, rather than only being able to demonstrate the skills they have learned, should have an impact on

the prediction of the manner in which employees ultimately perform in the workplace. It is for this reason that assessing for learning potential is crucial in the South African context. The high costs involved in training and the consequences of ill-fit between job and individual suggests that only employees with a reasonable chance to succeed should be identified through a selection process. In the past, traditional assessment techniques measured the already learned skills acquired from past opportunities, even though opportunities were not fairly provided in the past (Van Aswegen, 2000). Historically disadvantaged individuals had fewer opportunities to acquire knowledge and skills, prior to the new education dispensation. Today legislation such as the Skills Development Act 97 of 1998 (RSA, 1998) requires organisations to invest in ongoing training and development in order to redress the educational imbalances of the past in South Africa.

In an attempt to provide more equitable cognitive assessment, the measurement of learning potential has received increasing attention in South Africa (De Beer, 2003). Boeyens (1989) suggests that, to ensure fair selection, provision should be made for individuals who had inadequate school education, but who have the cognitive potential to obtain a tertiary qualification or learn new skills. The psychometric tests that are used for selection purposes should therefore assess learning potential rather than measuring crystallised cognitive competencies that often reflect formal education and school background. Charan, Drotter and Noel (2001) take the concept of potential further, they believe in human beings' ability to develop; and that society cannot achieve economic or cultural progress without it. These authors developed the Leadership Pipeline model classifying potential into three categories: (a) turn potential (able to do the work at the next level in three to five years or sooner); (b) growth potential (able to do the work of bigger jobs at the same level in the near term); and (c) mastery potential (able to do the same kind of work currently being done only better).

The impetus for this exploratory research has been the need to investigate whether a specific psychometric instrument stands up to scientific scrutiny imposed by the EEA. This would provide evidence that it is a useful tool for the identification of talent across a wide variety of occupations and staff levels, in a technically advanced automotive industry, within the South African multicultural society.

1.3 The Research Setting

In 2008, in an endeavour to retain global market leadership the research division in a multinational OEM in the Eastern Cape embarked on a strategic initiative. The aim was to meet global targets in terms of product cost, quality and delivery efficiency to negate the comparative disadvantages in economies of scale and excessive geographic distance in terms of global export markets and logistics supply pipeline. In response to these challenges, a strategic human resource plan was designed, requiring the organisation to strike a balance between headcount optimisation, talent retention and competence enhancement, without incurring losses in competent staff who are difficult to acquire externally.

Prior to this research study the organisation relied solely on its performance management system to identify talent. To ensure equal opportunity for all staff members, as well as meeting legislative requirements, management made a decision to embark on an extensive psychometric testing process to identify individuals with high learning potential. With a concurrent moratorium on external recruitment for the organisation, this study of the strategic staffing initiative will provide valuable information on the usefulness of a psychometric test battery to identify high-risk, high-cost strategic staffing issues, for a South African OEM, its international holding company and other similar companies.

1.4 Objectives of this research

In order for the OEM to remain a global competitor, management needs a highly skilled workforce. The primary purpose of this study is to investigate the usefulness of the Ability, Process of Information and Learning Battery (APIL) as a psychometric assessment tool for identifying talent, within a heterogeneous workforce. The APIL evaluates fundamental cognitive capabilities and potentialities rather than assessing existing specific skills and knowledge.

According to the APA (1999) guidelines, 'usefulness of an instrument' refers to the validation process which is determined by the degree to which evidence and theory support the interpretations of the test scores for the proposed uses of the test.

Heterogeneity refers to a plethora of variables that include (but are not necessarily limited to): race, culture, socio-economic status, historical and present advantagement or disadvantagement, and language (Zollezzi, 1999).

1.4.1 Aims of the research

To understand the need for this study one can question the appropriateness of including a psychometric test to identify talent in a South African industrial context. In order to determine the usefulness of the APIL the following aims were developed:

1. The first aim was to determine whether the APIL can stand up to scientific scrutiny imposed by the Employment Equity Act. It was hoped that this would indicate that the instrument could be used across the entire staff population to identify talent in an equitable manner.

2. The second aim was to identify talent in a more holistic manner, through the assessment of cognitive capabilities and potentialities in a multicultural industrial setting. This can add value to the performance management system, as research reveals that both cognitive potential and performance are considered important aspects to identify talent (Mucha, 2004).

3. The third aim was to recommend ways in which the organisation can manage talent more effectively. This information will assist the organisation in identifying and developing specific strategic training and development interventions.

It was envisaged that by introducing an assessment tool that can be universally used for the entire staff population, would prove significantly useful for the identification of talent in the South African automotive industry.

1.4.2 Research questions

Certain research questions emanate from the above background and problem statement:

- Is the APIL instrument a useful psychometric assessment tool for the identification of talent in a multicultural industrial environment?

- Does the APIL instrument promote cultural fairness in psychometric assessment thus affording all members of a heterogeneous staff population an equal opportunity to secure a position in industry?

1.4.3 General hypotheses

The following general working hypothesis could be formulated as a departure for this study:

- *The APIL psychometric instrument complies with the Employment Equity Act and therefore can be used in an equitable manner for the identification of talent in a multicultural South African automotive industrial context.*

Additional hypotheses are formulated and discussed in Chapter 4, page 67 & 68.

1.5 Defining the constructs used in this research

Constructs that play a dominant role in this research are discussed in this section; these include; intelligence, dynamic and static psychometric assessment techniques, learning potential, psychometric assessment in South Africa, talent and talent management.

1.5.1 Intelligence

Despite the concept “intelligence” eluding consensual definition, two themes frequently occur in expert’s definitions:

- The capacity to learn from experience.
- The capacity to adapt to one’s environment.

Papalia and Olds (1988) define intelligence as a constant interaction between inherited ability and environmental experience, which results in a person’s ability to acquire, remember and use knowledge in a purposeful way to solve problems in everyday life. Intelligence is used to predict individual differences in cognitive

or mental ability when defining functioning in a social context; therefore the social context and intelligence are inter-related (De Beer, 2000).

1.5.2 Dynamic and static psychometric assessment techniques

This research utilises a psychometric instrument that incorporates an integrated theoretical approach to assessment, incorporating both static and dynamic techniques. The basic principle of the learning potential or dynamic approach is that a test should also measure the ability to learn rather than only previously acquired knowledge and skills, as in static assessments (Hamers & Resing, 1993).

1.5.3 Learning Potential

Learning potential refers to an individual's fundamental cognitive capabilities and potentialities used to master new cognitively demanding material in a formal educational or training context (Taylor, 2007). Learning potential does not focus on acquired skills or abilities but on the ability to learn new skills and gain knowledge. Learning potential refers to an overall cognitive capacity and includes present and improved future performance (De Beer, 2000). As a result of the technological advances in the workplace high levels of cognitive ability are needed and cognitive assessment is widely used for selection, training and placement purposes. It is essential to identify those individuals with the potential to master the skills and abilities required in more demanding work roles. However in view of the cultural diversity of the South African population and current legislation, cognitive assessment has to be carefully considered if organisations wish to look beyond the effects of disadvantagement (Taylor, 2007).

1.5.4 Psychometric assessment in South Africa

Negative perceptions that prevail around assessments in South Africa have been exacerbated by complexities of multiculturalism and multilingualism (Pelser, Bergh & Visser, 2005). The major criticism revolves around the issue of cultural bias that may result in unfair discrimination against racial and ethnic groups or even people of low socioeconomic status (Jensen, 1980) and therefore equitable and fair test usage requires a focus on cross-cultural applicability of tests. Concerns include whether common and even separate psychometric instruments for different population groups should be used, due to South Africa's vast diversity (Pelser et al., 2005). With the removal of the apartheid laws on job reservation, South Africa's vast workforce is now competing for the same or similar jobs, which makes personnel decisions complex with regards to which candidate is the most suitable for the job, especially if all candidates have not completed the same psychometric test(s) (Owen, 1991). It is therefore reasonable to acknowledge that cultural variables exist when attempting to understand the effects of culture on psychological tests and assessments (Cuellar, 1998). This discussion is pertinent to this research to investigate whether a standardised psychometric assessment instrument can be fairly applied to an entire heterogeneous workforce, and which falls within the ambit of the relevant South African law.

1.5.5 Talent

There are many definitions of talent; however talent has been used broadly to describe an individual's skill, aptitude and achievement (Van Dijk, 2008). Research conducted by Ashridge (Blass, 2007) suggests that most organisations define 'talent' through some reference to cognitive potential, in particular high potentials, and are people who demonstrate some potential to progress in the organisation at any given point in time. For some organisations talent may be

defined as a critical skills set which has become difficult to obtain in the labour market. In this research the terms talent and potential are used interchangeably.

1.5.6 Talent management

Talent management can be defined as the strategic integrated approach to managing a career from attracting, retaining, and developing to transforming the organisations' human resources (TalentAlign 2007). American Society of Training and Development (ASTD 2009) defines talent management as an organisational approach to leading people by building organisational culture, engagement, capability, and capacity through integrated talent acquisition, development, and deployment processes that are aligned to business goals. Talent management is designed to improve the process for recruiting and developing people with the required skills and aptitude to meet current and future organisational needs.

1.6 Research Design

As far as can be ascertained, investigating the usefulness of the APIL instrument in a multicultural setting, to identify talent, has not been researched in any one study within the South African automotive industry, hence the exploratory nature of this study. In order to test the propositions an empirical quantitative design was employed.

1.6.1 Theoretical perspective in cross-cultural assessment

Cross-cultural psychology is the systematic study of relationships between the culture context of human development and the behaviours that become established in the repertoire of individuals growing up in a particular culture (Berry et al., 1996). There are different theoretical perspectives employed in the cross-cultural assessment literature. According to Church (2001) three dominant

perspectives towards assessment are cross-cultural, cultural and indigenous. This research adopts a cross-cultural approach, which according to Meiring (2007) has the following characteristics:

- Comparisons of multiple cultures in the search for cultural universals or culture-specific amidst universals;
- Treatment of culture, or quantitative variables related to ecology and culture, as variables outside the individual which can be used to predict behaviour;
- Use of traditional and relatively context-free psychometric scales and questionnaires;
- Concern about the cross-cultural equivalence of constructs and measures;
- A focus on individual differences.

To achieve the objectives of this research, test scores provide the basis for comparisons. There is a focus on individual differences and the test scores address the adequacy of a cognitive instrument in a multicultural context, thereby employing a cross-cultural approach.

1.6.2 Sample size

The sample consisted of monthly paid employees (*n* = 841) working at an OEM in the Eastern Cape that were on the organisation's payroll at 1 January 2008. Employees excluded from the assessment in South Africa were those who were on international assignments, head office staff, and employees at the Truck Plant.

The sample is representative of South Africa's diverse ethnicity. It also represents a sample frame from one of the seven OEMs in South Africa. The following grouping variables were considered important for analysis: race, age,

education, hierarchical level and functional occupation. Hypotheses will be tested by measuring these variables and statistically analysing the results.

1.6.3 APIL instrument

Hambelton and Oakland (2004) provide strong evidence to support the merits of tests for providing organisations with data for employee selection, promotion and evaluation of training. To measure learning potential the researcher uses the APIL, developed by Taylor for fair assessment in multicultural circumstances. It was classified as a psychological test by the South African Psychometrics Committee of the Professional Board for Psychology on 29 March 1999. Taylor (1994) stated that *"if South Africa is to address the inequalities of the past, then employers and educationalists will have to place more emphasis on potential rather than skill or specific ability and will have to be more prepared to give those with high potential the opportunities to develop specific skills through educational, training and other development programmes."*

1.6.4 Statistical analysis of the APIL

The primary purpose of this study is to investigate the usefulness of the APIL as a psychometric assessment tool to identify talent, within the heterogeneous workforce. Statistical analysis will be employed to determine whether the instrument meets the criteria imposed by the Employment Equity Act (EEA) 55 of 1998 and its subsections (Government Gazette, 1998). Examination and interpretation of data will be conducted using the STATISTICA software programme version 9.0, using both descriptive and inferential statistics. Details of the research model are described in Chapter 3, page 61, Figure 7.

The research analysis will firstly examine the psychometric properties of the APIL by examining reliability (internal consistency) and bias (construct equivalence

and item bias) to determine whether the instrument meets the requirements of the EEA and can be used for cross-cultural comparison.

Secondly the research will investigate whether significant differences exist among the identified subsets of the sample in terms of their cognitive capabilities and potentialities, in order to identify talent and develop appropriate strategic training and development initiatives that will promote fairness and equity.

1.7 Motivation for this study

The above introduction and the following literature review evidently stress the need for continued research in the assessment of learning potential in the South African industrial context. Selection represents a relatively visible mechanism through which access to employment opportunities are regulated, and it is for this reason that psychometric testing has been singled out for intense scrutiny from the perspective of fairness and affirmative action (Milkovich & Boudreau, 1994). The fundamental principle underlying the empirical fairness of selection instruments used as predictors is that selection techniques should not have an adverse impact on employment opportunities for individuals of different race, age, gender, religion or national origin (Byars & Rue, 1994).

This study contributes to the existing understanding of the assessment of cognitive potential in general, and specifically in the South African industrial context in terms of the following:

- No previous research study, investigating the usefulness of this specific learning potential instrument has been conducted on a heterogeneous sample within the automotive industry.
- A realistic workplace environment was used for this research study.
- Although there is a vast interest in cross-cultural studies, there is not sufficient well-established and widely adopted practice in cross-

cultural research to deal with issues such as instrument feasibility and multiple interpretations (Van de Vijver, 1998). Instrument feasibility refers to the psychometric property suitable for standardised routine use (Slade, Thornicroft & Glover, 1999).

1.8 Ethical considerations

In order to ensure ethical research, the researcher makes use of an informed consent agreement with the research organisation specifying:

- That their human resource data will be used as the research base.
- The purpose and procedure of the research.
- The risk and benefits of the research.
- The procedures used to protect confidentiality (Kvale, 1996; Arksey & Knight, 1999; Bless & Higson-Smith, 2000).
- The researcher explained the 'informed consent agreement' to the organisation's leadership team at the beginning of the study and was signed by the Site Leader.

Literature consulted is fully acknowledged and referenced and literature citings take place without creating an opportunity for plagiarism.

1.9 Summary

This chapter serves as the foundation for this study and provides a broad overview of the purpose and intention of the study. In order to develop and conduct an empirical study, it is important to examine the literature that exists on the topic. The literature review which is contained in the next chapter will give the reader an overview of psychometric assessment in a multicultural society, including the relevance of assessment in the South African context in general and within the automotive industry in particular.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

As discussed in the previous chapter the South African automotive industry requires a highly skilled workforce and lean structure to remain globally competitive into the future. The OEM in this study, embarked on a strategic initiative to identify talent within their staff population. The objective was to identify high potential employees and provide them with the requisite training and development to meet the demands of the rapidly advancing technology.

The chapter reviews current theoretical perspectives for the measurement of intelligence in a multicultural environment, and its contribution to the South African industry. A critical analysis of talent and the management thereof is also provided to contextualise the relevance of this research.

2.2 Intelligence defined

Within all individuals there exists various degrees of intelligence. The fact that assessments of intelligence are performed on individuals throughout their lives in educational and workplace settings for diagnostic and selection purposes is indicative of the significance society attaches to this construct.

Interest in intelligence can be traced back to Plato and Aristotle, where the debate emerged over the significance of inheritance and environment on intelligence (Hergenhahn, 2005). Today controversial concerns around the testing of intelligence still exist and include the ethical and moral implications; as well as the statistical basis of various conclusions such as whether tests are

biased or how much of intelligence is genetically determined (Sternberg & Grigorenko, 2002).

According to Sternberg and Kaufman (1998) intelligence is a social construct, where scores on psychometric intelligence tests are constructed to measure qualities that enable people to be successful within that culture. Intelligent behaviour also has different manifestations across and within cultures (Lim, 2005). Despite the numerous definitions of intelligence found in literature, it is generally accepted that intelligence is the capacity to learn new information, to understand one's world and to be resourceful in coping with challenges. It is also used to predict individual differences in cognitive or mental ability when defining functioning in a social context, thereby demonstrating the interrelatedness between social context and intelligence (De Beer, 2000).

2.3 Learning potential defined

Carter and Russell (2001) define intelligence as the capacity to acquire knowledge and understanding and to use it in different novel situations. Intelligence, as such, focuses on already acquired knowledge and on the potential to acquire new knowledge and skills; therefore, learning potential is a dimension of intelligence. Learning potential refers to an individual's fundamental cognitive capabilities and potentialities used to master new cognitively demanding material in a formal educational or training context (Taylor, 2007). Learning potential does not focus on acquired skills or abilities but on the ability to learn new skills and gain knowledge. Taylor recommends learning potential assessment to identify individuals with the potential for development and who would benefit from specific developmental programmes in organisations and educational institutions. Learning potential assessment seeks to examine cognitive processes that are important for learning and is seen as a more sensitive measure for minority populations (Elliott, 2003).

2.4 Central paradigms to assessment of intelligence

Over the past century there has been an emergence of different theoretical perspectives in an attempt to explain what constitutes intelligence, including how best to measure it, particularly in multicultural settings, in a fair and unbiased way (Gregory, 2007). These different perspectives can be broadly deliminated into two central paradigms: static intelligence assessment and dynamic intelligence assessment.

Resnick and Neches (1984) argue that in psychology two meanings of the concept intelligence exist:

- Firstly intelligence is considered a stable and possibly innate endowment which different people have in different quantities. This meaning is vested in the 'static' paradigm which assumes that intelligence or aptitudes may be measured as relatively fixed and quantifiable constructs (Taylor, 1994).
- Secondly intelligence is identified as the capacity of humans to adapt and function effectively in their environment and is vested in the dynamic paradigm. Biesheuvel (1973) conceptualises intelligence as the capacity for adaptation within the environment which Taylor (1994) considers to be a more appropriate approach for the basis of cross-cultural assessment.

Static assessment emphasises prior learning rather than the processes of learning, thinking and problem solving (Haywood, Brown & Wingenfeld, 1990). The assumption is that the individuals being assessed have been exposed to similar opportunities to learn and develop the specifically examined competencies (Elliot, 2003). However, due to the varying degrees of disadvantagement and widely dissimilar cultures in South Africa, this assumption will produce discriminatory results (Zollezzi, 1999). The static process also disregards the learning processes of the assessed individuals, thereby failing to recognise an individual's potential to succeed with appropriate environmental support. The degree to which static assessment measures learning potential is

also questionable as static assessment is a product-based approach to assessment founded on assumptions of performance stability (Lidz & Elliott, 2000). Dynamic assessment is more process orientated, focusing on the learning that takes place during assessment (Ruijssenaars, Castelijns & Hamers, 1993). The static approach to intelligence assessment however has specific advantages over dynamic assessment. They are easy to administer and economical to use on a large scale and the approach benefits from effective statistical analyses (Haywood & Tzuriel, 2002).

Dynamic assessment, as with other approaches in test theory, is irrevocably drawn into debates around the concept of intelligence (Murphy, 2006). Current theories of intelligence illustrate that there are many kinds of intelligence and that traditional psychometric tests capture only a select few of these types. This leads to criticism and questions the suitability of conventional psychometric tests (Daniel, 1997). A significant criticism of traditional static intelligence tests is that not everybody has the same exposures or opportunities to learn or to gather the necessary knowledge and skills to perform as expected on the standardised tests (Hamers & Resing, 1993).

According to Van de Vijver (1993), the traditional intelligence tests pose three main, unintended, problems;

- Test taker's verbal abilities are presupposed;
- Test items may contain implicit references to the cultural background of the test composer;
- Test-wiseness, which refers to secondary skills that are essential to the problem-solving process, such as the skill to handle multiple-choice items or time limits in speed tests, are more often tested than cognitive ability per se.

According to De Beer (2000) socioeconomic differences in South Africa also have an impact on performance on traditional intelligence tests. De Beer found

large discrepancies in various cultures when taking into account socioeconomic and educational indicators such as; educational attainment, unemployment, job type, income, availability of water in home, and access to toilet facilities. Sibaya, Hlongwane and Makunga (1996) also caution that assessments may be influenced by culture and that the assessor should have a sound knowledge of the cultural factors that may influence the test takers' behaviour. This includes cultural history as well as the degree to which the individual has been acculturated. Therefore when measuring cognitive development, it is crucial to use tools that have been designed to preclude these developmental disadvantages (De Beer, 2000).

The interest in dynamic assessment was partly sparked by the criticism of traditional intelligence testing. Central criticisms of static intelligence instruments can be summarised as follows:

- With the focus being exclusively on previously acquired knowledge and skills negates the potential for the development and improvement of cognitive faculties in the future (Zollezzi, 1999).
- Inappropriate norms can create a high possibility for bias thereby further compounding the problem of disadvantagement (Jitendra & Kameenui, 1993).
- They do not provide insight into the underlying causes and systems of the intellective process (Haywood & Tzuriel, 2002).
- Cultural bias against test takers who are not accustomed to experiences are taken for granted in test situations (Campbell & Carlson, 1995).

Researchers have employed different approaches, procedures, techniques and measures in their use of dynamic assessment for the measurement of learning potential. The common link between all of these is that they involve some form of help or assistance to the person being assessed with a view to providing a more accurate assessment of individual differences than can be obtained with standard test scores. Criticism against learning potential assessment includes

the requirement of some interaction or learning during testing, and the fact that the tests usually take much longer than standard tests to administer (De Beer, 2003). Jitendra and Kameenui (1993) discuss disadvantages of dynamic assessment approach in relation to issues of validity, such as construct fuzziness and instrument inadequacy, and issues of reliability, such as instructional aloofness and procedural spuriousness. According to Murphy (2006), differential item functioning (DIF) is a partial solution to this problem and adds credibility to the approach. This research aims to establish both item bias (DIF) and construct equivalence of the instrument.

In an attempt to provide more equitable cognitive assessment, the measurement of learning potential has received increasing attention, particularly in South Africa (Murphy, 2006). Industry and education sectors rely mainly on static tests, which indicate proficiencies or lack thereof in certain skills or abilities, and they do not test for the ability or the potential to learn a specific task at hand. Murphy (2006) believes that if static assessments continue to be used, such as conventional IQ tests, from which inferences are made about who will receive special treatment and thereby stigmatising other candidates, some candidates might be put at a disadvantage in terms of not being able to develop their full potential. However, according to Lidz (1987, p. 4), 'dynamic assessment is not intended as a replacement of current approaches, but as an addition to currently available procedures'.

2.5 Current research in the field of intelligence assessment

Neisser et al. (1996) identify five broad areas of focus in current research in the field of intelligence assessment:

1. Psychometric approach focuses on the research of intelligence tests.
2. Multiple forms of intelligence builds on research based on Gardner and Sternberg's theories.

3. Cultural variation aims to identify aspects of intelligence that is considered intelligent in one culture and not in another.
4. Developmental progression builds on Piaget and Vygotsky's opposing developmental theories.
5. Biological approaches focus on the workings of the brain and its anatomy.

2.5.1 An integrated approach to cognitive assessment

Taylor (1994) offers an integrated approach to cognitive assessment based on three traditional approaches that include:

- Structural or conventional approach
- Information processing approach
- Dynamic or learning potential approach.

According to Taylor (1994) each of the three approaches developed fairly independent of each other, consequently leaving very little theory to link the three approaches to one another. However, through the fusion of these three approaches, Taylor accommodated these theoretical underpinnings to construct a test battery reflective of all three approaches which can be used within the South African context (Murphy, 2006). According to De Goede (2007) Taylor's rationale for integrating these three approaches stems from an observation that the psychological tests that are widely available for use in industry and education are mostly designed to measure broad-based static psychological constructs such as abilities. Furthermore, the approaches of information processing and learning and modifiability tend not to be widely used in industry, despite a need for assessment techniques of a more dynamic nature.

Taylor (1994) developed a series of test batteries (TRAM-1, TRAM-2, and APIL Battery) for fair assessment in multicultural circumstances, with the emphasis on evaluating fundamental cognitive capabilities and potentialities rather than assessing existing specific skills and knowledge. The APIL is the psychometric

instrument used in this research study and hence an overview of Taylor's integrated theory is provided. He proposes that intelligence tests should tap the following four domains: fluid intelligence; information processing; transfer in tasks requiring learning potential; and automatisation in such tasks.

Taylor (1994) proposed an integrated two-factor cognitive theory to base the design of his psychometric test batteries that would adequately address the measurement needs in a changing multicultural South Africa. According to Taylor, the foundation of intelligence consists of two parts, namely information processing capacity (efficiency) and abstract thinking capacity (fluid intelligence). Taylor argues that these two parts are related in some way in that processing efficiency assists in the success in forming abstract concepts, and abstract thinking assists in the formation of effective strategies to process information in the most economical way. This implies that individuals who are able to process information faster are more competent at problem solving. Fluid intelligence is used to solve novel and unusual problems, and serves as catalyst for developing new skills and abilities (Taylor 1994). Learning potential is exhibited when a person comprehends a novel learning task involving unfamiliar stimulus material; where previously developed skills are of relatively little help, and the learner has to use very general transfer and skill acquisition strategies to solve abstract problems (Taylor 1994).

Taylor's approach includes both static and dynamic dimensions, which are both important in everyday life and work, as an individual has to constantly learn new processes and apply knowledge to master problems.

- The two static dimensions include fluid intelligence and information processing efficiency, which is the foundation of intelligence. Although these dimensions do not measure learning directly, they are important enabling capacities that underlie learning because the capacity to transfer knowledge is largely a function of fluid intelligence.

- The dynamic dimensions include learning rate (automatisation) and transfer (Taylor, 1994).

Taylor (1994) uses Ackerman's cylindrical cognitive (1988) model to explain the basis of his integrated theory. He suggests that the focus should be on learning potential (with the focus on fluid intelligence or general ability (*g*) which lies in the core of the cylinder) and not on learning performance (crystallized intelligence or specific abilities which are encountered when moving towards the periphery of the cylinder). This theoretical position is presented in Figure 1 below.

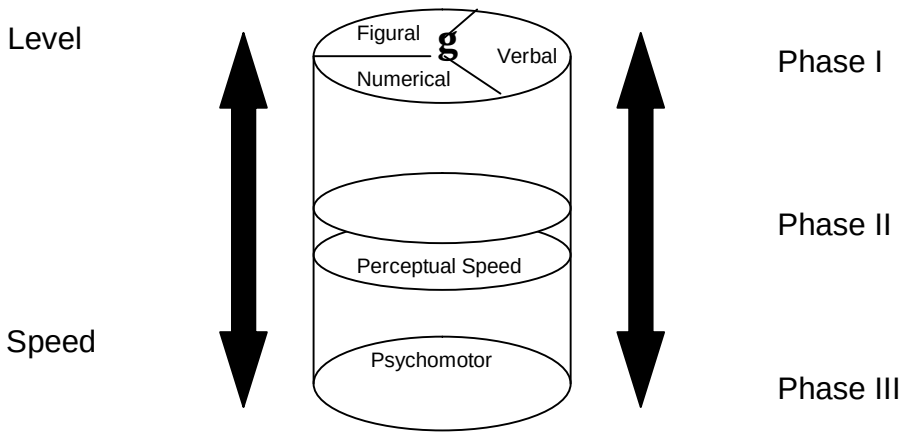


Figure 1. A modified cylinder model of cognitive abilities (Ackerman, 1988)

According to Taylor's theoretical model, competencies near the core of the cylinder are more general and closely related to fluid intelligence. The potentiality to think abstractly and to form concepts develops as fluid intelligence (Detterman, 2004). Fluid intelligence consists of a set of general cognitive tools and strategies for application to novel problems, and is placed in the core of the cylinder. Fluid intelligence also serves as catalyst for developing new skills and abilities (Taylor, 1994). The progressively larger concentric rings contain skills, which are more specific and remote from fundamental potential. These rings also reflect the

process of transfer in development and learning. The vertical dimension of the cylinder refers to speed. Starting from the top, each successive 'slice' through the cylinder contains skills, which are of an increasingly speeded nature (Taylor, 1994). As development proceeds, skills and knowledge accumulated in prior learning have a growing impact on the emergence of new skills, as they play a critical role in the transfer required for the development of later emerging skills on the outside edge of the cylinder. The processing speed and capacity impact on the development of the speeded skills in the lower reaches of the cylinder (Taylor, 1994).

Authors Anderson (1983) and Shiffrin and Schneider (1977) have distinguished three phases of learning: conceptual understanding of the task, compilation of execution procedures, and automatization of processing (Taylor, 1999). Abstract reasoning plays a major role in the first phase of conceptually understanding the task, whereas processing speed and capacity plays an increasingly important role as learning progresses to the third phase of automatisation. As automatisation progresses, skills shift outwards when they become more specific and downwards in the cognitive cylinder as execution becomes faster. Thus, skills at the outer rings of the cylinder are a product of a longer process of learning and transfer of skills and knowledge (crystallised intelligence). Consequently, measures in the core of the cylinder provide the best estimate of fundamental potentiality or fluid intelligence.

Garlick and Sejnowski (2006) suggest that fluid intelligence is an important construct for assessing the human capacity to perform successfully across a wide range of situations. This is also supported by psychometric findings suggesting that fluid intelligence is the best predictor of performance in situations that involve human intelligence, including performance in education and in cognitively demanding occupations (Gottfredson, 1997).

2.6 Development of psychological assessment in South Africa

At the beginning of the twentieth century psychological assessment in South Africa followed a similar path to the discipline's international history, with the development of psychology being rooted in its British colonial heritage. The early research of Rich (1917) described one of the first contacts ordinary South Africans had with psychology, where he was concerned with adapting European-designed psychometric tests for use on Zulus. These concerns are still relevant today as illustrated in a paper by Tollman and Msengana (1990). Psychologists adopted European and American methodologies, importing and adapting various psychological tools and technologies, in particular intelligence tests, for use in education and industry (Louw & Foster, 1991). Tests were applied in all sectors of the community without any distinction being made (Foxcroft, 1997). According to Kendell, Verster and Von Mollendorf, (1988), there was little attempt to assess cognitive competence in a culturally relevant framework and early pioneers in the assessment movement largely ignored the impact of culture on test results (Gregory, 2007).

Meiring (2007) summarises the period of psychological assessment between 1920 and 1960 as being characterized by three key factors:

- The focus was on standardising measures for white people only.
- Administering assessments that were standardised for one group were given to other groups without investigating appropriateness or bias.
- Test results were misused to make conclusions about differences between groups without taking into consideration the impact of cultural, socioeconomic, environmental and educational factors on test performance.

However cross-cultural comparison of cognitive test scores was not without consideration in South Africa (Irvine, 1969). Biesheuvel's (1949a; 1949b; 1952)

early work in South Africa focused on the empirical investigation of potential bias problems associated with cross-cultural assessment. Other earlier researchers in this field include Schepers (1974), Freeman (1984), Verster and Prinsloo (1988) and Claassen (1997).

From the mid 1980s the sociopolitical developments led to the abolition of job reservation and the advent of racial mixed schools (Foxcroft, 1997). Industry and educational authorities began to demand common tests that would not discriminate against any race or culture (Claassen, 1997). Lobbyists against testing called for a ban on tests stating that available tests were biased and led to discriminatory practices. In an attempt to address these concerns the development of separate measures for each cultural group and/or the use of group-specific norms were emphasised (Foxcroft & Roodt, 2006). Due to problems experienced in the comparison of the scores of tests developed for different groups, the focus since the late 1990s has been on the development of tests that are fair in terms of both language and culture (Foxcroft & Roodt, 2006). Psychometric testing is a common phenomenon in South African industry today, affecting more people than any other branch in psychology, thereby influencing the careers of thousands of people (Holburn, 1989; Veldsman, 1990). Sehlapelo and Terre Blanche (1996) believe that by reforming testing practices, psychometrics can be a tool for transformation and empowerment as psychological tests play a major role in who gains access to economic and educational opportunities. Pelser et al. (2005) cite two reasons why time and effort should be invested in the pursuit of valid personnel selection procedures as it provides both legal and economic incentives.

2.6.1 South African legislation in psychological testing

To protect the public against abuses, the South African Medical, Dental and Supplementary Health Service Professions Act (1974) legally specifies the use of psychometric tests. To ensure the ethical use of any method of assessment,

including the conduct of the assessment practitioner guidelines are provided by local and international psychological associations and legislative statutes (Anastasi & Urbina, 1997), which all emphasise the establishment of sound psychometric evidence. These include:

- The Society for Industrial and Organisational Psychology of South Africa (SIOPSA, 2005) *Guidelines for the validation and use of assessment procedures for the workplace*.
- *Psychological test use in South Africa* (Mauer, 2000).
- The Professional Board for Psychology Health Professions Council of South Africa. Ethical Code of Professional Conduct (2002).
- South African legislation, in particular the Employment Equity Act (EEA) 55 of 1998; the Skills Development Act 97 of 1998; as amended by the Skills Development Amendment Act 31 of 2003; the Basic Conditions of Employment Act 75 of 1997; the South African Qualification Authority Act 58 of 1995; which encompasses National Qualifications Forum.
- The American Psychological Association (APA) *Standards for educational and psychological testing* (1999).

Since the EEA was promulgated, the issues of the culture fairness and test bias of psychological instruments became points of continuous concern (Van de Vijver & Rothmann, 2004). It has also resulted in users of psychological tests to become increasingly concerned about the legitimacy of their use of assessment procedures, particularly in industry for purposes such as screening, selecting, and identifying potential (Pelser et al., 2005). Meiring (2007) argues that many tests that are used to make selection decisions within a multicultural context are still not properly validated despite the recent legislation. He believes that this problem has still to be adequately addressed in South Africa today.

2.7 Factors affecting test scores

An intelligence test is a neutral, inconsequential tool until significance is assigned to the results derived from it, resulting in repercussions, which may be viewed as fair or prejudiced, helpful or harmful, appropriate or misguided, depending upon the meaning attached to the test score (Gregroy, 2007). Gregory identifies five major controversies around the meaning of intelligence test scores; these include the question of test bias; genetic and environmental effects on intelligence; origins of IQ differences; the effects of age on intelligence; and generational changes in intelligence test scores. Some of these controversial issues are pertinent to this study and are further discussed.

2.7.1 Fairness and bias

Test fairness and test bias can be clearly distinguished, however they are often incorrectly considered to be interchangeable (Gregory, 2007). Fairness in psychometric testing refers to a values concept rather than a psychometric concept, which recognises the importance of social values in test usage (Meiring, 2007). Test bias refers to objective statistical indices that examine the patterning of test scores for relevant subpopulations and therefore is a statistical concept (Gregory, 2007). Cole and Moss (1989, p. 205) defined test bias as being present ‘when a test score has meanings or implications for a relevant, definable subgroup of test takers that are different from the meanings or implications for the remainder of the test takers’. This definition of bias implies that test scores obtained for various subgroups of a given population cannot be interpreted in the same way across the groups. Fairness is rather a consequence of the influence of all the variables that play a role in the final decision based on an assessment procedure. These may include the test; the predictor; the integration of data; recommendations based on these data or the final decision made by line management. Fairness therefore must be regarded as an important issue, especially in the case of large-scale testing of all employees in an organisation.

The fair use of tests and the decisions taken as a consequence of testing are in the hands of the test users, therefore test developers can control test bias, but they cannot control test fairness (Visser & Viviers, 2010).

Even an unbiased test may be considered unfair because of the social consequences of using it for selection decisions. According to Gregory (2007) the proper application of psychological tests is essentially an ethical conclusion which cannot be established on objective grounds alone and three ethical positions can be distinguished:

1. Unqualified individualism dictates that, without exception, the best qualified candidates should be selected, using all predictors.
2. The ethical stance of quotas acknowledges that organisations are ethically bound to act that is politically appropriate and selection is based upon population percentages. Consequently this does not necessarily mean that those selected have the highest scores on the predictor test.
3. Qualified individualism relies exclusively upon tested abilities, and is interpreted as an ethical imperative to refuse to use race, gender, etc., as a predictor even if proven scientifically valid.

The test-bias controversy has its origins in the observed differences in average IQ among various racial and ethnic groups and test bias could perpetuate a legacy of racial discrimination (Gregory, 2007).

The criteria of test bias fall under three main headings (Gregory, 2007):

1. Bias in content validity is demonstrated when an item or subscale of a test is relatively more difficult for members of one group than another after general ability level is held constant.
2. Bias in predictive or criterion-related validity is demonstrated when a test does not predict a relevant criterion equally well for persons from different subpopulations. An unbiased test possesses homogeneous regression;

where the results for all relevant subpopulations cluster equally well around a single regression line.

3. Bias in construct validity is demonstrated when a test is shown to measure different traits or constructs for one group than another. In comparisons across relevant subpopulations, a nonbiased test will reveal a high degree of similarity for the factorial structure of the test and the rank order of item difficulties within the test.

The term ‘culture fairness’ is also often mistaken for the lack of ‘cultural bias’, and presumes equal familiarity among participants who come from different cultural backgrounds (Oakland & Hambleton, 1995). These authors identified a number of culture-related factors that could affect the performance of test scores. These include the tester’s ethnic identity and linguistic expressions; test-takers’ level of education; relationship between the test administrator and the participants, which includes ambiguity in communication; familiarity with response procedures, such as the effects of incorrect answers; and stimuli, which includes familiarity with material, knowledge of testing language. Scarr (1994) believes that culture-free tests do not exist and Gregory (2007) argues that it is more realistic to develop a culture-fair test, where problems are equally familiar or unfamiliar to all cultures. Gregory however believes that culture-fair testing is an idealised abstraction that is never achieved in the real world. Even the meaning of a test may differ among cultural groups, which will affect the validity of comparisons; for example a person in a Western culture is trained to think in a linear and convergent way, whereas people from another culture may approach a problem in an alternative way to logical succession. Therefore Gregory (2007) believes that it is inappropriate to assume that a test can be equally fair to all cultural groups.

In South Africa there has been great disparity in the distribution of opportunities and education (Van Aswegen, 2000). Accordingly, there are fairness problems in using tests of specific skill that assess prior knowledge and crystallised intelligence because some individuals had less opportunity to develop specific

skills. To address the issue of fairness, Taylor (1994) emphasises the assessment of learning potential rather than assessing learning performance.

Anastasi (1988) argues that all behaviour is affected by culture and that cultural influences will always be reflected in test performances. However perceptions of unfair decision making can lead to legal action with substantial fines being imposed on employers (Bauer, Maertz, Dolen & Campion, 1998). Skarlicki (2003) believes that by extending fairness and equity in the assessment procedure as a whole, can further enhance the perception of testing. The test or method can be scientifically proven as fair, valid and reliable, but the perception of the method of assessment can still be perceived as negative by the test taker. However Skarlicki (2003) believes that if the procedure is viewed as fair, and the practitioner effectively handled interpersonal relationships, there is a bigger chance that the test taker will support assessment-based decisions. Test fairness is in the interest of both the employer and the employee, as both benefit from a fair and meaningful selection process in which the best employment decisions are made.

2.7.2 Bias and equivalence

According to Van de Vijver (1998) bias and equivalence are concepts that form the core of a framework attempting to incorporate aspects specific to cross-cultural research. According to Schaap and Vermeulen (2008) these two concepts in current cross-cultural research are treated separately and become associated with different aspect of cross-cultural comparisons. The concepts of bias and equivalence do not refer to properties inherent in any particular measuring instrument. They are characteristics of an instrument in a specific comparison between groups (such as groups from different cultures), rather than with the intrinsic properties of the measuring instrument (Van de Vijver & Tanzer, 1997).

Bias is the same as non-equivalence, and equivalence refers to the absence of bias (Van de Vijver, 2003). Equivalence is associated with the measurement level at which scores obtained in different cultures can be compared and bias is a generic term for all measurement artefacts that threaten the validity of cross-cultural comparisons (Van de Vijver & Leung, 1997). According to Visser and Viviers (2010) equivalence and bias are the fundamental concepts when comparisons between subgroups of populations or cross-cultural comparisons are made, because inferences based on biased (or non-equivalent) scores are invalid.

Previous studies in South Africa report race, the level of education, language and the understanding of English to be the main factors that affect the construct and item comparability of cognitive tests (Meiring, Van de Vijver, Rothmann & Barrick, 2005). These authors urge continued research into the issue of bias and equivalence in the culturally diverse South Africa. Meiring (2007) further emphasises this point by stating that equivalence of measures used for cross-cultural comparison should be empirically established rather than presumed. This present study empirically investigates construct equivalence and item bias of subtests of the APIL instrument to ensure that it can be used appropriately in the research organisation and is fair to all racial groups.

2.7.2.1 Construct Equivalence

Van de Vijver and Tanzer (1997) view equivalence from a measurement perspective and make a hierarchical distinction between three types of equivalence. Construct equivalence, which is also known as structural equivalence, is at the first measurement level and indicates the extent to which the same construct is measured across different cultural groups studied. It implies the universal validity of the underlying psychological construct (Meiring, 2007). Construct equivalence is a precondition to subsequent measurement levels known as measurement-unit equivalence, or ratio level, and scalar

equivalence, or interval level (Schaap & Vermeulen, 2008). Measurement-unit equivalence requires the offset of scales to be similar for groups and scalar equivalence requires scores on the instrument to have the same interval scales across cultural groups (Van de Vijver, 1998). This present study only establishes construct equivalence on the measuring instrument, due to dichotomous scales of the subtests. According to Eid, Langeheine and Diener (2003) the problem with dichotomous items is that they do not have an origin or a unit of measurement and the concepts of unit and scalar equivalence consequently cannot be applied to dichotomous variables.

2.7.2.2 Item bias

According to Meiring (2007) a distinction can be made between internal and external bias. External bias focuses on the relationship between two observed variables, the predictor and the criterion. If a test demonstrates external bias the accuracy of statements about which applicants should be accepted and rejected is moderated by culture (Meiring, 2007). Internal bias refers to the presence of nuisance factors that play a differential role in different cultures. Internal bias challenges the validity of comparisons of constructs or scores obtained in different cultural groups. Van de Vijver and Leung (1997) propose a taxonomy of three types of internal bias, namely construct bias, method bias and item bias. Construct bias occurs when the construct measured is not identical across groups. Method bias is due to various methodological aspects of a study, which includes sample bias, instrument bias and administration bias. The third type of bias is item bias (or differential item functioning) which refers to measurement artefacts at item level. It refers to the situation in which the psychological meaning of one or more items is not identical across cultures and relates to anomalies at the item level. A few examples of anomalies include poor translation, inappropriate item content, complex wording or inapplicability of an item to a specific culture. This present study specifically addresses the issue of item bias.

2.7.3 Genetic and environmental determinants of intelligence

One of the most extensively studied and debated topics in the study of intelligence are the contribution of heredity and environment to individual differences in test scores (Hilliard, 2004). Given a trait such as measured intelligence on which individuals vary, it is inevitable for people to ask what fraction is associated with differences in their genotypes, or the heritability of the trait, as well as what fraction is associated with differences in environmental experience. Gregory (2007) argues that scientists acknowledge that a person's intelligence is shaped also by the quality of experience but the question remains as to what extent the environment determines intellectual outcomes.

2.7.4 Impoverishment and enrichment

Vernon (1970) reviewed early studies of severe deprivation, noting that children reared under conditions where they received little or no human contacts can show striking improvements in IQ , as much as 30 to 50 points, when transferred to a more normal environment. Scarr and Weinberg's (1976) research also provides evidence of IQ improvement through environmental enrichment.

2.7.5 Age changes in intelligence

Fluid abilities, largely nonverbal and culture reduced mental efficiency, show a greater age decline than other abilities because of its reliance upon neural integrity (Horn & Cattell, 1966; Horn, 1985). A frequent conclusion from research examining age groups ranging from 21 to 60 and beyond is that there is an age-related general decline in intellectual functioning. Wang and Kaufman (1993) cross-sectional studies support this view when plotting age differences in vocabulary (crystallised measure) and matrices (fluid measure) scores, where they found little change in vocabulary but a sharp drop in matrices. Horn and Cattell (1967) presented data indicating a possible differential decline in

crystallised and fluid intelligence measures. Crystallised intelligence measures focus on verbal skills and knowledge whereas fluid intelligence measures focus on reasoning and problem solving with visual and geometric stimuli. The latter also often places an emphasis on performance speed. Fluid intelligence measures tend to show substantial declines as a function of age, whereas crystallized intelligence measures often show little or no decline until after age 65 (Greogry, 2007).

2.7.6 Language and its inextricable link to culture

Language is closely linked to the culture in which a test is developed, as language is almost always used to express the cultural concepts and constructs that need to be measured (McCrae, 2000). To compensate for the problems associated with the link between culture and language, some test developers sought to resolve such problems by developing tests in different languages (Bedell, Van Eeden & Van Stade, 2000). In the South African context, very specific problems arise in the translation of tests due to three main reasons, such as the existence of 11 official languages, a limited pool of test administrators who are multi-lingual and the existence of different dialects within one language. Apart from the link between culture and language, language is also influential on cognitive processes (Galotti, 2004). In reaction to criticism arguing that intelligence tests are culturally biased, a number of non-verbal tests of intelligence have been published (Owen, 1998). The development of non-verbal tests is seen as a possible solution to minimising the effect of language proficiency on the comparability of the test scores of different groups. According to Kline (1993), non-verbal items include pictorial odd-man-out; pictures with errors that have to be recognized; figure classification in which two figures of a series that belong together have to be selected; embedded figures where a shape embedded in other shapes has to be discovered; the identification of the sequence of shapes in matrix format; and other variations of pictorial stimuli.

2.8 The role of psychometrics in the changing world of work

The changing world of work has an impact on assessment practices. International and local organisations are adopting common selection and recruitment practices to stay competitive in securing optimal human resources (Bartram, 2004). Given the high costs of staff turnover and the heightened importance of identifying key staff from previously disadvantaged groups, psychometric assessment can make a major contribution to human resource management in South Africa.

In many organisations, promotion of staff is generally linked to productivity improvement. One of the important criteria for promotion is the employee's up-to-date knowledge and technical skills for which training is required. It is therefore important to consider which employees have the potential to work in more complex environments, and who would benefit the most from training. The organisation can expect more efficiency from employees by providing more training opportunities, thereby positively impacting career development (Yadavalli, Natarajan & Udayabhaskaran, 2002). Labour costs are often the largest single cost in many organisations, which have resulted in more attention being focused on the selection process (KPMG, 2009).

It is important to acknowledge that a test battery is designed to discriminate between candidates with higher and lower abilities on certain criteria, and a valid selection measure accurately discriminates between those with higher, and those with lower probabilities of job success (Cascio, 1987). The issue however is whether the test discriminates fairly and applicants in most countries enjoy protection against unfair discrimination. This has received much attention in the United States of America. In the conclusion of the United States National Academy of Sciences, as quoted by Schneider and Schmitt (1986, p. 45):

"The committee has seen no evidence of alternatives to testing that are equally informative, equally technically adequate, and also economically and politically viable ... and little evidence that well-constructed and competently administered tests are more valid predictors for one population subgroup than for another; individuals with higher scores tend to perform better on the job regardless of group identity".

Today South African organisations are greatly exposed to the effects of the world economy, technological advancement and strong international competition (Bosman, Rothmann & Buitendach, 2005). In the automotive industry the scale of restructuring and adaptation that is required by the decarbonisation of transport and the mechanisation through robotics is enormous. It is considered to be on a similar same scale as the transformation triggered by the Fordian innovation of mass production (Andor, 2010). The restructuring of the automobile industry will also have a lasting effect on the jobs in the sector. The industry requires both job creation and job destruction, as well as job transformation. New tasks, new skill profiles and new working arrangements will be needed. Andor argues for the necessity to reflect on ways to manage the transformation process. In anticipating the new job, skills and competence requirements and strengthening investment in education and training are essential if the industry is to have access to a suitably skilled workforce. This means also that a whole new training system must be developed and implemented. According to Cho (2009) the re-skilling of a country's labour force should be a priority during the current economic crisis, because without it, the skills shortage will constitute a major disadvantage in post-crisis times; holding back a country's ability to innovate and compete on global markets. If organisations are to keep pace with the complexity of technological innovation they must continually train and develop employees (Deloitte, 2008).

2.9 Development of human capital to increase global competitiveness

To be competitive in the global market, South Africa has to distribute its available and required skills throughout the whole population (Vorster & Roodt, 2003). This need was reflected in South Africa's position in the Global Competitiveness Report (2008-2009), citing South Africa 45th out of 134 countries, in relation to growth and development. Thus, the assessment, development and acquisition of competence become imperative to drive a country's growth and development. Coetzee, Botha, Kiley and Truman (2007) argue that training and development priorities of organisations and industry sectors constantly change in response to new challenges and innovations necessitating the training and retraining of people. The legislative mechanisms such as the National Qualifications Framework Act 67 of 2008, the Skills Development Act 97 of 1998, and the Skills Development Levies Act 9 of 1999 are initiatives focused on developing people to address these challenges (Erasmus, Loedolff, Mda & Nel, 2010). Through these legislations it is evident that the South African government is encouraging the development of people within organisations, ensuring that any assessment process for training and development purposes meets the objectives as described in the legislation (Vorster & Roodt, 2003).

2.10 The 'War for Talent'

In a 1997 McKinsey report, "The War for Talent*,"* alerted the business world to the importance of talent as a competitive advantage. However still today, there is no common definition of talent management nor is there any model of leadership for the kind of comprehensive approach that is needed (ASTD, 2009). Recent research indicates that the war for talent is intense due to labour market shortages (Cappelli, 2000; Nybo, 2004; Sparrow, 2004; Branham, 2005; Lawler, 2005; Boudreau & Ramstad, 2005) yet very little research attention has been aimed at competitive talent management strategies (ASTD, 2009).

Cataldo, Van Assen and D'Alessandro (2000) remark that the current skills sets are proving to be inadequate to meet the rapidly changing fast-paced world of technical and business needs. Due to the development of new first-time technologies and competitors emerging from unexpected fields, leading organisations are requiring new talent for jobs that did not previously exist (Barner, 2000). In this regard Cataldo et al. (2000) remark that it is no longer strange to lay off people, in order to eliminate obsolete positions, while simultaneously hiring people to acquire new talent.

During the first quarter of 2009 unemployment rate in South Africa rose to 23.5%, up from 22% in the previous three months, with Statistics South Africa showing a total of 208 000 people having lost jobs between December 2008 and March 2009 (SABC News, 2009). This rapid elimination of people from the workforce highlights the importance of knowing where critical capability needs to be in an organisation and where it actually exists. Downsizing creates talent gaps, thereby necessitating organisations to use and rotate remaining talent for maximum productivity, which requires a process to identify employees' strengths and capabilities that drives competitive advantage (ASTD, 2009).

Axelrod, Handfield-Jones and Michaels (2002) believe that winning the war for talent is not just about recruiting and retaining people, but it involves investing in 'A' performers, raising the bar for 'B' performers and dealing decisively with 'C' performers, with 'C' referring to the individual's performance in a given job and not to the person. 'A' performers are defined as employees who create significant value for their organisations directly and through their leadership of others while 'B' performers are employees who solidly contribute to the majority of the work force. Collectively Axelrod et al. (2002) view A and B employees to be critical to the success of the business and maintain that executives need to determine how to allocate scarce resources amongst these performers for further development. This emphasises the relevance of why organisations need to know which people

demonstrate both high cognitive potential and successful job performance to ensure they are investing in the right people.

2.10.1 Defining talent management in terms of performance and potential

Research conducted by Ashridge Consulting (2007) suggests that most organisations define 'talent' through some reference to potential, in particular high potentials. Many organisations seek to map individuals across the organisation in terms of performance and potential, and it is those who are identified as high performers with high cognitive potential who are most often the focus of talent management (Blass, 2007). One focus of talent management is to align existing performance appraisal processes with the creation of cognitive potential identification processes and it is important to differentiate between performance and potential (Mucha, 2004). Performance appraisals focus on past achievements and contributions, where performance is measured against specific objectives. Performance reviews describe current and past behaviour and may or may not be an indicator of potential. It is not either performance or potential, or performance versus potential, but both performance and potential (Mucha, 2004). Talent management is a constant challenge to have the right people matched to the right jobs at the right time, and doing the right things.

Toyota authorities Liker and Meier (2007, p 5), state that it is difficult to recruit people who have exactly the right skills an organisation may require. Toyota has adopted an approach to develop high levels of talent within their internal 'masses' through the identification of competent and trainable people.

2.11 Conclusion and summary

This chapter has provided a brief description of the history and societal context of South African psychological assessment. Legislation in the form of the Employment Equity Act has transformed the landscape of the use of

psychological measurement. It is clear that psychometric assessment in the multicultural South African industrial context requires continued scientific scrutiny to ensure that tests are standardised across all cultures and are not discriminatory in any form. This will then ensure that everyone is afforded an equal opportunity to demonstrate their potential to succeed into the future.

The following chapter discusses the research methodology. The empirical study and its accompanying methodology are discussed. The sample and research setting is described. Information about the characteristics of the measuring instruments is provided, including the method of data capture.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

The main objective of this research is to assess the usefulness of the APIL psychometric assessment instrument for identifying talent, within a heterogeneous workforce. Statistical analysis will be employed to determine whether the APIL meets the criteria imposed of the Employment Equity Act 55 of 1998 and its subsections (Government Gazette, 1998). It was also necessary to understand whether significant differences in cognitive capabilities and potentialities exist within subgroups of the multicultural workforce. The research methodology as described in this chapter was determined by the aims and objectives of the study as discussed in Chapter One.

The preceding chapter dealt with the theoretical foundation of the research subject. The concepts used in this study have been researched, either individually or in relation with one another; namely intelligence, dynamic and static psychometric assessment techniques, learning potential, psychometric assessment in South Africa, talent and talent management. A number of issues have emerged giving rise to an empirical study that will either confirm or reject the propositions set. This chapter outlines the research methodology: the design selected for the study, the sampling procedure used, research instrument, and data collection.

3.2 Research design

In order to test the propositions a quantitative research approach was employed through the use of a psychometric assessment tool, thereby employing an empirical quantitative design.

Rubin and Babbie (1989) maintain that exploratory research is typical when a researcher is examining a new interest, when the subject of study is relatively new and unstudied or when a researcher seeks to test the feasibility of undertaking a more careful study or wants to develop methods to be used in a more careful study. As far as can be ascertained, investigating the usefulness of the APIL instrument in a multicultural setting to identify talent, has not been researched in any one study within the South African automotive industry, hence the exploratory nature of this study. It is unclear whether the APIL instrument can be used in an equitable manner within a heterogeneous population; thus questioning the fact whether it is a useful assessment tool for the identification of talent in the South African automotive industry.

3.2.1 Respondents

The research sample consisted of monthly paid employees (n = 841) working at an OEM in the Eastern Cape. The respondents completed the APIL to assess their learning potential. The objective was to gain an understanding as to where the organisation's talent lies and to determine whether significant differences in learning potential exist among subgroups of the sample. This information will assist in developing strategic training interventions needed to remain globally competitive into the future.

Demographic information is reflected in the following section in order to provide a broad overview of the heterogeneous sample. Information was obtained from a questionnaire distributed to each respondent at the commencement of each assessment session. Additional demographic variables were obtained from the organisation's SAP Human Resource Information Technology System. In addition to the scores obtained from the psychometric instrument, the following information was retrieved from secondary data: age, race, gender, tenure, education, function and hierarchy. Descriptive statistics are provided in tabular and graphical form.

3.2.1.1 Gender composition

As this research takes place within an automotive environment, it is generally acknowledged that it is a male-dominated environment. It is therefore expected that there would be a predominance of males (*n* = 701, 83%) over females (*n* = 140, 17%) as displayed in Figure 2 below.

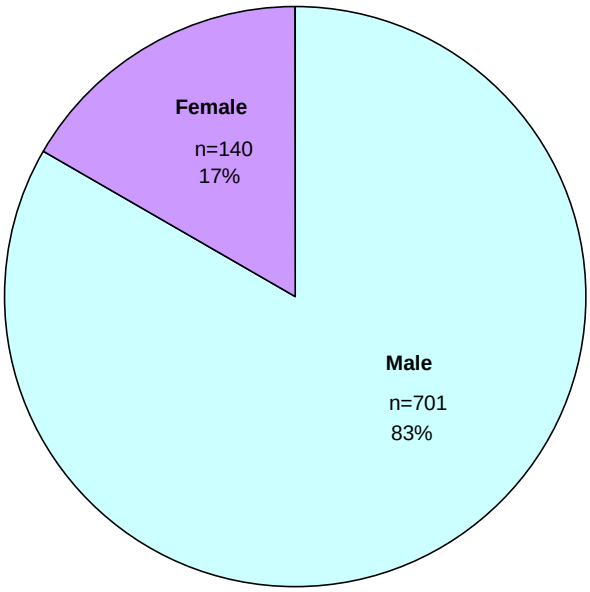


Figure 2. Gender distribution of sample

3.2.1.2 Race origin composition

The statistic composition of the research participants is representative of the South African heterogeneous population, comprising of the four officially recognised race groups, namely the Coloured race group (*n* = 167, 20%); White race group (*n* = 374, 44%); Black race group (*n* = 236, 28%) and the Asian race group (*n* = 64, 8%), (Figure 3).

Within the research sample many different home languages are spoken, namely English, Afrikaans and various African and European languages. However language did not constitute a demographic variable as the research organisation operates in a global environment. All business is conducted in English, and all staff are expected to converse fluently in this medium.

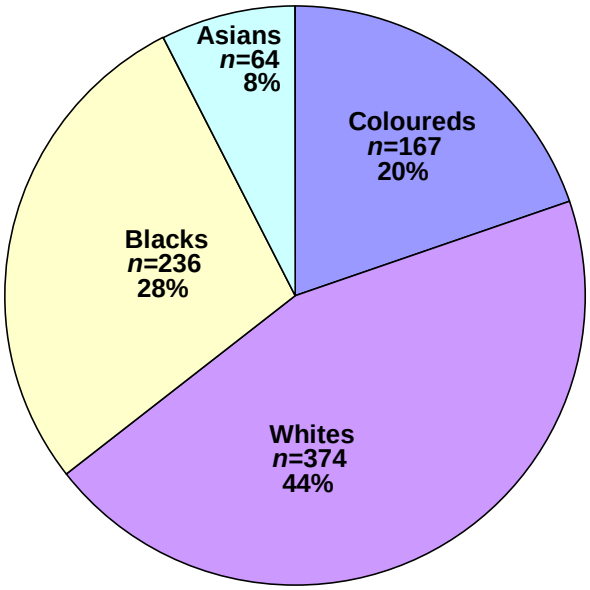


Figure 3. Race distribution of sample

3.2.1.3 Age composition

Statistics pertaining to the age parameters of the sample demonstrated an average age of 43, with a standard deviation of 8.3. The minimum age evidenced is 22 and the maximum age is 67.

Table 3.1. Age parameters

N	*Mean*	*Minimum*	*Maximum*	*SD*
841	43.3	22	67	8.31

By dividing the age data into ranges of equal width intervals (Figure 4), it is evident that the organisation has an ageing staff composition. Within the sample 85% are 35 years and older, with only 16% younger than 35.

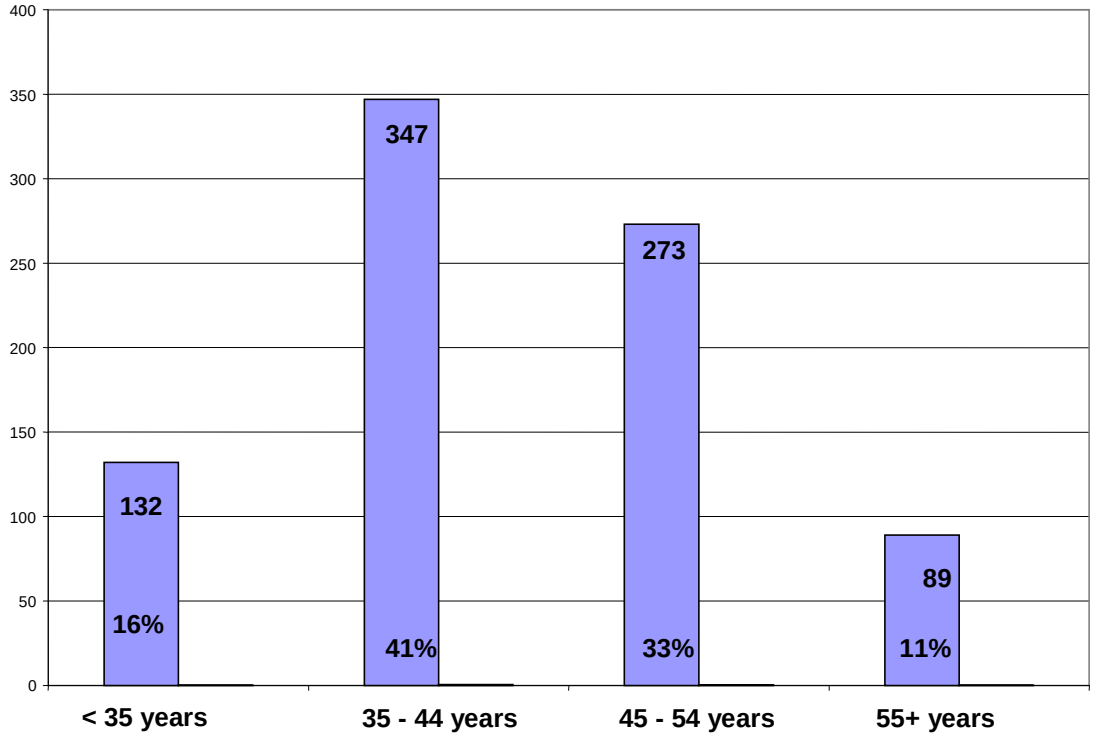


Figure 4. Age distribution of sample

3.2.1.4 Education composition

Over half of the sample (53%, *n* = 444) have only an NQF level 4, which is equivalent to either a Grade 12 (matriculation certificate) or a trade certificate (Figure 5).

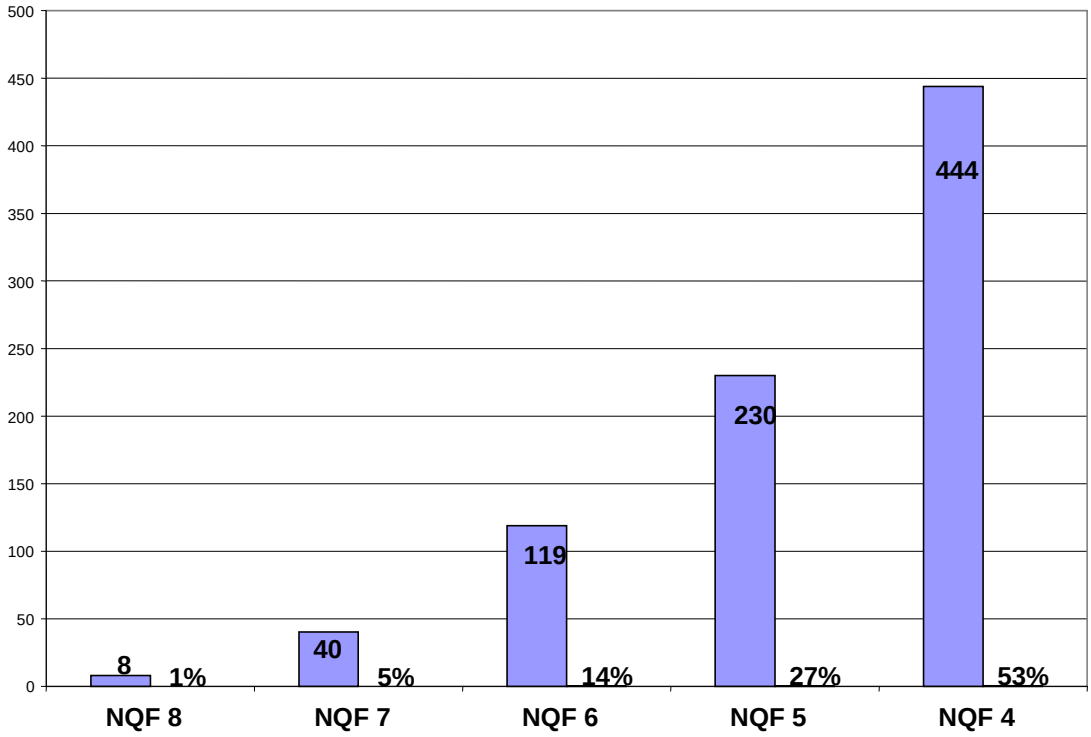


Figure 5. Educational level distribution of sample

3.2.1.5 Functional composition

The automotive industry differentiates between technical occupations (core functions), and those that are non-technical and supportive in nature (Table 3.2). Core business is the manufacturing of motor vehicles, and core functions include all the technical manufacturing occupations, such as those found in divisions such as Bodyshop, Assembly and Paintshop. Support functions are those occupations that support the core business, which include divisions such as Finance, Purchasing, Human Resources, Logistics, Projects and Quality.

Table 3.2. Functional group frequency

Functional Groups	*N*	*%*
Technical	450	53.51
Non-Technical	391	46.49

The highlighted groups in Table 3.3 are considered core technical occupational groups, namely Engineers (*n* = 104), Specialists (*n* = 129), Technical Experts (*n* = 26), Artisans (*n* = 86) and Technicians (*n* = 105).

Table 3.3. Occupational group frequency

Occupational Group	***N***	***%***
MANAGEMENT BOARD MEMBER	1	0.12
DIVISIONAL MANAGER	16	1.90
MANAGER	67	7.97
ACCOUNTANT	20	2.38
ADMINISTRATOR	23	2.73
ANALYST	2	0.24
BUSINESS ANALYST	12	1.43
CHEMIST	1	0.12
ENGINEER	104	12.37
METALLURGIST	1	0.12
METROLOGIST	2	0.24
SPECIALIST	129	15.34
SYSTEMS ANALYST	3	0.36
TEAM MANAGER	110	13.08
TECHNICAL EXPERT	26	3.10
ADMINISTRATION CLERK	30	3.57
ARTISAN	86	10.23
AUDITOR	16	1.90
CONTROLLER	49	5.83
OPERATOR	1	0.12
SECRETARY	18	2.14
TECHNICIAN	105	12.49
TRAINEE	7	0.83
ANALYST PROGRAMMER	3	0.36
CONTRACTOR	1	0.12
NURSE	3	0.36
MANUF OPS	1	0.12
OFFICER	2	0.24
PROJECT SUPPORT	1	0.12
STUDENT	1	0.12

In the research organisation German expatriates are assigned to South Africa for differing time periods to work on various assignments to transfer knowledge, across all hierarchical and functional levels. Figure 6 displays that 6% (*n* = 46) of the staff population comprises German expatriates who fulfil both Technical and Non-Technical roles.

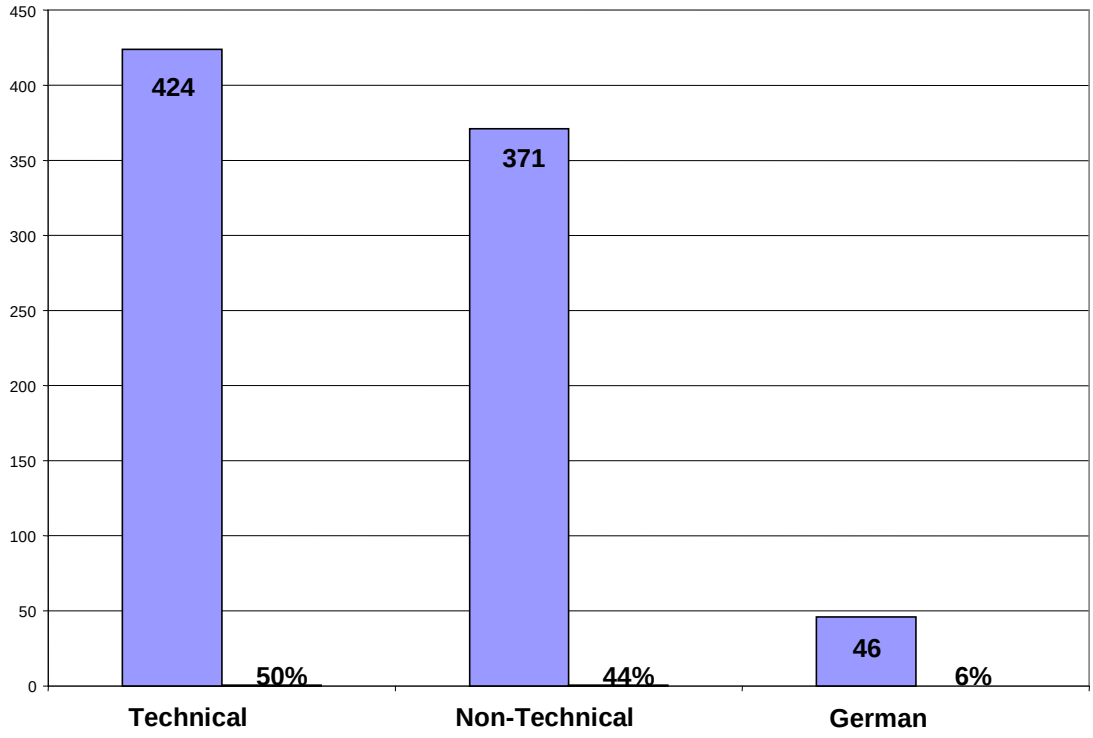


Figure 6. Functional frequency table for Technical, Non-Technical and German expatriates

3.2.1.6 Hierarchical composition

The research organisation is hierarchical in structure with six levels (Table 3.4). Table 3.5 differentiates between Management and Non-Management levels.

Table 3.4. Hierarchical structure frequency

Hierarchical Level	*N*	*%*
BAND 2	2	0.24
BAND 3	16	1.90
BAND 4	68	8.09
BAND 5	412	48.99
BAND 6	316	37.57
BAND 7	27	3.21

Table 3.5. Management and Non-Management structure frequency

Management Level	*N*	*%*
Senior management Bands 2, 3 & 4	86	10.23
First Line Supervision Band 5	110	13.08
Non-management Band 5, 6 & 7	645	76.69

- The first three levels (Bands 2, 3 & 4) comprise senior management (*n* = 86): Bands 2 (*n* = 2), Band 3 (*n* = 16) and Band 4 (*n* = 68)
- Band 5 (n = 412) comprises both first-line supervision (n = 110, Table 3.5) as well as specialist occupations (n = 302).
- Band 6 (*n* = 316) and Band 7 (*n* = 27) comprise of both technical and non-technical staff functions.

3.2.1.7 Hierarchy and education composition

Although the research organisation's recruitment policy states a requisite qualification per structural level, it is evident from the data in Table 3.6 below that this policy is not strictly adhered to. According to the policy the pre-requisite qualification for selection into staff ranks is:

- Band 6 and 7 requires an NQF 4 with an applicable certificate or diploma.
- Band 5 requires an NQF 5
- Band 4 requires an NQF 6
- Bands 2 and 3 requires an NQF 7

Table 3.6. Educational Level frequency per hierarchical level

	Band Level	***NQF 8***	***NQF 7***	***NQF 6***	***NQF 5***	***NQF 4***	***Total N***
N	BAND 2	0	2	0	0	0	2
Row %		0.00%	100.00%	0.00%	0.00%	0.00%	
N	BAND 3	6	5	5	0	0	16
Row %		37.50%	31.25%	31.25%	0.00%	0.00%	
N	BAND 4	2	14	20	28	4	68
Row %		2.94%	20.59%	29.41%	41.18%	5.88%	
N	BAND 5	0	18	83	138	173	412
Row %		0.00%	4.37%	20.15%	33.50%	41.99%	
N	BAND 6	0	1	11	60	244	316
Row %		0.00%	0.32%	3.48%	18.99%	77.22%	
N	BAND 7	0	0	0	4	23	27
Row %		0.00%	0.00%	0.00%	14.81%	85.19%	
N	All Groups	8	40	119	230	444	841

As Band 5 first-line supervision is the selection pool for future Band 4 managers it was deemed necessary to determine their educational level. In Table 3.7 below, it is evident that 60% (*n* = 66) of first-line supervision do not have the requisite qualifications (NQF 5) for their current position, and 89% (*n* = 98) of them do not have the requisite qualifications (NQF 6) for promotion into future Band 4 managerial positions.

Table 3.7. Educational status frequency of First Line Supervision

BAND 5 - First Line Supervision	***NQF 7***	***NQF 6***	***NQF 5***	***NQF 4***	***Totals***
N	1	11	32	66	110
%	1%	10%	29%	60%	100%

3.2.1.8 Tenure composition

It is evident from Table 3.8 below that 44.12% of employees (*n* = 371) have spent much of their working life (between 16 and 39 years) in this research organisation.

Table 3.8. Tenure frequency

Tenure	*N*	*%*
0-5	81	9.63
6-9	172	20.45
10-15	217	25.80
16-20	105	12.49
21-25	141	16.77
26-30	107	12.72
31-35	14	1.66
36-39	4	0.48

3.3 Assessment procedure

A company notice was sent to all employees informing them of the rationale of the strategic initiative to sustain global competitiveness. The fact that all employees completed the voluntary assessment process with no objections, is taken to be indicative that the employees were reassured that the information would not be used to discriminate against anyone in any manner. The assessment process was conducted over a period of several months, during working hours, commencing at 08h00 each week day. The research psychologist administered the entire assessment process. To ensure there were no interruptions to manufacturing operations, careful selection of employees, across different occupational levels, was undertaken to participate in each session. Considerations were made to employees on night shift and permitted to write the assessment on their free day. The administration and communication was conducted by a project team set up by the Human Resource department. All respondents completed a consent form, including a biographical questionnaire.

Testing was conducted in accordance with the recommendations made in the Administrator's Manual (Taylor, 2007).

3.4 Characteristics of the APIL psychometric instrument

The APIL is a comprehensive psychometric instrument comprising of eight sub-tests designed to assess an individual's core or fundamental cognitive capabilities and potentialities (Taylor, 2007). The target population of the APIL is persons with a minimum of twelve years of education. The aim in developing this psychometric instrument was to construct a test that *"addresses the needs confronting South Africa as it struggles to create a more just society – in particular, finding a way to identify those who have potential for development, even though they may have gaps or limitations in their skill repertoire due to past disadvantagement"* (Taylor, 1994, p 11). The rationale for selecting this instrument for this research was based on the psychometric qualities as described in 3.4.2.

3.4.1 Measurement instruments of the APIL

The test battery provides a profile of eight scores as well as a learning curve. The full battery takes approximately 3hours 45 minutes to administer, however the APIL does not have to be administered in its entirety and shortened versions are commonly used (Taylor, 2007). This research uses the Concept Formation Test (CFT), the Curve of Learning Test (COL) and Memory and Understanding Test (MU). The time to administer the instrument was approximately 2 hours.

Thirteen norm groups are currently incorporated in the software. For the purpose of this research the norm group *"working people with a post-matric education"* was used. The rationale was that current selection into staff positions requires a minimum of a matriculation certificate with a diploma or degree depending on the job level.

The APIL software provides for the inclusion of a disadvantagement value for factors of 'Race' and 'Age' to be added to individual's scores at the discretion of the test user (Taylor, 2007, p, 56). For the purpose of this study this decision process was overridden to provide a common platform for researching the heterogeneous sample.

The subtest CFT is classified as a "static" score, while scores from the subtests COL and MU are termed "dynamic" as they reflect the learning processes. The global score is the most reliable and representative index of the individual's cognitive potential and is useful for making development or selection decisions (Taylor, 2007). The global score gives an overall reading of the respondent's learning potential as referenced against the norm group. All the raw data from the tests were collected and organised into a workable format in Excel. Information was then combined with additional demographic employee data extracted from SAP. For the purpose of this research statistical analysis is conducted using both the composite global score, as well as the scores on the individual subtests. A brief description of the subtests follows below.

3.4.1.1 The Concept Formation Test

The Concept Formation test (CFT) is a classificatory task where the test taker is presented with sets of geometrical diagrams and has to identify a diagram, which does not share a characteristic that all the others share (Taylor, 2007). This subtest measures an individual's capacity to think abstractly and conceptually and to categorise and classify objects or ideas. Taylor argues that this competency is critical for complex problem solving and postulates that in work activities requiring additional effort above simple routine duties, conceptual thinking plays an important part. Cattell (1971) and Taylor (1994) share the opinion that the capacity to think abstractly forms an integral part of fluid intelligence.

3.4.1.2 The Curve of Learning Test

The Curve of Learning subtest (COL) specifically taps into the learning potential of an individual as it assesses the person's future achievement capability rather than measuring past achievements (Taylor, 2007). The test epitomises contemporary dynamic assessment philosophy for its test-teach-test format. During the assessment procedure comprehensive standardised lessons are incorporated into the material for learning and subsequent testing. The test taker is subjected to the same task on four occasions and is given three study periods. This relates to Vygotsky's theory of proximal development since learning takes place through doing, but no guidance is provided by a more capable individual. Two sets of scores are obtained from the learning assessment exercises, where the difference in output between the fourth and first session (COLdiff), and the total amount of work completed in all four sessions, measures an individual's learning rate (COLtot). Taylor (2007) describes learning rate as a function of improved performance (units of work correctly completed per unit time) from the first to the last session. Automatisation is assessed as the increase of work output over the four sessions. An indication of this would be if an individual becomes more adept and efficient at what he or she is doing. Such mastery is expressed as a learning curve reflecting the number of units of work correctly done in successive time segments. The steeper the learning curve, the more rapid the process of automatisation. According to Neubauer (1990) automatisation is significantly correlated with intelligence.

3.4.1.3 Memory and Understanding Test

The Memory and Understanding test (MU) is the final set of test scores which measure the capacity to memorise and master concepts. This subtest is a sequel to the COL in that it measures the individual's retention of the material exposed to during the COL series of exercises. Test takers who have internalised the information and understood the interrelationships among the concepts often

produce higher scores in comparison to those who have just copied the material from the dictionary without attempting to retain the information (Taylor, 2007).

3.4.2 Psychometric properties of the APIL

3.4.2.1 Reliability studies

In psychological testing reliability refers to the attribute of consistency in measurement (Gregory, 2007), and relates to the accuracy or precision of a measuring instrument (Kerlinger, 1986). Few behavioural measurements are perfectly reliable, there is always some degree of inconsistency present from one measurement to the next, and rather reliability should be viewed as a continuum (Gregory, 2007). A number of techniques are available to test the reliability of a measure. According to Gregory (2007) one needs to understand the nature and purpose of the individual test in question to ascertain which method is most appropriate. An overview of prior reliability and validity studies conducted on the APIL are discussed below.

According to the Administrator's Manual (Taylor, 2007) a variety of reliability evaluation techniques are necessary to estimate the reliability of the subtests due to the unusual format of some of the measures. The reliability of CFT and MU subtests are calculated using the KR-type estimates due to the dichotomous scored items. Reliability estimates for the six database sets in the manual (Taylor, 2007) range from 0.70 on the MU to 0.87 on the CFT. Research conducted by Lopes, Roodt and Mauer (2001) also revealed similar reliability estimates for CFT and MU, with scores of 0.85 and 0.76 respectively.

Taylor (2007, p. 97) explains how the reliability coefficients were determined for the Curve of Learning (COL) subtest:

- COLdiff's reliability was estimated by subtracting number correct in COL3 from number correct in COL1 to produce one score and subtracting number correct in COL4 from number correct in COL2 to produce a second score, and then correlating these. No correction for test shortening was applied because the COLdiff score is not twice the above scores.
- COLtot's reliability was estimated by computing COL1+COL3 and also COL2 and COL4 and then correlating these two scores and correcting for test shortening.

In the manual the reliability estimates on six data bases range from 0.62 on the COLdiff to 0.97 on the COLtot.

In this research reliability studies are conducted on the identified homogeneous subsets within the sample. Reliability coefficients can provide valuable clues about the measurement accuracy and the appropriateness of an instrument for cross-cultural comparison (Van de Vijver & Leung, 1997). This analysis is presented in the following chapter.

3.4.2.2 Validity studies

Numerous validity studies have been conducted in both education and industrial settings indicating favourable results. These can be referenced in the Administrator's Manual where studies emphasising predictive validity have yielded high coefficients of 0.69 for learning ability, supporting the utility of the instrument as a measure of learning potential (Taylor, 2007). Predictive validity research conducted by Lopes et al. (2001) also revealed favourable results.

3.4.2.3 Equivalence and bias

The APIL addresses cultural bias in that it is primarily non-verbal, except for the instruction, which is conducted in English. The test items are mainly presented in

a geometric diagrammatic format, thereby limiting the bias introduced by requiring that candidates respond to test items in a second or third language (Taylor, 1997). This research aims to establish whether the APIL can be used fairly for all race groups in the organisation through the establishment of bias and equivalence. Specifically the objective was to determine the construct equivalence and item bias of two cognitive subtests, namely the CFT and MU and the statistical analysis is presented in the following chapter.

3.5 Statistical analysis of the data

Figure 7 below provides the statistical model of the research.

STAGE 1: RESEARCH PROBLEM

Is the Apil-B a useful tool to identify talent within a multicultural South African industrial context?

STAGE 2: RESEARCH DESIGN

Empirical Quantitative Research Design and Exploratory Analysis

- Demographic variables included are:
  Gender, Race, Age, Education, Functions, Hierarchy, Tenure.
- Research sample: Heterogeneous workforce (*n* = 841)
- Define homogeneous subsets:
  - Subset 1: Race variable
  - Subset 2: Age variable
  - Subset 3: Education variable
  - Subset 4: Combined Age and Education variable
  - Subset 5: Functional variable
  - Subset 6: Hierarchical variable

STAGE 3: EXAMINATION & INTERPRETATION OF DATA

Software programme used: STATISTICA Version 9.0.

1. Descriptive Statistics to summarise the data by describing what was observed in the sample numerically and graphically.
   - Numerical descriptors of scores include Mean, Standard Deviation, Median.
     - Correlations and frequency tables
   - Graphical displays include:
     - Pie charts and histograms
     - Box and Whisker plots
2. Reliability Analysis conducted according to Administrator Manual (2007)
   - Kuder Richardson 20 (KR-20) on dichotomous subtests CFT & MU
   - Reliability formula as per Manual on COL subtest
3. Construct Equivalence on subtests CFT & MU: Exploratory Factor Analysis & Tucker's phi coefficient.
4. Item Bias on subtests CFT & MU: Scales are dichotomous therefore Logistic Regression Analysis is used. Due to large sample size Nagelkerke R-squared values used.
5. Pearson Correlation Coefficients to measure the degree of relationship between the scores on the APIL subtests.
6. ANOVA to establish the existence of differences among subsets of the sample.
7. Scheffé's Multiple Comparison Method to determine where such differences exist.

Figure 7. Statistical model for research analyses

The data received from the assessments was captured in Microsoft Excel and was processed using the STATISTICA Version 9.0. Inferential as well as descriptive statistics were used for data processing.

3.5.1 Descriptive statistics

Descriptive statistics was used to summarise the data by describing what was observed in the sample numerically and graphically.

3.5.2 Inferential statistics

Analysis of variance (ANOVA) was used to establish whether mean differences exist in learning potential among subgroups in the population. According to Hinkle, Wiersma and Jurs (1994), in ANOVA, the hypothesis is that the mean performance in the population is the same for all groups.

ANOVA offers discernment into the differences between groups, but does not provide a precise indication as to where the differences exactly remain. Hinkle et al. (1994) contend that when a statistically significant *F* ratio is obtained in ANOVA, and the null hypothesis is rejected, it can be concluded that at least one population mean is different from the others. The authors also mention that all the sample means could differ or any combinations could differ, and as a result, in order to validate which pairs of means differ, it is necessary to do a subsequent analysis such as the Scheffé Multiple Comparison procedure. This procedure was utilised to establish precisely where such learning potential differences exist based on the demographic variables.

Although the data may indicate that a difference is significant, it does not answer the question as to whether the difference is large enough to be of practical importance. Effect size indices are directly proportional to the size, and therefore the importance of the difference. Consequently, a large index will lead to

concluding that the effect is 'practically significant'. A large value for η^2 (eta-squared) will therefore indicate that the differences are of practical importance.

The following guidelines, as recommended by Cohen (1988), will be used in this research for the interpretation of η^2 to determine whether there are significant mean differences in the scores measured on the APIL among the different subgroups:

- $\eta^2 \leq$ to 0.035 Small effect size
- $0.035 < \eta^2 \leq$ to 0.100 Medium effect size
- $\eta^2 > 0.100$ Large effect size

3.6 Defined homogeneous subsets

The sample is a representation of the heterogeneous South African population and is considered the universal set *U*. Given the socio-political past of South Africa one would expect differences in learning potential scores among the heterogeneous workforce. For greater understanding of the talent composition amongst the employees, it was deemed necessary to divide the sample into more homogeneous grouping variables before conducting the statistical analysis. Division into subsets was based on set theory, which is a general and widely applicable tool of conceptual and analytical thinking (Kerlinger & Lee, 2000). According to these authors a set is well defined when there is no doubt as to whether a given object does or does not belong to a set. The formation of these subsets was based on demographic variables pertinent to the automotive industry in South Africa.

The six following homogeneous subsets were defined from the *U* set:

Subset 1: **Race variable**

Asian	*n* = 64
Black	*n* = 236
Coloured	*n* = 167
White	*n* = 374

Subset 2: **Age variable**

< 35 years	*n* = 132
35 – 44 years	*n* = 347
45 – 54 years	*n* = 273
55+ years	*n* = 89

Subset 3: **Education variable**

NQF 4	*n* = 444
NQF 5	*n* = 230
NQF 6-8	*n* = 167

Subset 4: **Combined Age and Education variable**

The following criteria were used:

- To differentiate between young and old employees, the youngest 33% (< 39 years) and the oldest 33% (47+ years) of the sample was used.
- Employees were then categorised by their educational level.

- Employees without a tertiary education (NQF 4)
- Employees with a tertiary education (NQF 5+).

- Grouping Variables:

-	Young & NQF4	*n* = 118
-	Young & NQF 5+	*n* = 176
-	Old & NQF 4	*n* = 188
-	Old & NQF 5+	*n* = 105

Subset 5: Functional variable

- It was deemed necessary to differentiate between the South Africans and the Germans due to their different socio-political and economic environment.
- Grouping variables:
  - Technical *n* = 424
  - Non-Technical *n* = 371
  - German expatriates *n* = 46

Subset 6: Hierarchical variable

- Senior Management *n* = 86
- First Line Supervision *n* = 110
- Non-Management *n* = 647

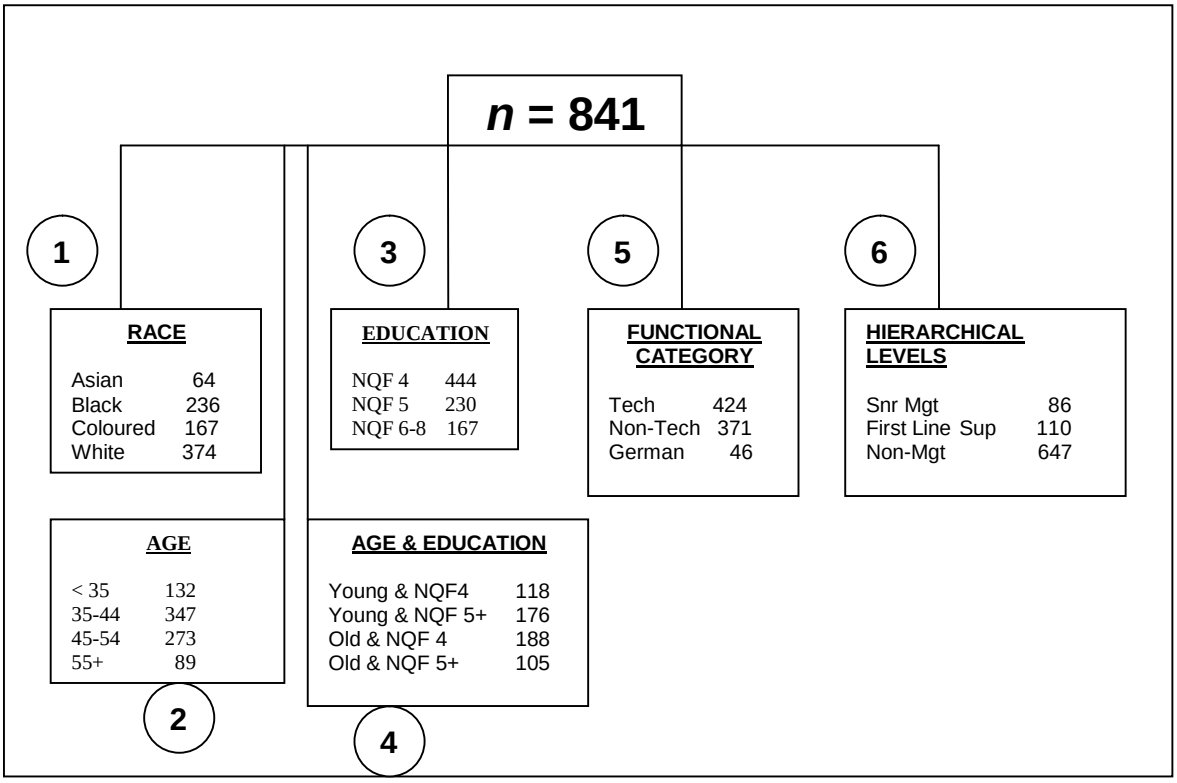


Figure 8. Six homogeneous subsets of sample

3.7 Summary

This chapter describes the research methodology employed in the study. It describes the systematic examination of the broad research problem to determine the usefulness of the APIL test battery as a psychometric assessment tool for identifying talent through learning potential in a heterogeneous population. To facilitate statistical analyses the sample was divided into more homogeneous sub-groupings to determine the relationships within the heterogeneous sample. Furthermore it aimed at investigating whether the APIL could stand up to scientific scrutiny as imposed by the Employment Equity Act. The following chapter details the statistical process and the focus will be on the presentation of the results obtained.

CHAPTER 4
PRESENTATION OF RESULTS

4.1 Introduction

As stated in Chapter 1, the primary aim was to determine the usefulness of the APIL for identifying talent, within a heterogeneous workforce, through the assessment of learning potential. In accordance with the literature study and the proposed research problems, the following substantive research hypotheses are formulated.

The research analysis will firstly examine the psychometric properties of the APIL to determine whether it can stand the scientific scrutiny imposed by the Employment Equity Act, through the measurement of internal consistency, construct equivalence and item bias.

Hypotheses setting for the psychometric properties of the APIL instrument include:

H_{1A} - *The APIL subtests are internally consistent for all subgroups.*

H_{1B} - *The APIL subtests correlate positively with each other.*

H_{1C} - *The CFT and the MU subtests are structurally invariant indicating lack of construct bias.*

H_{1D} - *The CFT and the MU subtests are unbiased in terms of item level analysis.*

Secondly, the research will investigate whether differences exist among the identified subsets of the sample in terms of their cognitive capabilities and potentialities.

Hypotheses settings for the six homogeneous subsets in the sample include:

H_{2A} - *There are significant mean differences on the learning potential global scores among the four race groups.*

H_{2B} - *There are significant mean differences on the learning potential global scores among the different age cohorts.*

H_{2C} - *There are significant mean differences on the learning potential global scores among the different education groups.*

H_{2D} - *There are significant mean differences in the learning potential global scores among the different combined age and education groups.*

H_{2E} - *There are significant mean differences in the learning potential global scores among the different functional group variables.*

H_{2F} - *There are significant mean differences in the learning potential scores among the different hierarchical groups.*

4.2 Psychometric properties of the APIL

The psychometric properties of the APIL instrument will be discussed in terms of internal consistency, construct equivalence and item bias.

4.2.1 Reliability estimates of the APIL

Reliability is not a characteristic inherent in the test itself, but rather is an estimate of the consistency of a set of items when they are administered to a particular group of respondents at a specific time under particular conditions for a specific purpose (Brown, 2002). Nunnally and Bernstein (1994) provided guidance in the interpretation of the reliability coefficient by stating that a value of 0.70 is sufficient for early stages of research, but that basic research should require test scores to have a reliability coefficient of 0.80 or higher. When important decisions are to be made about individuals, a reliability coefficient of 0.90 is the minimum with 0.95 or higher a desirable standard (Salvia & Ysseldyke, 1988; Nunnally & Bernstein, 1994). The guiding values for interpretation of this research are as follows (HR Guide, 1999):

Table 4.1. Guidelines for interpretation of reliability coefficient values

Reliability coefficient value	Interpretation
0.90 and up	Excellent
0.80 - 0.89	Good
0.70 - 0.79	Adequate
< 0.70	May have limited applicability

4.2.1.1 Internal consistency of scores obtained on the APIL subtests for the identified subsets

Table 4.2 below provides reliability estimates of the APIL subtests for the grouping variables. The key for the acronyms in the table heading include:

- CFT – Concept Formation Test,
- MU – Memory and Understanding Test,
- COLdiff – Curve of Learning Difference (difference in output),
- COLtot – Curve of Learning Total (learning rate).

Table 4.2. Reliability estimates of APIL subtests for the grouping variables

Population Group	Variables	CFT	MU	COLdiff	COLtot
Total Population		0.88	0.85	0.75	0.95
Subset 1 Race	Asians	**0.90**	0.81	0.71	0.93
	Blacks	0.84	0.85	0.75	0.93
	Whites	0.88	0.84	0.76	0.95
	Coloureds	0.87	0.80	0.60	0.92
Subset 2 Age	< 35 years	0.85	0.78	0.76	0.95
	35-44 years	0.87	0.86	0.74	0.95
	45-54 years	0.86	0.79	0.63	0.92
	55+ years	0.82	0.77	**0.40**	**0.85**
Subset 3 Education	NQF 4	0.85	0.82	0.64	0.93
	NQF 5	0.86	0.81	0.71	0.93
	NQF 6-8	0.88	**0.87**	0.78	0.95
Subset 4 Age & Education	Y_NQF4	0.82	0.83	0.59	0.93
	Y_NQF5+	0.87	0.83	0.80	0.96
	O_NQF4	0.81	0.75	**0.39**	0.89
	O_NQF5+	0.84	0.78	0.56	0.87
Subset 5 Functional	Non-Technical	0.88	0.84	0.71	0.94
	Technical	0.87	0.83	0.71	0.93
	German	**0.72**	**0.72**	0.76	0.95
Subset 6 Hierarchy	First-line Sup.	0.88	0.84	0.66	0.95
	Non- Mgt	0.87	0.84	0.74	0.94
	Senior Mgt	0.87	0.86	0.77	0.95

- The KR-20 reliability estimates for CFT range between 0.72 for the German variable in Subset 5, to 0.90 for the Asian variable in Subset 1. The German variable is lower as item 14 had to be omitted since there was no variation (all items were correct). The reliability coefficients for all subgroups, except for the Germans, are higher than 0.80 which is considered 'good', indicating that the CFT is a reliable subtest for the entire research sample.

- The KR-20 reliability estimates for MU range between 0.72 for the German variable in Subset 5, to 0.87 for the group of people who fall into the NQF 6-8 variable in Subset 3. The reliability estimate is lower for the German variable as items 17 and 18 had to be omitted since there was no variance (all items were answered correctly). The reliability coefficients range from an 'adequate' to 'good' level which indicates that the MU subtest is reliable for the entire research sample.

- It is interesting to note that the reliability estimates for COLdiff are considerably lower than that of the COLtot estimates. This is indicative of the different learning strategies individuals employ in an attempt to improve their work output over the four testing sessions. The lowest estimates of 0.39 and 0.40 for COLdiff are scored by older people with no tertiary education. The reliability coefficients however, for the COLtot, are considerably higher, with all grouping variables having estimates at the 0.90 or higher, except for the categories with older people that drop to the 0.85 level. The COLtot is the total output score for the COL subtest and the reliability estimate is 'highly desirable' standard according to Nunnally and Bernstein (1994), indicating that this subtest is reliable for the entire research sample.

The reliability estimates obtained for this research sample agrees highly with previous research (Lopes *et al.*, 2001; Taylor, 2007).

From the results obtained the null hypothesis must be rejected and the alternative hypothesis H_{1A} must be accepted.

H_{1A} - The APIL subtests are internally consistent for all subgroups

4.2.1.2 Interrelatedness of the APIL subtests for all race groups

The rationale for using the Pearson correlation coefficient was to determine whether the individual subtests correlate positively with one another for all race groups.

Table 4.3. Inter-correlations of the APIL subtests for all race groups.

1. Research Sample n=841	***CFT***	***MU***	***Global score***	***COLtot***	***COLdiff***
CFT	1.00				
MU	0.68	1.00			
Global score	0.87	0.88	1.00		
COLtot	0.69	0.70	0.90	1.00	
COLdiff	0.62	0.65	0.84	0.91	1.00

2. Asians n=64	***CFT***	***MU***	***Global score***	***COLtot***	***COLdiff***
CFT	1.00				
MU	0.68	1.00			
Global score	0.88	0.87	1.00		
COLtot	0.65	0.68	0.87	1.00	
COLdiff	0.58	0.60	0.80	0.90	1.00

3. Black n=236	***CFT***	***MU***	***Global score***	***COLtot***	***COLdiff***
CFT	1.00				
MU	0.61	1.00			
Global score	0.85	0.87	1.00		
COLtot	0.66	0.68	0.88	1.00	
COLdiff	0.55	0.60	0.79	0.90	1.00

4. Coloureds n=167	***CFT***	***MU***	***Global score***	***COLtot***	***COLdiff***
CFT	1.00				
MU	0.63	1.00			
Global score	0.86	0.84	1.00		
COLtot	0.59	0.53	0.83	1.00	
COLdiff	0.50	0.51	0.77	0.88	1.00

5. Whites n=374	***CFT***	***MU***	***Global score***	***COLtot***	***COLdiff***
CFT	1.00				
MU	0.69	1.00			
Global score	0.86	0.89	1.00		
COLtot	0.69	0.74	0.92	1.00	
COLdiff	0.64	0.69	0.87	0.92	1.00

Table 4.3 indicates that the CFT scores correlates the lowest ($0.50 < r < 0.69$) with the COL and MU scores for all race groups, indicating that the CFT measures to some extent something different to the other tests. This is in line with the design of the APIL, namely that the CFT is a 'static' score and measures fluid intelligence while scores from the subtests COL and MU are termed 'dynamic' as they reflect the learning processes.

However there is also evidence that scores on all the subtests correlate strongly ($r \geq 0.83$) with the global composite score for all race groups, although the COLdiff drops to 0.77 for reasons explained in 4.2.1.1. These strong correlations indicate that to a degree, the battery of tests as a whole, contributes to the measuring the same construct (learning potential) for all race groups. This is in line with the rationale of the APIL design, where Taylor (2007) states that the

global score is the most reliable and representative index of the individual's cognitive potential.

From the results obtained the null hypothesis must be rejected and the main hypothesis H_{1B} must be accepted.

H_{1B} - The APIL subtests correlate positively with each other.

4.2.2 Analysis of bias at the level of constructs and items

Construct bias and item bias was addressed in two series of analyses for both cognitive tests, CFT and MU. The first involved scale-level analyses and examined the similarity of the factors underlying the cognitive tests, whereas the second addressed bias at item level of the instruments. Analysis of bias was not conducted on the COL subtest due to the unusual format of the test.

4.2.2.1 Scale-level analysis (construct bias)

A two-step procedure was used to examine construct bias which is based on exploratory factor analysis (EFA). In the first step the covariance matrices of all the race groups were combined (weighted by sample size) in order to create a single, pooled covariance matrix (Muthén, 1991; 1994). Factors derived from this pooled covariance matrix define the global solution, with which the factors obtained in the separate race groups were compared. The agreement was evaluated by means of a factor congruence coefficient, Tucker's phi (Van de Vijver & Leung, 1997). Values above 0.90 are taken to point to essential agreement and value above 0.95 to very high agreement (Meiring, 2007). High agreement implies that the size of the factor loadings correspond to a high degree among race groups.

Table 4.4. Agreement of the CFT and MU in the pooled solution with Race

Tucker's Phi coefficient		
Race Groups	***CFT***	***MU***
Asians	0.984	0.968
Blacks	0.978	0.994
Coloureds	0.994	0.991
Whites	0.995	0.998

Inspection of Table 4.4 shows that Tucker's phi coefficients with values higher than 0.95 are present in all the different race groups in both the CFT and the MU subtests. Both cognitive tests showed a unifactorial solution in the pooled data, which provides a strong indication of structural equivalence. It can therefore be deduced that the construct in CFT, namely conceptual reasoning, is equivalent for all four race groups. It can also be deduced that the construct in MU, namely memory and understanding, is equivalent for all four race groups. Constructs that are equivalent for different race groups indicate an absence of construct bias in an instrument (Schaap & Basson, 2003). Both cognitive subtests showed low levels of construct bias; revealing factorial invariance in all the race groups.

From the results obtained the null hypothesis must be rejected and the main hypothesis H_{1C} must be accepted.

H_{1C} - The CFT and the MU subtests are structurally invariant indicating lack of construct bias.

4.2.2.2 Item level analysis (item bias analysis)

Logistic regression analysis was used to detect both uniform and non-uniform item bias for the cognitive tests CFT and MU as both tests yield dichotomous scores. Three analyses are performed, and in each analysis the dependent variable is the item value:

1. In the first analysis, only the scale total is the independent variable.
2. In the second analysis, the group variable is added as a second independent variable.
3. In the third analysis the interaction of group and scale total is added.

A statistically significant *main effect* for group indicates that the item is *uniform biased*, while a statistically significant *interaction effect* indicates that the item is *non-uniformed biased*. Since statistical significance is influenced by sample size conventional tests of significance could not be used in this research due to the large sample size. Nagelkerke R^2 values are recommended in order to identify biased items in large samples. At each stage, therefore the Nagelkerke R^2 value is calculated. These values are then used to determine the increment in R^2 due to the group effect, and the increment in R^2 due to the interaction effect. The criterion if the increment in R^2 is ≥ 0.06 is an indication of significant bias whether it is uniform or nonuniform (Meiring, 2007).

The following tables, Table 4.5 and 4.6 display the proportion of items correct per race group on the CFT and MU subtests respectively.

Table 4.5. Proportion of items correct on the CFT per race group

CFT items	Asians	Blacks	Coloureds	Whites	All Groups
Item1	0.97	0.93	0.93	0.94	0.94
Item2	0.81	0.72	0.81	0.84	0.80
Item3	0.92	0.92	0.95	0.95	0.94
Item4	0.69	0.50	0.63	0.66	0.61
Item5	0.67	0.54	0.61	0.76	0.66
Item6	0.55	0.45	0.55	0.66	0.57
Item7	0.95	0.89	0.92	0.95	0.93
Item8	0.47	0.31	0.35	0.46	0.40
Item9	0.45	0.49	0.59	0.67	0.59
Item10	0.78	0.49	0.60	0.69	0.63
Item11	0.83	0.70	0.67	0.79	0.74
Item12	0.59	0.63	0.60	0.65	0.63
Item13	0.20	0.25	0.24	0.34	0.28
Item14	0.86	0.79	0.85	0.92	0.86
Item15	0.42	0.29	0.31	0.53	0.41
Item16	0.69	0.49	0.61	0.67	0.61
Item17	0.70	0.55	0.55	0.72	0.64
Item18	0.70	0.64	0.78	0.84	0.76
Item19	0.63	0.49	0.49	0.72	0.60
Item20	0.42	0.31	0.33	0.41	0.37
Item21	0.59	0.45	0.50	0.61	0.54
Item22	0.75	0.60	0.65	0.80	0.71
Item23	0.36	0.20	0.28	0.34	0.29
Item24	0.63	0.34	0.46	0.53	0.47
Item25	0.28	0.31	0.28	0.37	0.33
Item26	0.64	0.70	0.78	0.82	0.76
Item27	0.28	0.11	0.17	0.29	0.22
Item28	0.44	0.22	0.38	0.44	0.37
Item29	0.22	0.13	0.19	0.23	0.19
Item30	0.52	0.43	0.49	0.57	0.51

Table 4.6. Proportion of items correct on the MU per race group

MU items	***Asians***	***Blacks***	***Coloureds***	***Whites***	***All Groups***
Item1	0.73	0.69	0.80	0.76	0.75
Item2	0.66	0.55	0.60	0.65	0.61
Item3	0.55	0.46	0.47	0.59	0.52
Item4	0.92	0.75	0.89	0.90	0.86
Item5	0.75	0.60	0.77	0.81	0.74
Item6	0.58	0.48	0.50	0.66	0.57
Item7	0.84	0.80	0.84	0.82	0.82
Item8	0.67	0.62	0.67	0.81	0.72
Item9	0.53	0.49	0.53	0.55	0.53
Item10	0.31	0.19	0.30	0.30	0.27
Item11	0.25	0.22	0.38	0.37	0.32
Item12	0.20	0.18	0.25	0.27	0.23
Item13	0.89	0.68	0.77	0.86	0.80
Item14	0.55	0.47	0.57	0.60	0.55
Item15	0.25	0.15	0.20	0.29	0.23
Item16	0.42	0.36	0.40	0.53	0.45
Item17	0.14	0.12	0.12	0.14	0.13
Item18	0.86	0.79	0.88	0.90	0.86
Item19	0.69	0.59	0.71	0.76	0.70
Item20	0.33	0.27	0.26	0.36	0.31
Item21	0.75	0.56	0.75	0.78	0.71
Item22	0.48	0.35	0.47	0.57	0.48
Item23	0.11	0.13	0.12	0.16	0.14
Item24	0.42	0.37	0.43	0.55	0.47
Item25	0.48	0.32	0.44	0.49	0.43

Table 4.7. Item bias statistics of the CFT for the different race groups

CFT items	***Nk r-sq increment due to Group***	***Nk r-sq increment due to Interaction***
	Uniform Bias	***Non-uniform bias***
Item1	0.00886	0.00697
Item2	0.00234	0.00297
Item3	0.00289	0.01769
Item4	0.00557	0.01588
Item5	0.00770	0.00172
Item6	0.00150	0.00303
Item7	0.00207	0.00608
Item8	0.00366	0.00273
Item9	0.01194	0.00052
Item10	0.01260	0.00324
Item11	0.01344	0.00037
Item12	0.02237	0.01565
Item13	0.00868	0.00506
Item14	0.00400	0.00074
Item15	0.00912	0.00688
Item16	0.00400	0.00439
Item17	0.00565	0.00103
Item18	0.02235	0.00141
Item19	0.01624	0.00107
Item20	0.00558	0.00251
Item21	0.00069	0.00599
Item22	0.00436	0.00109
Item23	0.00167	0.01257
Item24	0.01000	0.00392
Item25	0.01006	0.00146
Item26	0.01335	0.00079
Item27	0.00266	0.01728
Item28	0.00663	0.00872
Item29	0.00863	0.01420
Item30	0.00051	0.01046

It is clear from Table 4.7 that when bias is evaluated in terms of significance, no items (R^2 is ≥ 0.06) revealed significant bias. Therefore from a practical perspective it can be concluded that the CFT is not biased against any one race group and therefore the test is applicable for use in a cross-cultural industrial setting.

Table 4.8. Item bias statistics of the MU for the different race groups

MU items	***Nk r-sq increment due to Group***	***Nk r-sq increment due to Interaction***
	Uniform Bias	***Non-uniform bias***
Item1	0.00941	0.00147
Item2	0.00233	0.00575
Item3	0.00364	0.00561
Item4	0.00978	0.00111
Item5	0.00195	0.00378
Item6	0.00536	0.00214
Item7	0.01456	0.00686
Item8	0.01023	0.00541
Item9	0.00474	0.00123
Item10	0.00568	0.00390
Item11	0.01079	0.00166
Item12	0.00171	0.00114
Item13	0.01202	0.00671
Item14	0.00142	0.00082
Item15	0.00275	0.00904
Item16	0.00341	0.00061
Item17	0.00239	0.01678
Item18	0.00078	0.00989
Item19	0.00119	0.00544
Item20	0.00408	0.00894
Item21	0.00302	0.00036
Item22	0.00283	0.00332
Item23	0.00523	0.00623
Item24	0.00264	0.00144
Item25	0.00183	0.00309

It is clear from the Table 4.8 that when bias is evaluated in terms of significance, no items (R^2 is ≥ 0.06) revealed significant bias. Therefore from a practical perspective it can be concluded that the MU is not biased against any one race group and therefore the test is applicable for use in a cross-cultural industrial setting.

If the presence of a medium or large effect size for the indicators of uniform or non-uniform bias is taken as the criterion of item bias, no items showed significant bias. It seems fair to conclude that the extent of item bias in the CFT or MU subtests is not consequential from a practical perspective.

From the results obtained the null hypothesis must be rejected and the main hypothesis H_{1D} must be accepted.

H_{1D} - The CFT and the MU subtests are unbiased in terms of item level analysis.

4.3 Establishing the existence of learning potential differences among subsets of the sample

The results will be discussed under the identified homogeneous subsets within the heterogeneous sample:

Subset 1: Race variable
Subset 2: Age variable
Subset 3: Education variable
Subset 4: Combined Age and Education variable
Subset 5: Functional variable
Subset 6: Hierarchical variable

4.3.1 Subset One: Race Variable

Table 4.9. Descriptive statistics on global scores for Race variable

Race Origin	***N***	***M*** ***Global Score***	***SD***
Coloured	167	43.9	13.27
White	374	51.1	16.63
Black	236	38.9	13.79
Asian	64	47.4	15.29
All Groups	841	45.98	15.96

Below is a graphical presentation of the distribution of the global learning potential scores of the different race groups.

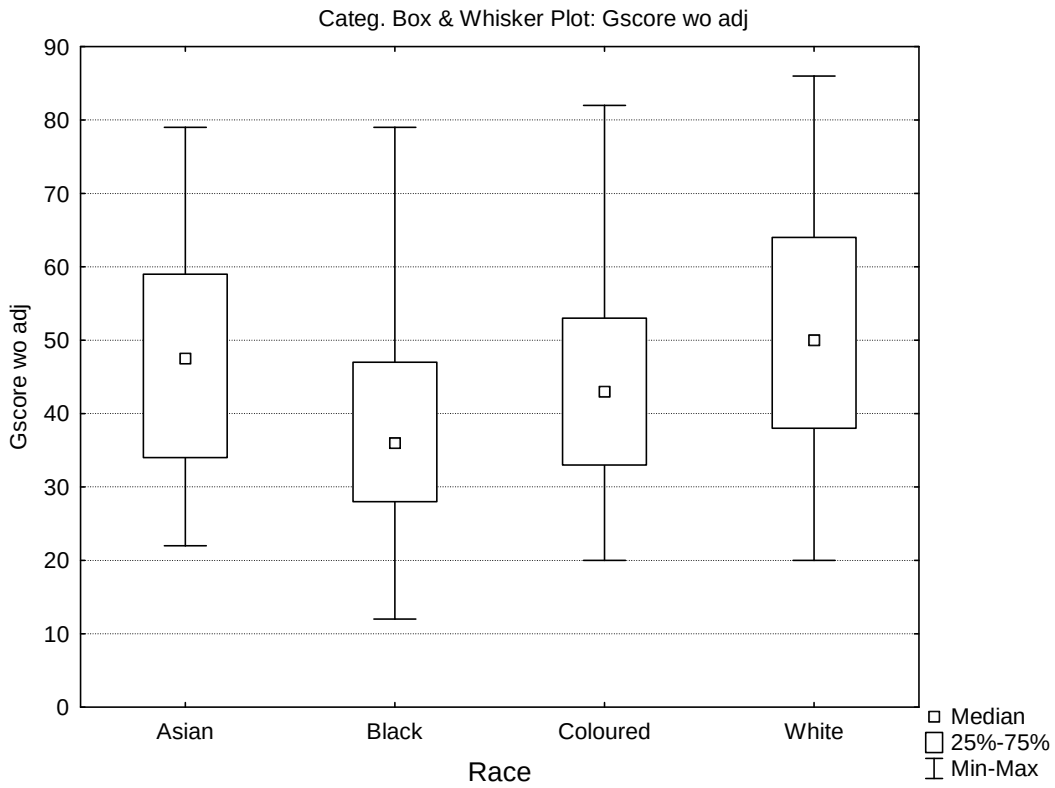


Figure 9. Box and Whisker Plot for Race variable

The analysis of variance (ANOVA) showed that there are statistically significant (at the 5% level) mean differences in the learning potential scores among certain of the race groups (F = 32.47, p = 0.00, η^2 = 0.10). A large effect size (η^2 = 0.10) is indicated and therefore the differences can be considered as being of practical importance. Since there are statistically significant differences the Scheffé post hoc test was done to show between which race groups these differences exist.

Table 4.10. Scheffé post hoc test – Race variable

Race Origin	***Coloured***	***White***	***Black***	***Asian***
	M=43.9	M=51.1	M=38.9	M=47.4
Coloured		0.00001	0.01411	0.50283
White	0.00001		0	0.34073
Black	0.01411	0		0.00149
Asian	0.50283	0.34073	0.00149	

Shaded areas are indicative of significant differences (at the 5% level).The Scheffé post hoc test indicated that there were differences in the learning potential scores among the following race groups:

Statistically significant mean differences (Table 4.10) exist between:

- Coloureds and Whites, where $p < 0.05$
- Whites and Blacks, where $p < 0.05$
- Blacks and Asians, where $p < 0.05$
- Coloureds and Blacks, where $p < 0.05$

No statistical significant mean differences (Table 4.10) exist between:

- Coloured and Asians, where $p = 0.50$
- Asians and Whites, where $p = 0.34$

From the results obtained the null hypothesis must be rejected and the alternative hypothesis H_{2A} must be accepted.

H_{2A} – *There are significant mean differences on the learning potential global scores among the four race groups.*

4.3.2 Subset Two: Age Variable

Table 4.11. Descriptive statistics on global scores for Age variable

Age Cohort	*N*	*M* *Global Score*	*SD*
< 35 years	132	56.85	13.97
35 - 44 years	347	49.98	15.67
45 - 54 years	273	39.51	13.22
55+ years	89	34.16	11.22
All Groups	841	45.98	15.96

Below is a graphical presentation of the distribution of the global learning potential scores of the different age cohorts.

Figure 10. Box and Whisker Plot for Age variable

The analysis of variance (ANOVA) showed that there are statistically significant (at the 5% level) mean differences in the learning potential global scores among all the age groups (F = 74.27, p = 0.00, η^2 = 0.210). It indicates that as people age so their learning potential scores generally decrease. This is also clearly observable on inspection of Figure 10.

A large effect size (η^2 = 0.210) is indicated and therefore the differences can be considered as being of practical importance. Since there are statistically significant differences the Scheffé post hoc test was done to show between which age cohorts these differences exist.

Table 4.12. Scheffé post hoc test – Age variable

Age Cohort	***< 35 years***	***35 - 44 years***	***45 - 54 years***	***55+ years***
	M=56.856	M=49.983	M=39.513	M=34.169
< 35 years		0.00006	0	0
35 - 44 years	0.00006		0	0
45 - 54 years	0	0		0.02395
55+ years	0	0	0.02395	

The Scheffé post hoc test indicated that all age groups differ from each other in terms of their global learning potential scores.

From the results obtained above the null hypothesis must be rejected and the alternative hypothesis H_{2B} must be accepted.

H_{2B} - *There are significant mean differences on the learning potential global scores among the different age cohorts.*

4.3.3 Subset Three: Education Variable

Table 4.13. Descriptive statistics on global scores for Education variable

Educational Level	***N***	***M Global Score***	***SD***
NQF 4	444	40.12	13.56
NQF 5	230	49.43	13.86
NQF 6-8	167	56.83	17.50
All Groups	841	45.98	15.96

Below is a graphical presentation of the distribution of the global learning potential scores of the different education groups.

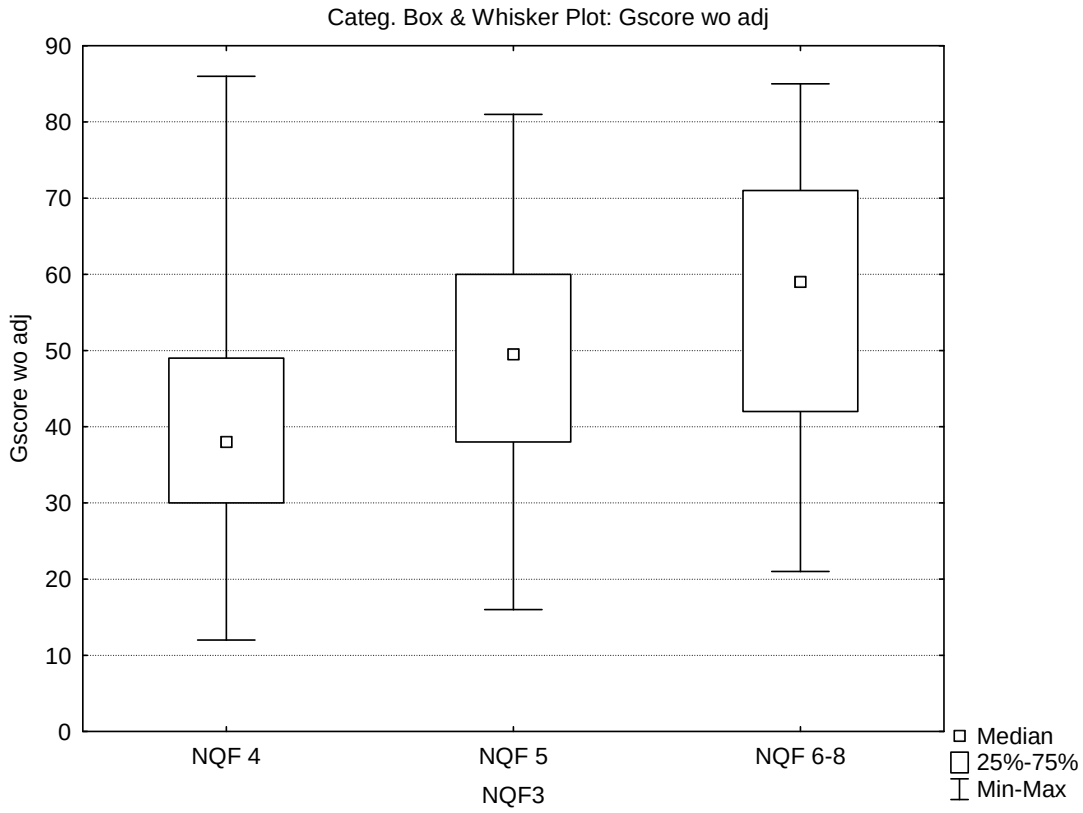


Figure 11. Box and Whisker Plot for Education variable

The analysis of variance (ANOVA) showed that there are statistically significant (at the 5% level) mean differences in the learning potential global scores among all the education groups (F = 89.5, p = 0.00, η^2 = 0.176). It indicates that people who have acquired higher education generally attain higher learning potential scores. A large effect size (η^2 = 0.176) is indicated and therefore is of practical importance. Since there are statistically significant differences the Scheffé post hoc test was done to show between which education levels these differences exist.

Table 4.14. Scheffé post hoc test – Education variable

Education Levels	NQF 4	NQF 5	NQF 6-8
	M=40.12	M=49.44	M=56.84
NQF 4		0	0
NQF 5	0		0.00000
NQF 6-8	0	0.00000	

The Scheffé post hoc test for significance indicates that all education groups differ from each other in terms of their global learning potential scores.

From the results obtained the null hypothesis must be rejected and the alternative hypothesis H_{2C} must be accepted.

H_{2C} - *There are significant mean differences on the learning potential global scores among the different education groups.*

4.3.4 Subset Four: Combined Age and Education Variable

Table 4.15. Descriptive statistics on global scores for combined Age and Education variable

Age & Educational Level	*N*	*M* *Global Score*	*SD*
Y_NQF4	118	48.3	13.60
Y_NQF5+	176	58	15.56
O_NQF4	188	33.8	10.14
O_NQF5+	105	42.1	13.23
All Groups	587	45.5	16.36

Below is a graphical presentation of the distribution of the global learning potential scores of the different combined age and education groups.

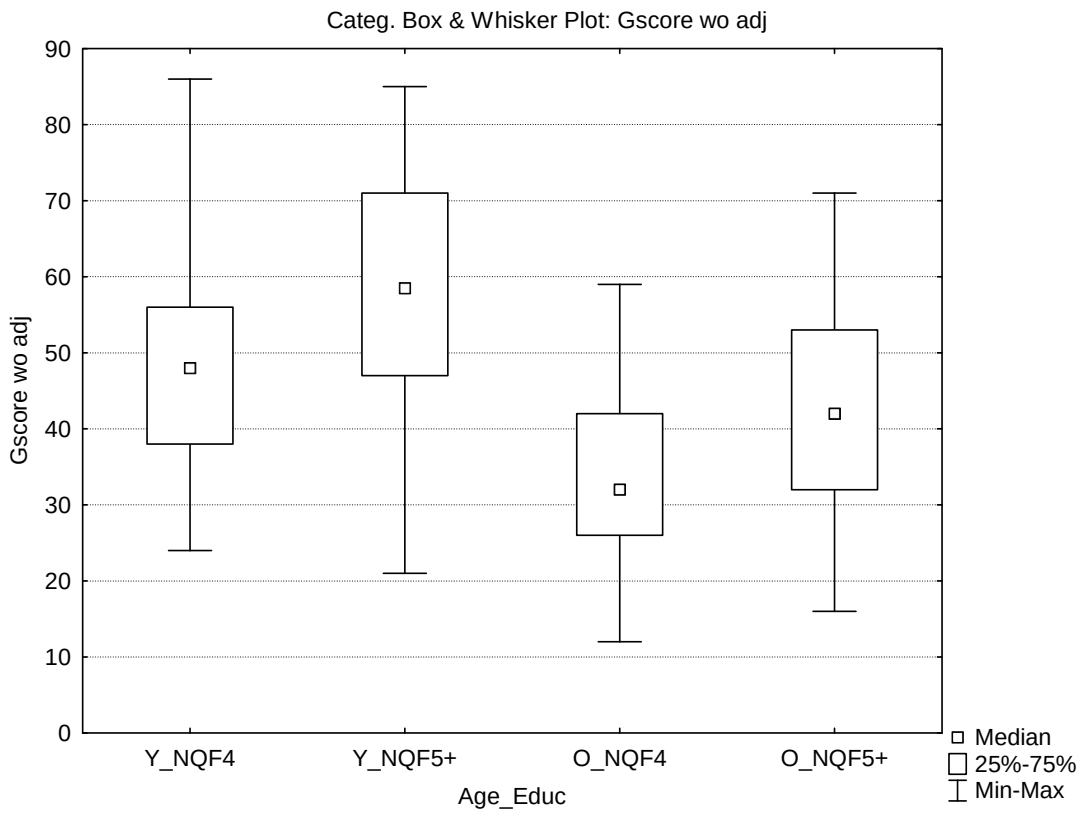


Figure 12. Box and Whisker Plot for combined Age and Education variable

The analysis of variance (ANOVA) showed that there is statistically significant (at the 5% level) mean differences in the learning potential global scores among all the combined age and education groups (F = 106.07, p = 0.00, η^2 = 0.3531). A large effect size (η^2 = 0.3531) is indicated and therefore is of practical importance. Since there are statistically significant differences the Scheffé post hoc test was done to show between which combined age and education levels these differences exist.

Table 4.16. Scheffé post hoc test – Age and Education variable

Combined Age and Education levels	Young with NQF4	Young with NQF5+	Old with NQF4	Old with NQF5+
	M=48.30	M=58	M=33.80	M=42.12
Young with NQF4		0	0	0.00722
Young with NQF5+	0		0	0
Old with NQF4	0	0		0.00000
Old with NQF5+	0.00722	0	0.00000	

The Scheffé post hoc test indicates that all combined age and education groups differ from each other in terms of their global learning potential scores.

From the results obtained above the null hypothesis must be rejected and the alternative hypothesis H_{2D} must be accepted.

H_{2D} - *There are significant mean differences in the learning potential global scores among the different combined age and education groups.*

4.3.5 Subset Five: Functional Variable

Table 4.17. Descriptive statistics on global scores for Functional variable

Functional Level	***N***	***M*** ***Global Score***	***SD***
Technical	424	45.6	14.81
Non-Technical	371	43.4	15.36
German	46	69.9	10.65
All Groups	841	46	15.96

Below is a graphical presentation of the distribution of the global learning potential scores of the different functional groups.

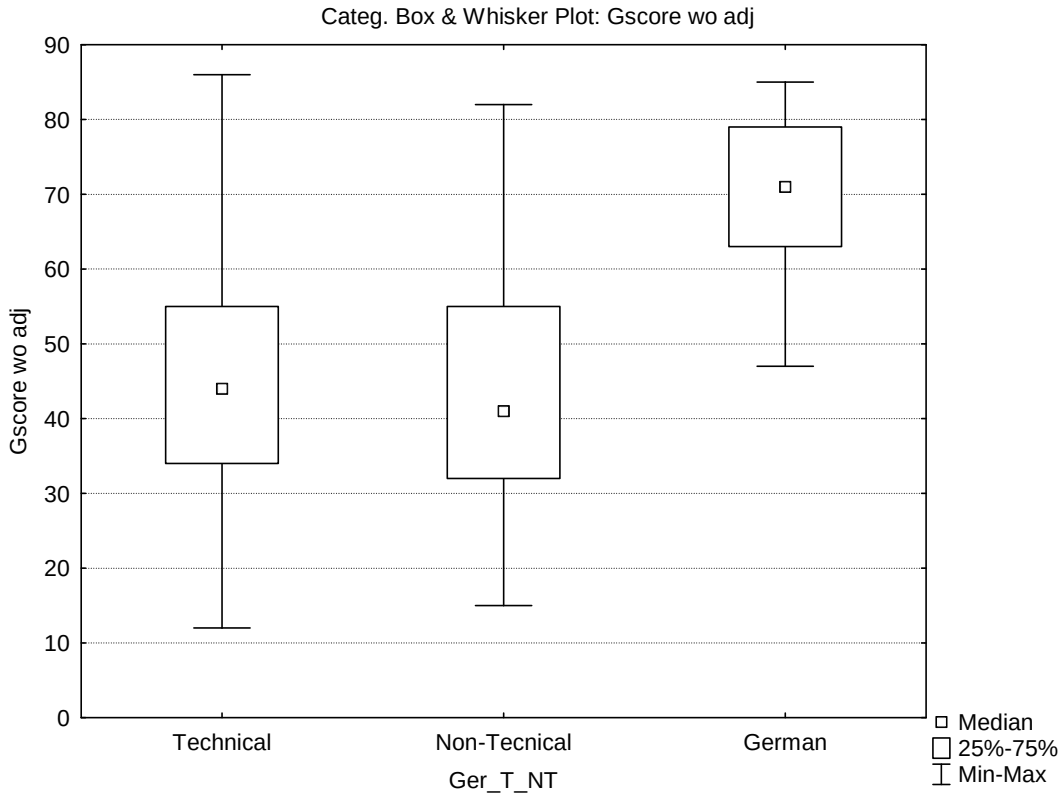


Figure 13. Box and Whisker Plot for Functional variable

The analysis of variance (ANOVA) showed that there is statistically significant (at the 5% level) means differences in the learning potential scores among certain of the functional groups (F = 64.95, p = 0.00, η^2 = 0.13). A large effect size (η^2 = 0.13) is indicated and therefore is of practical importance. Since there are statistically significant differences the Scheffé post hoc test was done to show between which functional levels these differences exist.

Table 4.18. Scheffé post hoc test – Functional variable

Functional Group	Technical	Non Technical	German
	M=45.65	M=43.4	M=69.9
Technical		0.109698	0
Non-Technical	0.109698		0
German	0	0	

The Scheffé post hoc test indicates that there were differences in the learning potential scores among the following functional groups:

There are statistically significant mean differences between:

- Technical functions and German expatriates, where $p < 0.0001$
- Non-technical functions and German expatriates, where $p < 0.0001$

No statistical significant mean differences exist between:

- Technical functions and Non-Technical functions, where $p = 0.1096$

This is also evident on inspection from Figure 13.

From the results obtained above the null hypothesis must be rejected and the alternative hypothesis H_{2E} must be accepted.

H_{2E} - There are significant mean differences in the learning potential global scores among the different functional group variables.

4.3.6 Subset Six: Hierarchical Variable

Table 4.19. Descriptive statistics on global scores for Hierarchical variable

Hierarchical Level	*N*	*M* *Global Score*	*SD*
Senior management	86	54.89	16.17
Team management	110	37.95	14.92
Non-management	645	46.17	15.45
All Groups	841	45.99	15.96

Below is a graphical presentation of the distribution of the global learning potential scores of the different hierarchical groups. The first level of management in the automotive industry use titles of Team management and First-Line Supervision interchangeably.

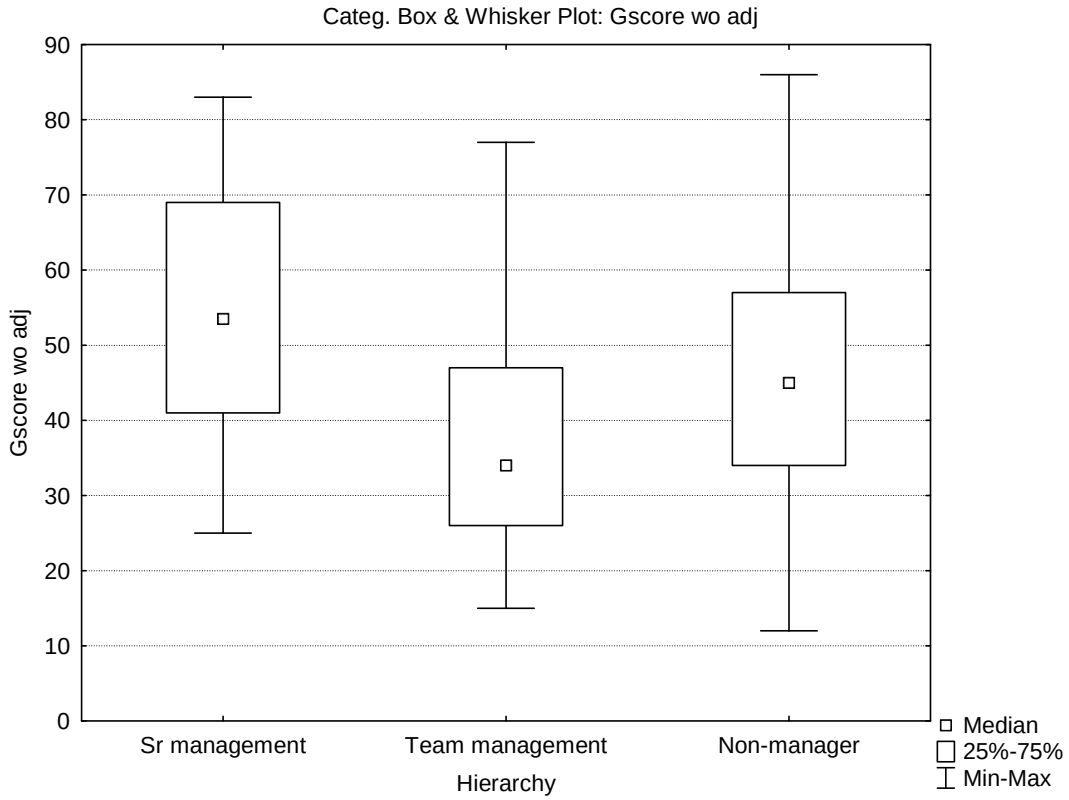


Figure 14. Box and Whisker Plot for Hierarchical variable

The analysis of variance (ANOVA) showed that there is statistically significant (at the 5% level) mean differences in the learning potential global scores among all the hierarchical levels (F = 29.19, p = 0.00, η^2 = 0.065). A medium effect size (η^2 = 0.065) is indicated and therefore is of relative practical importance. Since there are statistically significant differences the Scheffé post hoc test was done to show between which functional levels these differences exist.

Table 4.20 Scheffé post hoc test – Hierarchy variable

Hierarchical Level	Senior management	Team management	Non-manager
	M=54.90	M=37.96	M=46.17
Senior management		0	0.00000
Team management	0		0.00000
Non-manager	0.00000	0.00000	

The Scheffé post hoc test indicates that all hierarchical groups differ from each other.

From the results obtained above the null hypothesis must be rejected and the alternative hypothesis H_{2F} must be accepted.

H_{2F} - *There are significant differences in the learning potential scores among the different hierarchical groups.*

First Line Supervision (Team Management) is considered an important hierarchical level in the automotive industry due to the large number of subordinates reporting to them and therefore a wide span of influence. It is evident from Table 4.19 (p. 92) that the global scores for this level are considerably lower than that of senior management and it was deemed necessary to investigate the mean scores on all the subtests to determine appropriate training initiatives.

Table 4.21. Performance on the APIL subtests in the hierarchical levels

APIL subtests	***Team Management***		***Non-Management***		***Senior Management***	
	Means	*SD*	*Means*	*SD*	*Means*	*SD*
CFT	13.6	6.33	17.43	6.10	21.71	5.66
MU	11.24	5.15	13.35	5.07	14.71	5.34
Global score	37.95	14.92	46.17	15.45	54.90	16.17
COLtot	151.09	78.75	186.03	88.34	244.44	106.82
COLdiff	23.62	24.57	33.68	28.68	50.38	36.79

The results demonstrate that First Line Supervision (Team Management) scored the lowest on all the subtests, which supports the South African literature which highlights that South African managers identify the lack of adequately trained supervisors as a critical challenge (Creamer, 2008; Van der Merwe, 2009).

4.4 Conclusion

The research analysis firstly examined the psychometric properties of the APIL to determine whether it stands up to scientific scrutiny imposed by the Employment Equity Act through the measurement of internal consistency, construct equivalence and item bias.

Secondly the research investigated whether significant differences exist among the identified subsets of the sample in terms of their cognitive capabilities and potentialities. The quantitative results were reported under the identified subsets within the heterogeneous sample.

As the presenting of results as graphics and tables do not provide sufficient insight and understanding, the results will be discussed in detail in the following chapter.

CHAPTER FIVE
DISCUSSION

5.1 Introduction

The primary purpose of this study was to investigate the impact of a psychometric assessment technique in the South African automotive industry. More specifically it was to determine the usefulness of the APIL for identifying talent within a heterogeneous workforce through the assessment of learning potential.

As stated in Chapter one, this study had three main aims:

1. To determine whether the APIL meets the criteria imposed by the Employment Equity Act.
2. Identify talent through the assessment of cognitive capabilities and potentialities.
3. Recommend ways to manage talent more effectively.

This final chapter provides a discussion of the research findings of this study. The researcher will interpret and explain the findings in conjunction with previous research conducted. The purpose of examining previous research is to either refute or concur with the findings of this study in order to make more meaningful contributions to industry.

5.2 Psychometric properties of the APIL

In the process of addressing the research objectives it was deemed necessary and beneficial to first examine the measuring instrument, the APIL, with regards to its reliability and bias. The results of these analyses revealed that the instrument demonstrates reliable evidence that it stands up to scientific scrutiny

in terms of the legislation as set out in the Employment Equity Act 55 of 1998, Section 8.

5.2.1 Internal Consistency

The reliability estimates (Table 4.2, p. 70) obtained for the research population agrees highly with previous research findings (Lopes et al., 2001; Taylor, 2007). Within this research sample the reliability estimates obtained on all the APIL subtests indicate good internal consistency, thereby supporting the usefulness of the instrument for cross-cultural comparison (Van de Vijver & Leung, 1997).

There is also evidence that all the subtests correlate positively (Table 4.3, p. 72) with each other for all race groups. These strong correlations indicate that to a degree, the battery of tests as a whole is reliable for the measurement of the same construct (learning potential) for all race groups. This supports the design of the APIL as discussed in the Administrator's Manual (Taylor, 2007).

5.2.2 Construct Bias

Both the CFT and the MU (Table 4.4, p. 75) cognitive subtests showed low levels of construct bias, revealing factorial invariance in all the race groups. These high levels of structural equivalence indicate that the APIL is an appropriate and therefore useful tool to use in the South African multicultural industrial context. This evidence aligns with the literature by Berry, Poortinga, Segall and Dasen (2002), which provides support for the structural equivalence of most cognitive tests.

5.2.2 Item Bias

No items in the CFT (Table 4.7, p. 79) or the MU (Table 4.8, p. 80) cognitive tests revealed significant bias. Therefore from a practical perspective it can be concluded that these subtests are not biased against any cultural group and therefore can be considered appropriate for use in this multicultural industrial setting.

5.3 Establishing the existence of learning potential differences among subsets of the sample

The relationships among the identified subsets are discussed in relation to the global learning potential scores obtained on the APIL. Understanding the differences in cognitive capabilities and potentialities that exist among subsets of the heterogeneous sample will enable the organisation to identify high potential talent. It will also provide information to assist in developing strategic training interventions targeted at the individual, functional and organisational level to sustain global competitiveness into the future (Erasmus et al., 2010).

The results will be discussed under the identified subsets within the heterogeneous population.

Subset 1: Race Origin variable
Subset 2: Age variable
Subset 3: Education variable
Subset 4: Combined Age and Education variable
Subset 5: Functional variable
Subset 6: Hierarchical variable

5.3.1 Race Group Subset

The statistical trend line (Table 4.9, p. 82) of the mean differences in the global scores among the four race groups is indicative of the past disadvantages and advantages in the South African socio-political system during the Apartheid Era. There is much research written around the consequences of the Bantu Act 47 of 1953 and it is suffice to say that the Apartheid legislation negatively affected the educational potential of students (Garson, 2004; O'Gorman, 2004; Pearce, 2004; Kader, 2005). Verwoerd's statement made in South African Parliament 57 years ago; *"Do not teach a black child mathematics and science. It will not need it"* became the de facto policy in the way the South African government of the time dealt with the educational provision of black learners. It can be said that today science and mathematics are still the most neglected areas in the South African educational curriculum (Persens, 2006). The Global Competiveness Report released by the World Economic Forum reveals that South Africa ranks 137 out of 139 countries in terms of the quality of science and maths education (Mazibuko, 2010). This has serious consequences for upskilling of people in the increasingly high technological field of the automotive industry.

Although it is 16 years since the fall of Apartheid, it must also be borne in mind that 85% (Figure 4, p. 48) of the population fall into the 35 to 55+ age category and therefore obtained their education during the Apartheid era. Today the South African government is attempting to provide equitable education; however the matriculation results are clearly demonstrating that there is still a long road ahead to achieve such status. In 2008 the Eastern Cape Province, where this research is conducted, reported the weakest matriculation results in the country, with a 54% pass rate and a 6.9% university exemption, with one fifth of its schools achieving pass rates of less than 20% (Keeton, 2009). In 2009 the province's pass rate dropped even further to 50% (Axium, 2010). The research organisation draws on this population to provide employment. It therefore is

important to recognise that much of the workforce has not been exposed to quality education.

However, it is evident from the learning potential scores obtained in the APIL that there are individuals who demonstrate strong cognitive potential in all race groups (maximum values in Figure 9, p. 82), which confirms research findings cited by Gregory (2007). It is these individuals who should be provided with the necessary development opportunities and placed in the high potential talent pool to be considered in future succession planning. This demonstrates that through the assessment of learning potential on the APIL it is possible to identify high potential individuals, despite the fact that they have been disadvantaged through education. This is one of the premises that the instrument was designed upon (Taylor, 2007).

During the Apartheid era the White race group was afforded an advantageous education, with a 1:18 ratio of teacher to pupil, and 96% of all teachers having the requisite teaching qualifications (Ocampo, 2004). It is therefore expected that this group's mean global score (M = 51.1) is higher than that of the other race groups.

The Asian population placed great emphasis on education throughout the Apartheid era, and government provided more funding to Indians, than for the Coloured and Black race group, with a 1:24 ratio of teacher to pupil (Ocampo, 2004). The Asian group's mean global score (M = 47.4) is not significantly different to that of the White race group.

During Apartheid the education department provided Coloured population with a 1:27 ratio of teacher to pupil (Ocampo, 2004). Although there is a statistically significant mean difference between the White and Coloured race groups (M = 43.9) in their global scores, there is no significant differences between the Coloured and Asian race group.

Research confirms that the Black population received the least budget during the Apartheid era. The children were at a considerable disadvantage having a 1:39 teacher to pupil ratio and with only 15% of their teachers having the requisite qualifications (Ocampo, 2004). The research data provides evidence that there is a statistical difference in the mean global score between the Black race group (M = 38.9) and all other race groups.

Statistically a large effect size exists between all the race groups (η^2 = 0.10) and therefore is of practical importance for the organisation. They need to take into consideration the effects of disadvantagement on their current staff to enable them to identify and provide appropriate training interventions at both the individual and organisational level.

5.3.2 Age Group Subset

From the statistical trend line (Figure 10, p. 84)) it is evident that the mean global score decreases considerably per age cohort. These findings support the literature that cognitive functioning decreases with advancement in age (Horn & Cattell, 1966; 1967; Horn, 1985; Schaie, 1989; Wang & Kaufman, 1993; Taylor, 2007). Table 4.11 (p. 84) displays that the highest mean score (M = 56.85) is attained by individuals below the age of 35. Between the ages of 35 and 44, the mean score drops by 7 points (M = 49.98) and a further 10 points (M = 39.51) for ages between 45 and 54. The groups of individuals who are 45 years and older score below the average mean score (M = 45.98).The mean score drops a further 5 points (M = 34.16) for the group of individuals who are 55 years and older.

These results are of practical importance to the organisation when designing training and development interventions at both the individual and organisational level. At the individual level, high potential young people under the age of 35 will more likely be successful in adapting quickly to complex new ways of working,

either on a job rotational basis or in educational programmes (Taylor, 2007). High potential, good performing candidates in the older age groups, and who have a long tenure, are not necessarily looking for new career directions but may be highly satisfied with adopting the role of mentor and coach in the organisation. This role not only provides status but also adds to job satisfaction by imparting their specialist knowledge on to the younger generation (Charan et al., 2001). This helps us to understand that since cognitive capacity declines to some extent with increase in age this has important implications for training at the organisational level. As a result it is suggested that complex technical training interventions should be targeted at the younger generation whereas 'softer' inter and intra-personal skills should be considered for the older groups of people. This is of particular relevance for older people who already occupy or are to be considered for leadership positions.

It is also important to note that the organisation has an ageing population (Figure 4, p. 48), with only 16% of their workforce in the '< 35 age' group, with 44% of the workforce 45 years and older. In the Eastern Cape Province, there are few job opportunities in the surrounding business environment, with an unemployment rate of 27.7% (Labour Force Survey, 2010). The Eastern Cape is geographically the second largest province in South Africa, (representing 14% of South Africa), yet the poorest province in terms of average on monthly expenditure, contributing 13.3% of the country's GDP. It is evident from the tenure data (Table 3.8, p.54) that 43% of the employees have spent much of their working life (16 years and over) within this research organisation. This long tenure can be in part contributed to lack of job availability in the geographical area. Due to the economic recession the research organisation currently has a moratorium on external recruitment. One solution to counteract the problem of an ageing workforce is to open the recruitment process to attract high potential young people and offer voluntary separation packages (VSP) to staff over the age of 55. It is also important however for the organisation not to lose high performing talented older staff members. Older staff members who could be eligible for

VSPs are those who are struggling in their new roles due to the complex transforming environment.

5.3.3 Education Group Subset

The statistical analysis indicates a trend line (Table 4.13, p. 86) that demonstrates a substantial increase in the mean global score amongst groups of individuals who have attained higher educational levels. The trend line increases with individuals who have obtained degrees and continues to increase with those who have continued successfully to complete post-graduate studies. However it is also evident from the maximum point in Figure 11 (p. 86) that there are people who have no tertiary education (NQF 4) but who still demonstrate high cognitive potential. This is one of the premises that the APIL is designed upon; that it should identify high potential individuals despite their lack of education acquirement. It is these individuals that the organisation should be assisting in their personal development through the provision of tertiary education opportunities as they are more likely to master new cognitively demanding material (Taylor, 2007).

This information is of particular importance for the South African organisation wishing to provide development opportunities to previously disadvantaged groups of employees. Investing in the identified high potential candidates, who have not had the opportunity to acquire an education, will also ensure the organisation aligns with the Skills Development Act 97 of 1998. This legislation aims to improve the employment prospects of persons previously disadvantaged by unfair discrimination and to redress those disadvantages through training and education. Investing in such individuals will also ensure that the organisation's Employment Equity targets are met throughout all levels of staff by identifying and developing high potential employees.

5.3.4 Age and Education Group Subset

The combined age and education trend line (Table 4.15, p. 88) again confirms that cognitive capacity decreases with age despite the fact that the 'Old with NQF 5+' category includes individuals who have acquired higher education. It is evident from the maximum point reflected in Figure 12 (p. 88) that there are young people without any other formal education (NQF 4) who demonstrates high cognitive potential for further development. It is these individuals in whom the organisation should place special interest in.

It is also interesting to note that there are young individuals with higher education (NQF 5+) who scored very low, which is reflected in the minimum point displayed in Figure 12 (p. 88). It is highly probable that these individuals had to work extremely diligently to achieve a higher level of education. It is also acknowledged that institutions of Higher Education in South Africa vary in their standard and quality of education delivery. It is also pertinent at this point to state that the standard of the matriculation qualification in South Africa has also dropped significantly over the past few years (Deloitte, 2008).

The automotive industry is a rapidly changing technological environment which requires a workforce to be on a constant learning curve. Training is an expensive and time consuming activity. Therefore to ensure a return on investment it is imperative to select people who are most likely to succeed in complex training programmes. It is evident from the results in this study that some people with higher education may not necessarily succeed. Results also display that there are people who have not had the opportunity to acquire higher education but who possess strong cognitive potential. To ensure an equal opportunity to attend specialised training courses it is evident that organisations would benefit from employing a selection process to assess cognitive potential.

It is for these reasons that it is imperative for organisations to implement a standardised assessment process for recruitment and selection to identify high potential candidates, as they can not rely on a matriculation certificate or university degree to be indicative of high cognitive capacity and potential. Many universities are now implementing assessment processes to determine cognitive potential of individuals at entry level. Some of these include the University of the Witwatersrand, the University of Kwa-Zulu Natal, and the University of Cape Town (Murphy, 2006).

5.3.5 Functional Group Subset

When discussing the organisation as a South African entity (excluding German expatriates), and dividing the population into Technical (*M* = 45.65) and Non-Technical (*M* = 43.4) functions, it is clear that there is great similarity in the mean global scores in the staff composition (Table 4.17, p. 90). This is understandable as both core and service functions require highly qualified employees.

However when one takes the German expatriate group into consideration there is clear evidence (Figure 13, p. 90) that they demonstrate significantly higher cognitive potential (*M* = 69.9) than their South African counterparts. It is important to note that these expatriates are from a variety of functional groups and across different hierarchical levels and not only highly qualified engineers as one would assume. Many of the Germans are artisans who are deployed to South Africa to transfer their specialised technological skills. In Germany these artisans are hourly paid employees unlike their South African counterparts who are monthly paid staff members. Currently the South African automotive industry depends largely on foreign expertise and therefore the transfer of skills is imperative to strengthen the independency of the South African industry.

It is universally acknowledged that Germany delivers a high standard of education, where there is an emphasis on analytical thinking, which is evident

from the mean global scores obtained. This has important ramifications for the South African organisation. The German expatriates need to be sensitised and made acutely aware of the differing education levels when coming to South Africa to train the workforce. This requires the Germans to adopt different training strategies to ensure that when transferring knowledge it is understood and retained. One approach to ensure that this transfer is successful is through the identification of high potential technical candidates and place them on training programmes together with the German trainers.

5.3.6 Hierarchical Group Subset

In any organisation one would expect senior management to be operating at a high cognitive level. The data (Table 4.19, p. 92) demonstrates that the mean global score for senior managers are significantly higher than those of non-management and first-line supervision. However it is evident from the minimum value displayed in Figure 14 (p. 92), that some senior managers are performing well below the expected level and it is highly probable that these individuals are struggling with the challenging demands of their job.

First line supervision is a group that demonstrates a very low mean global score (Table 4.19, p. 92). This confirms South African literature which emphasises the dire need for upskilling and developing this first level of management (Creamer, 2008; Van der Merwe**,** 2009). These results have important ramifications for the organisation as this level is the grooming ground for promotion into the next level of management. This job level involves more than mere routine and rule following activities than in the levels they were promoted from; making this is an important group to consider for development. This hierarchical level also has the largest group of subordinates reporting to them with a wide sphere of influence, thus a complex supervisory position. Problem solving skills have been identified as a key focus area within the South African auto industry (DAC, 2008). First line supervision obtained a mean score of 13.6 (*SD* 6.33) on conceptual reasoning on

the CFT, whereas senior management scored a mean of 21.71 (*SD* 5.66) (Table 4.21, p. 94). These results clearly indicate that the first line supervisors generally have poor capacity in their abstract functioning and problem solving ability. This indicates that they will have difficulty in thinking logically and seeing critical connections between different facts or sets of information. Poor conceptual thinking inhibits the ability to organise and solve problems (Taylor, 2007). As technology becomes more advanced so do the jobs of their subordinates which will further increase the challenges of this supervisory role. One of the identified top barriers to improved productivity in the automotive sector cited by sector managers is the quality of supervisors (Van der Merwe, 2009). This critical shortage of technically skilled managers, particularly from previously disadvantaged groups, also has a negative impact on the industry, with South Africa ranking 42nd out of 46th in terms of economic growth and competitiveness (NPI, 2002). It is evident that this hierarchical level should be on the top of the organisation's training agenda. At the forefront of supervisory training programmes should be a focus on analytical skills to improve problem-solving on the shopfloor. Another strategy to improve future first line supervision is to identify high potential, high performing hourly paid employees who report into this level of management. Through the development of a talent pool in the hourly ranks and implementing specific training programmes to groom these high potential candidates will ensure that the organisation has competent employees to promote to First Line Supervision into the future.

The non-management group consists of many different functions, including specialist roles, so it is expected to find cognitively strong individuals in this group. To ensure that these strong individuals are retained within the organisation, specific personal development programmes are needed. Promotion into management positions is not necessarily what all specialists aspire to, so it is imperative that the organisation understands the specific needs of these individuals who possess critical skill sets and provide them with personalised development opportunities, as well as considering other retention

strategies. On way to assist organisations in identifying specific training needs can be achieved through combining cognitive potential scores and performance management outcomes into a matrix. A practical model combining these two outcomes is further elaborated on in the next chapter.

5.4 Conclusion

In the process of addressing the research objectives, the preceding analyses demonstrates strong evidence that the APIL stands up to scientific scrutiny in terms of the legislation as set out in the Employment Equity Act 55 of 1998, Section 8. Statistical analysis provides clear trend lines indicating that sociopolitical and socioeconomic factors of advantagement and disadvantagement, age and education influence learning potential. It is also evident that the South African automotive industry is faced with a diverse set of employees who possess a wide range of differing cognitive capabilities and potentialities. The following chapter discusses the implications of these findings, limitations of this study and recommendations for future research.

CHAPTER 6
CONCLUSION

6.1 Introduction

This chapter discusses the contributions and implications that the findings of this study make toward the body of knowledge. Limitations and shortcomings will be highlighted, and recommendations for future research will be made in terms of theory and methodology. A practical application of the research findings is further illustrated and discussed by means of a guideline.

To contextualise this chapter an overview of the previous chapters is provided.

Chapter One

Chapter one provides an orientation to investigating the usefulness of the APIL for identifying talent within a heterogeneous workforce in a South African multinational automotive industry. A strategic initiative was embarked upon to identify talent through the psychometric assessment of learning potential. This research adopts a cross-cultural approach. A sample of 841 heterogeneous staff employees was assessed with three major research objectives: (a) to ensure that the instrument could stand scientific scrutiny thereby complying with the Employment Equity Act; (b) to recommend ways the organisation can identify and understand employees' talent more holistically; and (c) to manage talent more effectively.

The core concepts (intelligence; dynamic and static psychometric assessment techniques; learning potential; psychometric assessment in South Africa; talent and talent management) are identified and defined and their relationship discussed. An overview of the research problem is also provided.

Chapter Two

Chapter two is based on extensive secondary research through interdisciplinary literature study. The concept of learning potential is defined and an integrated approach to cognitive assessment is provided, laying the foundation for the research of assessment of intelligence in a multicultural society. A review of the relevance of psychometric assessment in the South African context in general, and within the automotive industry in particular is provided. A critical analysis of talent management and its importance contextualised the relevance of this research. This chapter can be seen as ideographic in nature, implying that many constructs are examined in an exploratory fashion.

Chapter Three

Chapter three describes the primary methodology, which entailed an integrated psychometric assessment approach. The empirical work conducted and its accompanying methodology is discussed. The sample and research setting is described. The heterogeneous sample was divided into six homogeneous subsets (race, age, education, combined age and education, function and hierarchy) for statistical analysis. Information about the characteristics of the measuring instruments is provided, including the method of data capture.

Chapter Four

Chapter four presents the results and statistical analysis of the data. Analyses are carried out in an attempt to find answers and to prove or disprove the set hypotheses. Statistical analyses were conducted by:

- Examining internal consistency, bias and equivalence of the APIL,
- Investigating whether significant difference in mean learning potential scores occur among the identified subsets in the sample.

This chapter can be seen as nomothetic in nature, since greater focus is placed on the numerical component than the conceptual component of the constructs.

Chapter Five

Chapter five provides a discussion of the main findings in terms of the research problem and findings are integrated with the literature review. Results showed good internal consistency; very good construct equivalence and low item bias, demonstrating the APIL can be applied fairly in a multicultural industrial setting. Statistical analyses provide clear trend lines indicating that sociopolitical and socioeconomic factors of advantagement and disadvantagement, age and education influence learning potential.

6.2 Contributions and Limitations of this Study

It is evident from this research that the South African automotive industry is faced with a diverse set of employees who possess a wide range of differing cognitive capabilities and potentialities. What has emerged from the cognitive analysis of potential is that tests should rather be used for diagnostic purposes to inform instructional needs rather than for classification.

South African organisations can play an integral role in the transformation of the country by continually upskilling their workforce. Through the employment of an equitable assessment process, organisations can identify specific groups that require targeted training interventions. This has far more beneficial affects than merely classifying groups or individuals into weak or strong cognitive potential. A practical model to assist organisations in this endeavour is further elaborated on in this chapter.

A clear and important implication of this work, as confirmed by Carpenter, Just and Shell (1990), is that it is more beneficial for organisations to understand staff

differences through the profile of information processing, learning and modifiability. Such analyses will lead to improvement in the organisation's ability to assess an individual's current level of intellectual functioning and to prescribe instructional interventions that will maximize each individual's potential, as well as developing the organisation's competence levels thus ensuring global competitiveness into the future.

The APIL software provides for the inclusion of a disadvantagement value for factors of 'Race' and 'Age' to be added to individual's scores at the discretion of the test user (Taylor, 2007, p, 56). For the purpose of this study this decision process was overridden to provide a common platform for researching the heterogeneous sample. From this study it is evident that people from different races and older people in general scored lower on the APIL. Therefore if this instrument is to be used for recruitment purposes it is recommended that the disadvantagement value is considered to provide a more equitable basis.

This current study did not address all aspects of test usage. More specifically, the predictive validity and predictive bias of the APIL were not considered. To provide a final verdict on the cross-cultural suitability for the test battery in the automotive industry can only be given when data on the predictive bias is available. As training results on recently implemented programmes within the research organisation become available it is recommended that they become the basis for future research.

6.3 Recommendations for future research

The implicit agenda guiding early cross-cultural research was the demonstration of cross-cultural differences; however today the interpretation of these differences in South Africa is pivotal for further scrutiny (Meiring, 2007). The impact of bias and equivalence in research can be expected to grow as they are central concepts in the interpretation of observed cross-cultural differences.

6.3.1 Practical implications for organisations

This research has also practical implications for organisations employing a multidimensional assessment process, using correlates of performance measurement and learning potential data, as proposed by Mucha (1994). By combining employee demographics within the framework of the Leadership Pipeline model (Charan et al*.,* 2001) this information can assist organisations to manage their talent more effectively to meet global demands of competitiveness and sustainability and to manage risk.

The Leadership Pipeline model is a "useful and flexible tool" providing a holistic framework for growing internal talent from entry level to Chief Executive Officer (Charan et al*.,* 2001). The benefit of this flexibility affords an organisation the opportunity to design a process for managing talent to align with their business strategy. These authors argue that for long-term sustainability organisations should build, develop and maintain a pipeline of talent within the organisation. As discussed in Chapter one the Leadership Pipeline model classifies an individual's potential into three categories:

1. Turn Potential – able to do the work at the next level in three to five years or sooner.
2. Growth Potential – able to do the work of bigger jobs at the same level in the near term.
3. Mastery Potential – able to do the same kind of work currently being done only better.

It is possible to translate the global scores obtained from the APIL into one of the three potential categories depending on the employee's current job level. An extract from a sample technical report contextualises how an organisation could apply this is described in Figure 15 below.

PRACTICAL APPLICATION GUIDELINE

The global score attained is based on the selected norm group and would be different if a different norm group had been chosen. APIL scores can also be placed on a more universal scale benchmarked with job levels. The system has five levels: Unskilled, Semi-Skilled, Skilled/First Line Supervision, Middle Management/Subject Matter Specialist, and Senior Management/Advanced Subject Matter Specialist.

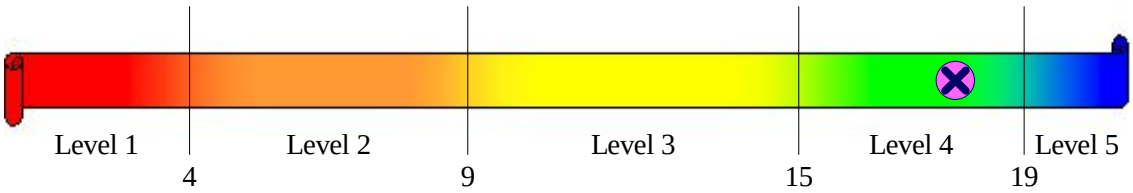
The continuum effectively has 20 points, although extremely gifted performers may obtain scores up to about 22. The range for each job level on this continuum is indicated. These ranges reflect the spreads of learning potential scores that are typically obtained for individuals at the different job levels.

A respondent who obtains a score higher than the requirements of his or her current job level is a good candidate for further development. Additional training, education and work experience will probably be required to prepare the person, as high potential is not an indication of the person's immediate suitability for a job. An individual whose score falls significantly below the range for his or her current work responsibilities may feel stressed and may struggle to cope with some of the more demanding aspects of the job. Appropriate ways to handle this situation should be sought.

The continuum of 20-plus points is shown below, benchmarked with the five job levels. Mr Respondent's score is indicated with a cross. Definitions of the job levels and associated NQF levels are available in the appendix of this thesis.

The respondent's global score is 64, with a job level score of 17.5, which places the respondent at Level 4: Middle Management or Subject Matter Specialist (NQF 5/6).

Job Levels



Level 1: Unskilled (Below NQF levels)
Level 2: Semi-Skilled (NQF 1/2)
Level 3: Skilled/First-Line Supervision (NQF 3/4)
Level 4: Middle Management or Subject Matter Specialist (NQF 5/6)
Level 5: Senior Management or Advanced Subject Matter Specialist (NQF 6-8)

Description of the APIL job levels can be found in the Appendix (p. 141)

Figure 15. Extract from an APIL report (source APIL software)

An explanation of how this can be interpreted is discussed below.

- If the respondent's current job position in the organisation is First-Line Supervisor – Band 5 (equivalent to APIL job level 3) the employee's plotted global score would fall into the Turn potential category.
- If the employee's current job position is Middle Manager or Subject Matter Specialist – Band 4 (equivalent to APIL job level 4) the global score would fall into the Growth potential category.
- If the employee's current job position is Senior Manager - Band 2 and 3 (equivalent to APIL job level 5) the global score would fall into the Mastery potential category.

Charan et al. (2001) suggest categorising performance management outcomes into three levels, namely; not yet full performance, full performance and exceptional performance. This will then enable an organisation's workforce to be evaluated through a combined potential-performance matrix, as described in Figure 16 below.

	Exceptional Performance	Full Performance	Not Yet Full Performance
Turn Potential	**Exceptional Turn** Box 1	**Full Turn** Box 3	**Not Yet Full Turn** Box 6
Growth Potential	**Exceptional Growth** Box 2	**Full Growth** Box 5	**Not Yet Full Growth** Box 8
Mastery Potential	**Exceptional Mastery** Box 4	**Full Mastery** Box 7	**Not Yet Full Mastery** Box 9

Figure 16. Performance – Potential Matrix (source Charan et al., 2001).

Through combining the measurements of learning potential and performance management into a matrix, together with employee demographics, will provide a full perspective of an organisation's pool of human capital, enabling the organisation to make informed strategic staffing decisions to meet future demands to remain globally competitive and to manage risk. Within this framework the organisation can track staffing decisions and manage talent more effectively, ensuring a skilled workforce to take them successfully into the future.

Within each of the nine boxes Charan et al. (2001) provide suggestions on how to develop an organisation's human capital. These suggestions are briefly summarised below.

Table 4.22. Recommendations on how to manage talent (source Leadership Pipeline, Charan et al., 2001)

BOX	CATEGORY	RECOMMENDATIONS
1	Exceptional/Turn	Individuals with this combination of superior performance and potential are ready for an assignment at a higher organisational leadership level.
2	Exceptional/Growth	Although this person should remain at the same level for the time being, development steps should commence for the next level.
3	Full/Turn	This category consists of people who are as valuable to the company in the future as they are now. Focus now is on helping them improve their performance
4	Exceptional/Mastery	These seasoned employees should remain at their current levels, but their contributions should be recognised. Although development probably is not as relevant, they should be involved in the training and development of others
5	Full/Growth	Performance improvement is the key here. These individuals should be considered for a bigger job at their level if they can deliver better results.
6	Not Yet Full/Turn	People who were recently promoted often receive this rating, and they usually just require some time and experience – coupled with some coaching – to improve performance.
7	Full/Mastery	These individuals could go either way, depending on whether their performance improves or declines over time. They may become valuable in their current role or slip and become marginal performers.
8	Not Yet Full/Growth	Tight performance management is crucial here. These people cannot afford any slippage in how they do their jobs
9	Not Yet Full/Mastery	These individuals are frequently working at the wrong level and should be reassigned to a lower level or asked to leave the company. Pipelines become clogged when these people are allowed to remain in place and block others who have higher performance and potential.

Within this framework the industrial psychologist can play a strategic role in assisting the organisation develop and manage talent at organisational, divisional, team and individual levels.

It must however be borne in mind that any theoretical model may have good explanatory value but not necessarily good predictive value, and theoretical models may also change over time. Development of this model is recommended for further research, as applications of this model can contribute to the discipline of Industrial and Organisational Psychology being of practical relevance to the automotive industry and other similar organisations.

6.4 Conclusion

The test scores clearly indicate that significant differences in the cognitive capabilities and potentialities occur within the multicultural workforce. Results are also indicative of past advantagement and disadvantagement factors that exist in the South African sociopolitical arena. However, results do indicate that there are individuals with strong cognitive potential across all cultural groups, despite these factors. This research can confirm that the test battery is useful for the identification of talent in a multicultural automotive setting and meets the criteria as imposed by the Employment Equity Act through encouraging statistical results.

The rich cultural diversity of the South African society provides many opportunities for behavioural scientists working in an increasingly global environment. The automotive sector provides an extensive platform for interdisciplinary research and can derive considerable benefit from the contributions made by industrial psychology.

Japan’s ambassador to South Africa, Toshiro Ozawa (Andersen, 2010), criticised the manufacturing sector, saying it was barely competitive when contrasted with

other countries. It is hoped the findings presented in this thesis will lead to further research, and subsequently better understanding in the identification and development of talent. With over one million jobs being shed since the beginning of 2009 (Andersen, 2010) it is key for the manufacturing industry, and in particular the automotive industry, to have the requisite skills to remain viable in this country (Creamer, 2010).

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APPENDIX

Appendix: APIL Job Level Descriptions (Taylor 2007)

Level 1: Unskilled (Below NQF levels)

Decision-Making

Decisions are made by supervisors, and the individual carries out clearly specified instructions; no interpretation is required.

Level of Abstraction of Thinking

Reasoning required is concrete and based on directly observable and routine events currently occurring in the work flow.

Judgment and Analytical Skills

Judgments involve elementary job-specific situations and analysis required is simple and clearly specified (e.g, "when the tank is empty, refill it").

Knowledge, Training and Experience Required

Job tasks are limited to a small range of well-structured procedures. These can be learned after a short induction period (at most a few days).

Level 2: Semi-Skilled (NQF 1/2)

Decision-Making

Decisions made by the incumbent are directly linked to specific processes and outcomes and are automatic ("if x occurs, then I do y").

Level of Abstraction of Thinking

Reasoning required is concrete and is applied to the current situation or to processes that extend only into the near future.

Judgment and Analytical Skills

Judgments are based on observable events, facts and situations, and involve fairly straightforward analysis of a limited number of elements.

Knowledge, Training and Experience Required

Required knowledge and skill is acquired through induction and training that will last no longer than a few weeks.

Level 3: Skilled/First-Line Supervision (NQF 3/4)

Decision-Making

Most decisions are fairly routine and based on clear guidelines and policies, but some slightly non-standard events requiring a moderate degree of interpretation may sometimes occur.

Level of Abstraction of Thinking

Mostly concrete but requiring consideration of facts and events that may extend into the future and have a bearing on a whole process.

Judgment and Analytical Skills

Judgments are based on a moderate range of factors and may require an analysis of the implications of different concrete options on outcomes (which normally have a time horizon of no more than a few weeks).

Knowledge, Training and Experience Required

Knowledge and skill is usually acquired through formal training or equivalent experience, usually extending over more than a year. Knowledge base is mainly practical, with limited theoretical content.

Note: First-line supervisors (as opposed to skilled workers) should ideally score in the upper half of the range for this level.

Level 4: Middle Management or Subject Matter Specialist (NQF 5/6)

Decision-Making

Decisions require interpretation within parameters set by more senior management. The incumbent has a fair degree of autonomy in making decisions regarding work activities, subject to general monitoring by superiors.

Level of Abstraction of Thinking

Reasoning is abstract and based on non-observable facts, events, phenomena and trends. A degree of conceptualization and re-configuration of these elements may be required.

Judgment and Analytical Skills

The range of facts and situations to be considered may extend outside immediate work domain and be fairly extensive. Analytical tasks can involve extracting and manipulating information from fairly complex arrays and basing conclusions or judgments on the findings. The outcomes may at times have consequences at organizational or divisional levels.

Knowledge, Training and Experience Required

Knowledge and training is usually acquired through formal training, although significant on-the-job training through courses, mentoring, coaching, etc may also be involved. The knowledge base includes a significant theoretical content.

Level 5: Senior Management or Advanced Subject Matter Specialist (NQF 6-8)

Decision-Making

Decisions involve conceptualization of procedures and frameworks that will affect all or a significant part of the organization. The incumbent receives only general guidelines (from top management).

Level of Abstraction of Thinking

Abstract conceptual reasoning needs to be applied to problems and tasks, and may involve taking into account trends across the industry and devising future scenarios.

Judgment and Analytical Skills

Judgments involve complex facts and situations requiring the integration and analysis of extensive, diverse and complex data and information, facts and scenarios. The data may be drawn from activities across all or a large part of the organization, and possibly from the industry at large.

Knowledge, Training and Experience Required

Training is lengthy and usually includes a degree or equivalent and may include post-graduate education. This is often followed or accompanied by extensive practical experience.