THE RELATIONSHIP BETWEEN LEARNING POTENTIAL AND JOB PERFORMANCE

by

NELISE GILMORE

submitted in part fulfilment of the requirements
for the degree of

MASTER OF ARTS

in the subject

INDUSTRIAL PSYCHOLOGY

at the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: ANTONI BARNARD

MARCH 2008

DECLARATION

Student number: **3212-558-5**

I declare that the dissertation, “THE RELATIONSHIP BETWEEN LEARNING POTENTIAL AND JOB PERFORMANCE”, is my own work and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

_____ _____

SIGNATURE DATE

(Nelise Gilmore)

ACKNOWLEDGEMENTS

First and foremost acknowledgement must be given to the Heavenly Father who has afforded me the opportunity to learn, as well as the privilege to do so. I am aware of, and thankful for, His grace which was and is present throughout these difficult times.

I would also like to acknowledge and express sincere gratitude to the following persons:

- Antoni Barnard, for her expert assistance and continual support: I feel honoured to have been a student under her supervision and this while she was completing her PhD. You continue to inspire me.
- Pule Tshelane, Elrinda Kruger, Anton van der Merwe, Stephan Muller and Deryck Spann, without whose assistance, insight into the research organisation and support, this project simply would not have been possible.
- Prof Ricky Mauer and Edmund Engelbrecht, for their expert assistance with the statistical analyses of the data as well as their tutorage and patience – this will never be forgotten, and can never be repaid.
- Moya Joubert, for so expertly performing the timeous job of editing this dissertation.
- On a personal note, to my parents, Dudley and Sonja, who have always stood by me, and cultivated an enquiring nature and love for studying from a young age. You have always been and remain impeccable examples. To my sister, Liesl; for all the assistance with the resources during my theoretical year.
- I would like to thank my friend, Aunty Pam Muna, who was and always is, willing to assist with the support of running my household during my studies. I will forever be grateful and indebted to you.
- My admiration and gratitude to my friend, fellow student and researcher, Tessa de Wet: Together we travelled this journey. You were always there for me, with a shoulder to lean on, to motivate me and to make me laugh.
- My indebtedness to my cherished and beloved daughters, Erin and Lauren, whose time I stole to complete this project. My absolute adoration, love for, appreciation of and gratitude to my husband and best friend, Mark. You are the most unselfish person I know. You constantly encouraged and motivated me, especially when I felt that giving up was the easier, saner option. The three of you will be “home” to me always.

ABSTRACT

THE RELATIONSHIP BETWEEN LEARNING POTENTIAL AND JOB PERFORMANCE

By: Nelise Gilmore

Degree: MA

Subject: Industrial and Organisational Psychology

Supervisor: Antoni Barnard

In South Africa, legislation dictates that employees must be developed resulting in the need to identify candidate's development capability. As such, it is essential to be able to measure the learning potential of candidates. In practice, cognitive ability has been linked to the complex process of job performance.

This study aimed to determine whether learning potential can be used as a predictor of job performance. The Learning Potential Computerised Adaptive Test (LPCAT) was utilised to measure learning potential and job performance was measured through a promotion ratio (taking job knowledge and tenure into account). The moderator variables were investigated. A sample of 135 technical employees was drawn. The data was statistical manipulated reporting various significant relationships confirming the internal reliability of the LPCAT and indicating a strong significant relationship between learning potential and job performance. Variables such as learning potential, job grade and tenure are significant when predicting job performance.

Key words:

Psychometric assessment; cognitive ability; learning potential; dynamic assessment; job performance management; criterion validity; traditional vs dynamic assessment methods; judgemental and nonjudgemental performance measurement criteria, regression analysis.

TABLE OF CONTENTS

	Page
Acknowledgements	**iii**
Abstract	**iv**
List of tables	**xiii**
List of figures	**xiv**
List of appendices	**xv**

CHAPTER 1

INTRODUCTION TO AND RATIONALE FOR THE RESEARCH

1.1	**INTRODUCTION**	1
1.2	**BACKGROUND TO AND RATIONALE FOR THE STUDY**	1
1.3	**PROBLEM STATEMENT**	4
1.3.1	**Research question**	5
1.4	**AIM**	5
1.4.1	**General aim**	5
1.4.2	**Specific theoretical aims of the literature review**	6
1.4.3	**Specific aim of the empirical study**	6
1.5	**THE VALUE OF THIS STUDY**	6
1.6	**THE PARADIGM PERSPECTIVE**	7

1.7 RESEARCH DESIGN 7
1.7.1 Type of research 7
1.7.2 Research variables 8
1.7.2.1 The predictor/independent variable 8
1.7.2.2 The criterion/dependent variable 10
1.7.2.3 The moderator variables 11
1.7.3 The unit of analysis 11

1.8 RESEARCH METHOD 11
1.8.1 Phase 1: literature review 12
1.8.2 Phase 2: empirical study 12
1.8.2.1 Population and sample 12
1.8.2.2 Measuring instruments 12
1.8.2.3 Data collection *12*
1.8.2.4 Data processing 13
1.8.2.5 Hypotheses 13
1.8.3 Results 14

1.9 CHAPTER LAYOUT 14

CHAPTER 2

LEARNING POTENTIAL

2.1 INTRODUCTION 15

2.2 THE EVOLUTION OF THEORIES OF COGNITIVE OR MENTAL ABILITY 15
2.2.1 Introduction 15
2.2.2 Plato (427-347 BC) 16
2.2.3 Aristotle (384-322 BC) 17
2.2.4 The rise of psychological measurement 17
2.2.4.1 Francis Galton (1822-1911) 18

2.2.4.2 Alfred Binet (1857-1911) and Theodore Simon (1873-1961) 18
2.2.4.3 Charles Spearman (1863-1945) 19
2.2.4.4 James McKeen Cattell (1860-1944) 20
2.2.5 Learning potential and dynamic assessment 21
2.2.5.1 LS Vygotsky (1896-1934) 22

2.3 THE MEASUREMENT OF COGNITIVE ABILITY 23
2.3.1 Introduction 23
2.3.2 Psychological testing 23
2.3.3 The basic requirements for psychological assessments 25
2.3.3.1 Reliability 25
2.3.3.2 Validity 27
2.3.3.3 Standardisation and normalisation (norms) 29
2.3.4 Cognitive assessment in the context of a democratic South Africa 30
2.3.5 Approaches to assessing cognitive ability 31
2.3.5.1 The conventional or structural approach 32
2.3.5.2 The information-processing approach 33
2.3.5.3 The Piagetian approach 34
2.3.5.4 The learning or dynamic approach 35

2.4 DYNAMIC ASSESSMENT 36
2.4.1 Criticism of the traditional testing method 37
2.4.2 Dynamic versus traditional cognitive assessments 38
2.4.3 Dynamic assessment theories and instruments 40
2.4.3.1 Conceptualisation of learning potential 40
2.4.3.2 Vygotsky's Zone of Proximal Development (ZPD) 42
2.4.3.3 Other theorists' views on dynamic assessment 43
2.4.4 Dynamic assessment in South Africa 46

2.5 CHAPTER SUMMARY 47

CHAPTER 3

JOB PERFORMANCE

3.1 INTRODUCTION 49

3.2 CONCEPTUALISING JOB PERFORMANCE 49
3.2.1 Challenges in the South African context 49
3.2.2 Definition of job performance 50

3.3 MEASURING JOB PERFORMANCE 52
3.3.1 Purposes of measuring job performance 52
3.3.2 Measurement criteria 53
3.3.3 Judgemental or subjective measurement criteria 53
3.3.4 Nonjudgemental or objective measurement criteria 55
3.3.4.1 Absenteeism 56
3.3.4.2 Turnover 56
3.3.4.3 Job knowledge 57
3.3.5 Sources of variance in job performance measurement 58

3.4 MANAGING JOB PERFORMANCE MEASUREMENT 60
3.4.1 The performance management system (PMS) 61

3.5 DIFFERENT APPROACHES TO JOB PERFORMANCE MANAGEMENT 62
3.5.1 The systems approach to job performance management 62
3.5.2 Sink and Tuttle's approach to job performance management 63
3.5.3 The balanced scorecard approach to job performance management 65
3.5.4 The performance pyramid of job performance management 65
3.5.5 Medori and Steeple's approach to job performance management 67

3.6 PERFORMANCE MANAGEMENT IN THE RESEARCH ORGANISATION 69

3.7 CHAPTER SUMMARY 70

CHAPTER 4

EMPIRICAL STUDY

4.1 INTRODUCTION 71

4.2 POPULATION AND SAMPLE 71

4.3 RESEARCH METHOD 73
4.3.1 The evaluation of the feasibility of the study 73
4.3.1.1 Job stability 73
4.3.1.2 Evaluation of criteria 73
4.3.1.3 Sample representativeness 74
4.3.1.4 Power of the study 74
4.3.2 Rationale for the utilisation of the measuring instruments 75
4.3.2.1 Measurement of the predictor variable 75
4.3.2.2 Measurement of the criterion variable 76
4.3.2.3 Measurement of the moderator variables 77
4.3.3 Strategies employed to ensure the reliability and validity of the study 77
4.3.3.1 Researcher influence 77
4.3.3.2 Participant influence 78
4.3.3.3 Measurement instrument influence 78
4.3.3.4 The research context 79
4.3.4 Data gathering 79
4.3.4.1 Learning potential data 79
4.3.4.2 Job performance data 80
4.3.4.3 Biographical data 80

4.4 MEASURING INSTRUMENTS 80
4.4.1 The LPCAT 80
4.4.1.1 Main features of the LPCAT 81
4.4.1.2 Culture fairness of the LPCAT 82

4.4.1.3 Reliability and validity of the LPCAT 83
4.4.1.4 Measuring learning potential with the LPCAT 84
4.4.1.5 The LPCAT for the purpose of this research 84
4.4.2 Career Development Paths (CDPs) 85
4.4.3 Biographical data 87

4.5 DATA PROCESSING 87
4.5.1 Statistical data-processing program 87
4.5.2 Descriptive statistics 87
4.5.3 Correlations 88
4.5.4 Analysis of variance 88
4.5.5 Regression analysis 89
4.5.6 T-test 89

4.6 LEVEL OF STATISTICAL SIGNIFICANCE 89

4.7 HYPOTHESES 90

4.8 REPORTING OF RESULTS 90

4.9 CHAPTER SUMMARY 90

CHAPTER 5

RESULTS AND DISCUSSION

5.1 INTRODUCTION 91

5.2 RESEARCH FINDINGS 91
5.2.1 Biological profile of the research sample 91
5.2.1.1 Total population 92
5.2.1.2 Gender 93

5.2.1.3 Race 93
5.2.1.4 Age 94
5.2.1.5 Job level 94
5.2.1.6 Departments 95
5.2.2 Descriptive statistics 96
5.2.2.1 Age 97
5.2.2.2 Pre- and post-test data 97
5.2.2.3 Difference in pre- and post-test scores 98
5.2.2.4 Composite score 99
5.2.2.5 Years of service and number of promotions 99
5.2.3 Data analysis 99
5.2.3.1 Validation of the LPCAT 99
5.2.3.2 Correlations 103
5.2.3.3 Regression analysis 107
5.2.3.4 Analysis of variance (ANOVA) 109
5.2.3.5 T-test 113

5.3 INTERPRETATION OF THE RESULTS 115

5.4 CHAPTER SUMMARY 117

CHAPTER 6

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

6.1 INTRODUCTION 118

6.2 REVIEW OF AIMS 118

6.3 LIMITATIONS OF THE RESEARCH STUDY 121

6.4 RECOMMENDATIONS 123

6.5 CONCLUSIONS 124

6.6 STRENGTHS OF THE STUDY 125

6.7 SUMMARY 125

REFERENCES 126

APPENDICES 140

LIST OF TABLES

TABLE 3.1	**RATER SKILLS REQUIRED PER STAGE IN PERFORMANCE MANAGEMENT**	55
TABLE 4.1	**RESEARCH SAMPLE**	72
TABLE 4.2	**RELIABILITY DATA FOR LPCAT**	83
TABLE 4.3	**VALIDITY DATA FOR LPCAT**	83
TABLE 4.4	**THE LPCAT COMPOSITE SCORE INTERPRETATION**	85
TABLE 5.1	**BIOGRAPHICAL DETAILS OF THE RESEARCH SAMPLE**	91
TABLE 5.2	**DESCRIPTIVE STATISTICS ACROSS ALL VARIABLES**	97
TABLE 5.3	**SIGN TEST PROFILE**	102
TABLE 5.4	**CORRELATIONS**	103
TABLE 5.5	**REGRESSION STATISTICS**	107
TABLE 5.6	**ANOVA**	108
TABLE 5.7	**REGRESSION ANALYSIS**	108
TABLE 5.8	**ANOVA RESULTS OF COMPOSITE VERSUS PRE-TEST AND POST-TEST SCORE AND PROMOTION RATIO**	110
TABLE 5.9	**ANOVA RESULTS PROMOTION RATIO VERSUS RACE AND GRADE**	112
TABLE 5.10	**ANOVA RESULTS OF COMPOSITE VERSUS PROMOTION RATIO OF OTHER AND WHITE SUBSAMPLES**	112
TABLE 5.11	**T-TEST RESULTS OF THE COMPOSITE SCORES OF THE RACE GROUPS**	113
TABLE 5.12	**T-TEST RESULTS OF THE AGE OF THE RACE GROUPS**	115

LIST OF FIGURES

FIGURE 3.1	**THE SYSTEMS APPROACH TO JOB PERFORMANCE**	51
FIGURE 3.2	**FACTORS INFLUENCING JOB PERFORMANCE MEASUREMENT**	59
FIGURE 3.3	**THE SYSTEMS APPROACH TO PERFORMANCE MANAGEMENT**	63
FIGURE 3.4	**SINK AND TUTTLE'S APPROACH TO PERFORMANCE MANAGEMENT**	64
FIGURE 3.5	**THE PERFORMANCE PYRAMID APPROACH TO JOB PERFORMANCE MANAGEMENT**	67
FIGURE 3.6	**MEDORI AND STEEPLE'S APPROACH TO JOB PERFORMANCE MANAGEMENT**	68
FIGURE 5.1	**HISTOGRAM OF DIFFERENCE SCORES**	98
FIGURE 5.2	**MAIN FEATURES OF THE LPCAT**	100
FIGURE 5.3	**SUCCESSES, FAILURES AND TIED VALUES FOR THE SIGN TEST**	101
FIGURE 5.4	**PRE-TEST MEAN SCORE**	110
FIGURE 5.5	**POST-TEST MEAN SCORE**	111
FIGURE 5.6	**PROMOTION RATIO**	111
FIGURE 5.7	**QQ PLOT INDICATING DEVIATION FROM NORMAL DISTRIBUTION FOR THE WHITE SUBSAMPLE**	114
FIGURE 5.8	**QQ PLOT INDICATING DEVIATION FROM NORMAL DISTRIBUTION FOR THE OTHER SUBSAMPLE**	114

LIST OF APPENDICES

APPENDIX 1	**OUTLINE OF RESEARCH STUDY**	140
APPENDIX 2	**PRODUCTION PROGRESSIONAL ROUTES**	141
APPENDIX 3	**ENGINEERING PROGRESSIONAL ROUTE FOR ARTISAN**	142
APPENDIX 4	**LABORATORY PROGRESSIONAL ROUTE FOR JUNIOR STAFF**	143
APPENDIX 5	**VALUES ASSIGNED TO NONNUMERICAL MODERATOR VARIABLES**	145

CHAPTER 1
INTRODUCTION TO AND RATIONALE FOR THE RESEARCH

1.1 INTRODUCTION

In this chapter the background to and rationale for the research is discussed. The research problem is formulated and the research questions around the research problem posed. The aims of the research are defined and the value of the study explained. In order to properly contextualise the research and define its limited scope, the paradigm perspective is outlined. This is followed by the description of the research design and methodology. Chapter 1 concludes with an overview of the layout of the chapters in this dissertation.

1.2 BACKGROUND TO AND RATIONALE FOR THE STUDY

In order to select individuals who will contribute to the effectiveness of organisations, certain selection methodologies are employed. These selection methods need to remain within the ambit of the law as well as have the ability to potentially select the most productive employees for an organisation (Mauer, 2000a; 2000b; Schmidt & Hunter, 1998).

Valid selection procedures should translate into productivity and improvements in performance levels, and ultimately, into the overall effectiveness of any organisation (Anastasi, 1988; Schmidt & Hunter, 1998). 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 learnt, should have an impact on the prediction of the manner in which employees ultimately perform in the workplace (Sternberg & Grigorenko, 2002). It is therefore crucial for organisations to investigate the validity of any selection methods employed by them. The validity of a selection tool indicates most importantly the extent to which the instrument accurately predicts future performance on the job.

Assessment in the South African context is regulated by, inter alia, the Employment Equity Act (EEA). The EEA (1998) only allows the use of instruments that have been proven to be valid and reliable, fair to all employees or groups of employees and can be fairly applied to all employees. The basic requirements for psychometric assessment are discussed further in chapter 2, section 2.3.3, and the validity and reliability of the assessment instrument utilised in this study are highlighted in chapter 4, section 4.4.1.3.

The government has set stringent targets for the large mining houses in particular, to ensure that the demographics of their organisations change in order to more fairly reflect the demographics of the regions within which the companies are housed. Legislation, in particular, the Broad-based Socio-economic Empowerment Charter for the South African Mining Industry (or Mining Charter as it has become known) indicates that achievement of these targets will ensure that the mining houses will secure their current mining rights. Failure to meet the targets may result in the loss of these rights.

The Mining Charter and the Employment Equity Act (1998) state that all employers should take steps to promote equal opportunities in the workplace. In order to develop employees, it is essential to be able to identify which employees have the potential to be developed and which employees do not.

The literature provides evidence of the assumption that cognitive ability may be used to predict job performance (Hunter, 1986; Pelser, 2002). When assessing the potential for development, many standard assessments tend to measure crystallised intelligence (largely the product of education and life experience), while it is actually the innate fluid or dynamic intelligence, (that which a person is assumed to have been born with), that should be measured (Cattell, 1963; De Beer, 2000b). Fluid intelligence gives an indication of a person's potential to learn new skills and novel tasks (Sternberg & Grigorenko, 2002).

In the current context, assessing the potential of employees is highly desirable in contributing to developing talent and meeting legislative requirements in terms of employee development and quotas.

A person's fluid intelligence can be measured through dynamic testing which, according to Sternberg and Grigorenko (2002), is the method used to uncover the underlying capacities of individuals and understanding how these capacities differ from individuals' developed abilities. Dynamic testing includes an instructional intervention as part of the testing process, and is different from the conventional or static test in which no feedback is given. It provides a method of reducing the effects of possible contextual variables (childhood upbringing; educational history, etc.) and of measuring the individual's learning potential (Sternberg & Grigorenko, 2002).

Although there are various approaches to dynamic testing, basically two commonly used formats exist. In the first, the instruction is positioned between a pre- and post-test. In the second format the instruction may be in response to the test taker's solution to each item (see Guthke, 1993; Laughon, 1990; Sternberg & Grigorenko, 2002; Taylor, 1994)

Historically, in the research organisation, learning potential has been assessed for career guidance purposes only. This was done by using the APIL-B, TRAM 1 and TRAM 2[1] assessment batteries (depending on level of education) to assess whether or not employees have the potential to be developed. The Mining Charter, however, was responsible for the move to use learning potential assessment tools for selection purposes, as a standard practice.

[1] The Apil-B, Tram 1 and Tram 2 are learning potential assessments developed by Terry Taylor (Taylor, 1997; 1999)

Recently, a nonverbal, computerised adaptive assessment tool has been introduced (the Learning Potential Computerised Adaptive Test or LPCAT[2]) as an organisation-wide standard for the following reasons:

- Language was offered as a possible barrier to performance on the previous tests used.
- The large number of employees who need to be assessed in order to identify potential or talent requires a quicker, cost-effective tool.

The previously used assessment tools and the LPCAT assessment makes use of the opportunity to test, train and retest in an attempt to assess the potential to learn new tasks (De Beer, 2000b; Taylor, 1997). Assumptions and interpretations regarding learning rate and future job performance are made when taking the results of the pre-test and the post-test into consideration. However, in the research organisation, there is no supporting in-house documentation to assess whether learning potential results can be utilised to predict job performance.

Since it is essential in the field of industrial psychology to determine whether the tools used to assess employees' potential are valid in predicting job performance and useful to business in contributing to achieving business goals, there is a need in the research organisation, to determine whether or not there is a correlation between the results of the new learning potential assessment tool and job performance.

1.3 PROBLEM STATEMENT

In the platinum mining industry, there is growing competition between the various platinum producers to supply the emerging shortfall of this precious metal, at the largest profit margins possible. To ensure this, the cost curve needs to decline.

[2] The LPCAT is a learning potential assessment developed by Marie de Beer (De Beer, 2000a; 2000b; 2000c; 2004).

This translates into a need for a more productive workforce, working more efficiently. Valid selection processes are required to ensure that the most productive individuals are selected for the right jobs. Validation studies based on in-house company data that provide supporting empirical evidence of the utilisation of current assessment instruments in the research organisation do not exist. In the light of the legislation criteria for fairness (see the EEA, 1998), it is essential that the research company has in-house validation studies to prove that the assessments utilised meet the required assessment standards.

In order to investigate whether the research organisation's preferred measurement instrument does predict job performance, the following question for the research study was formulated:

1.3.1 Research question

Is learning potential as measured by the LPCAT a valid predictor of the future job performance of employees?

1.4 AIM

Corresponding to the research question posed above, the problem statement translates into the following general and specific aims:

1.4.1 General aim

To determine whether learning potential as measured by the LPCAT is a valid predictor of employee job performance.

1.4.2 Specific theoretical aims of the literature review

(1) To gain an understanding of the various theories on learning potential and conceptualise how it is operationalised as a measurement construct
(2) To explore job performance and the measurement thereof, in the literature and previous research
(3) To provide clarity on the LPCAT as an assessment tool

1.4.3 Specific aim of the empirical study

(1) To determine whether learning potential as measured by the LPCAT predicts job performance

1.5 THE VALUE OF THIS STUDY

Mouton (2002) believes that research can contribute on three different levels (which he terms “worlds”): Firstly, to the world of everyday life and lay knowledge (the pragmatic interest); secondly, to the world of science (the epistemic interest); and thirdly, to the world of metascience (the critical interest). The value of this research project will be discussed as a contribution to the world of lay knowledge and of science.

According to Mouton (2002), the world of lay knowledge and everyday life is concerned with objects or entities, including individual human beings and organisations. It involves the practical knowledge necessary for our day-to-day lives. This study will add value to this pragmatic world in so far as it explores the relationship between the learning potential and job performance of individuals and will help organisations to evaluate this relationship. It will therefore assist with potentially selecting the best candidates upfront. In the mining industry, this study will add value by exploring the predictive validity of learning potential, as measured by the LPCAT. If such a predictive relationship does exist, this study would provide support for the use of the LPCAT in accordance with the EEA (1998).

Mouton (2002) maintains that the world of science concerns itself with disciplines, theories and methodologies. This includes the social science disciplines, various theories, and quantitative research. This study can be described as a quantitative study based on the theories of learning potential and job performance in the field of industrial psychology. Its value lies in the validation of an assessment instrument. The validation of the LPCAT is valuable for the developers of the instrument, both for themselves and future developers of other possible learning potential instruments. In industry, the results of this study could be utilised to support similar studies.

1.6 THE PARADIGM PERSPECTIVE

The study was conducted in the industrial and organisational psychology discipline, with the focus on the subdisciplines of personnel psychology and psychometrics. According to Theron (2003), the industrial and organisational psychological field of study fundamentally seeks to understand, explain, predict and influence human behaviour and experience in the context of work.

The functionalistic paradigm informed this research. This paradigm is based on the assumption that society is concrete and real, as well as systematic and orderly. Behaviour is seen as contextual and there is a belief that objective observations can be made and conclusions drawn (Cilliers, 2004; Morgan, 1980; Mouton & Marais, 1991). This paradigm is significant to the study because the research attempts to draw objective conclusions by minimising errors through statistical data analysis.

1.7 RESEARCH DESIGN

1.7.1 Type of research

This study is a descriptive study, which means that the relationship between the variables was described rather than assumed to be causal (Christensen, 1997; Cooper & Schindler, 2001; Mouton & Marais, 1991).

This research report contains an exploratory literature review and a quantitative empirical study that investigated the relationship between the variables (Christensen, 1997). Hypotheses were tested by measuring the variables and statistically analysing the results. This research study has a quantitative design.

According to Mouton and Marais (1992), a quantitative research design has a clear goal and certain intrinsic requirements. The goal of the study is to explain and describe, rather than to understand, and requires operational justification for the study, as well as proof of internal control and reliability. The operational rationale for this research is discussed in sections 1.2, 1.5 and chapter 6. The internal control of the study is discussed in section 4.3.3, while reliability is discussed in sections 2.3.3.1 and 4.4.1.3.

1.7.2 Research variables

This study deals with the relationship between an independent (or predictor) variable and a dependent (or criterion) variable. An independent variable refers to what the researcher is investigating. It is the antecedent condition and the response to varying changes or degrees thereof, within a defined range. The dependent variable measures the influence or consequence of the independent variable (Christensen, 1997; Mouton & Marais, 1992).

In this study, learning potential is identified as the independent or predictor variable and job performance the dependent or criterion variable.

1.7.2.1 The predictor/independent variable

Cognitive ability has been an area of interest for institutions globally (Cascio, 1998). It has been used to predict scholastic and job performance. Cognitive ability has historically been measured through traditional cognitive assessments, which have been limited to assessing only current performance (Sternberg & Grigorenko, 2002).

Learning potential refers not only to the individuals' current level of ability, but also to the probable future level of their ability. It allows for the measurement of both dynamic intelligence (what can still be learnt) and crystallised intelligence (that what has already been learnt). Cognitive ability and learning potential are discussed further in chapter 2. One of the benefits of measuring learning potential as opposed to crystallised intelligence is that the effects of unequal upbringings can be minimised (De Beer, 2000a).

One of the assessments utilised in measuring learning potential is the Learning Potential Computerised Adaptive Test (LPCAT), which was designed and standardised in the multicultural South Africa, so that it could be used as a selection tool for South Africans.

The LPCAT is a nonverbal reasoning adaptive test designed to ascertain learning potential. Although the test is adaptive, the design is such that the test results can be compared (De Beer, 2000b). The distinguishing characteristic of a learning potential test is that the test takers learn a new skill in the process of doing the test tasks. Some test takers become more competent than others, and the differences in competency are captured in the test scores (Taylor, 1999).

A major benefit for the mining environment is that language has been eradicated because assessment is nonverbal hence cultural bias is limited.

The LPCAT is a standardised, registered[3] tool that affords each candidate an equal opportunity to be measured cognitively. A major benefit is that even illiterate individuals can be measured.

[3] Only assessments that are registered with the Health Professions Council of South Africa (HPCSA) should be utilised in the South African context. Prior to registration, the assessments are scrutinised and finally, consent in terms of meeting basic requirements of assessments, is given by the HPCSA for registration and subsequent utilisation.

1.7.2.2 The criterion/dependent variable

The measurement of job performance is often difficult in the business field, because it remains an emotive experience for the employee. It is therefore necessary for this measurement to remain as objective as possible (Cascio, 1998). In this research study, job performance, as measured through a promotion ratio, is the dependent or criterion variable.

With the various pieces of legislation governing both the field of assessment and the mining industry (discussed further in ch. 2, sec. 2.3.4), it is imperative for a research organisation to assess its employees' performance in order to identify and develop talent. Since 1991, the research organisation has afforded employees a formalised opportunity to progress through ranks in its departmental career development paths (CDPs). These CDPs are also known as progressional routes and encapsulate the knowledge that employees require to be promoted to the next position in the hierarchical structure of the mining organisation.

The research organisation in this study is a refining plant that is divided into departments based on the role that department fulfils, for example, human resources, engineering, and production etcetera. These departments are further subdivided into sections. The technical departments (Engineering, Production and Laboratory) have discrete and formalised routes for progression. The employees may decide to participate in the progressional route programme with a view to being promoted to the next position in the career path. Involvement in the CDP programme involves acquiring technical knowledge of each section and writing a written and practical examination. Once this has been passed, and no disciplinary issues are present on record, an employee may be promoted. These progressional routes are available to all employees and it is at the discretion of the employee whether or not to participate. Furthermore, the promotions within the CDP programme are not vacancy driven but based on passing the required written and practical examinations. Therefore equal opportunities exist for all employees to partake and subsequently be promoted.

These discipline-specific CDPs have long been used as a measure of performance because the employees are motivated to perform well in order to be promoted. In an effort to normalise the tenure of the employees in the sample, a ratio of the number of promotions (since the date of engagement with the company) divided by years of service, was calculated for each employee in the sample. This was done for comparison purposes. This promotion ratio is identified as the measure of the dependent or criterion variable.

1.7.2.3 The moderator variables

Moderating or extraneous variables are those limitless variables that may have an effect on the relationship between the independent and dependent variable (Christensen, 1997). To optimise the validity and the reliability of this study, an attempt was made to minimise the effect that extraneous or moderating variables may have had on the study. Analyses were performed on the biological variables (ie race, job level, gender and age) that may have been influential in the relationship between learning potential and job performance.

The methods to ensure the reliability and validity of the study are elaborated on in chapter 4.

1.7.3 The unit of analysis

According to Mouton (2001), the unit of analysis is identified as being the individual, group, organisation or social artefact studied. In this study, the individual was used as the unit of analysis because the measures were obtained on an individual basis.

1.8 RESEARCH METHOD

This study consisted of two phases, namely an explorative literature review and an empirical study.

1.8.1 Phase 1: literature review

The explorative literature review endeavoured to determine the following:

(1) the theory of learning potential and the conceptualisation of learning potential as a measurement construct

(2) the exploration of job performance and the measurement thereof.

1.8.2 Phase 2: empirical study

The empirical study involved a quantitative investigation into the relationship between the LPCAT results and job performance.

1.8.2.1 Population and sample

The population consisted of full-time employees working in the technical departments at a precious metal refinery (p=479). A sample was drawn of all technical employees who entered into the CDP programme and had valid LPCAT results up to the end of 2005 (n=135).

1.8.2.2 Measuring instruments

The instrument utilised in this study to measure the predictor variable was the LPCAT. The promotion ratio (as described in sec. 1.7.2.2 and ch. 4, secs. 4.3.2.2 and 4.4.2) was used to measure job performance. A biographical database was used to measure the moderating variables.

1.8.2.3 Data collection

The LPCAT results were recorded once the employees had been assessed. The employees were required to sign consent forms.

The names of the employees partaking in the CDP programme and the data relating to calculating promotional ratios were obtained from the Human Resource Department. The biographical information was obtained from the Employee Development Department. Names, company numbers and identity numbers were removed from the data set, and the employees' confidentiality was protected at all times. A sample of 135 data sets was collected.

1.8.2.4 Data processing

The study dealt with interval data, and since the research question involved determining a relationship, a correlation study was deemed appropriate. Correlation is a measure of the relationship between two or more variables (StatSoft, 1996). This study attempted to determine the correlation, if any, between learning potential and job performance.

The study also made use of regression to ascertain the predictability of the variables and descriptive statistics (which were calculated separately for each variable and provided information on the mean, distribution, minimum and maximum values). Analysis of variance as well as t-tests were utilised to ascertain possible differences, if any, between the various groups that could not have occurred by chance.

The empirical study is explicated in chapter 4.

1.8.2.5 Hypotheses

To investigate the relationship between learning potential and job performance, the following hypotheses were formulated:

H0: There is no statistically significant relationship between the learning potential and the job performance of technical employees.

H1: There is a statistically significant relationship between the learning potential and the job performance of technical employees.

1.8.3 Results

The data were analysed and the results are reported and presented graphically, in chapter 5. The relationship between the variables is interpreted. The statistical analyses indicate whether the relationship is significant. The statistical significance of the various analyses is considered in the interpretation of the results.

1.9 CHAPTER LAYOUT

This chapter consisted of an introduction, the background to and rationale for the study and the formulation of the problem statement. It explained the aims of the study, the potential value of the research and summarised the research methodology and design.

Chapter 2 comprises a literature review of the theory on cognitive ability and learning potential. The literature review starts with a historical perspective of the concept of cognitive ability, followed by a summary of the approaches to the measurement of the concept. Since this study follows the dynamic learning approach to learning potential the various dynamic learning theories are discussed.

Chapter 3 comprises a literature review focusing on job performance. The challenges in the South African context are explained and job performance defined. Job performance measurement and its management are discussed, and various models of performance management presented.

To achieve the empirical aims of this study, chapter 4 describes the methodology followed in this study,

In chapter 5 the results are reported and interpreted.

In chapter 6, the results and limitations of this limited scope research project are discussed and recommendations are made on the basis of the empirical results.

CHAPTER 2
LEARNING POTENTIAL

2.1 INTRODUCTION

Over the years, both in research and practice, the subject of cognitive ability has received increasing attention from philosophers, researchers and scholars. The fact that general cognitive ability assessments are performed on individuals across the school and working life for diagnostic, selection and educational purposes, is indicative of the significance society attaches to this construct. In the South African context in particular, learning potential as a cognitive construct receives much attention, especially when addressing the educational imbalances of the past equitably.

Chapter 2 is devoted to the explication of cognitive ability, and specifically, learning potential, as one of the psychological variables pertaining to this research. To provide a sound theoretical base for the understanding of learning potential, an historical overview of the evolving theories of cognition is provided as the departure point. Thereafter, the various approaches to intelligence measurement are presented, and finally, the learning potential construct and its dynamic testing discussed.

2.2 THE EVOLUTION OF THEORIES OF COGNITIVE OR MENTAL ABILITY

2.2.1 Introduction

Much debate has surrounded the concept of intelligence and related terms, so much so that, according to the literature, in 1927, Spearman was so disheartened with the notion of intelligence, that he called it "…. a mere vocal sound, a word with so many meanings that finally it had none" (Reber, 1995, p. 379).

For the purpose of this research, intelligence is defined as “that which intelligence tests measure” (Reber, 1995, p. 380). It refers to the construct that can be measured using psychometric tests and provides numerical values to represent current performance. According to De Beer (2000a), these numerical values gained from psychometric tests are generally accepted to represent a static measure of intelligence. Many researchers and psychologists agree that although intelligence or intelligent behaviour is understood, it is difficult to grasp its complexity (Lehrl & Fischer, 1990). The layperson’s understanding of intelligence is more likely to be the broader concept of cognitive ability, which is used in a wider sense and has contextual and cultural value (De Beer, 2006). 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, 2000a).

The psychology of humans, or the study of the psyche, has intrigued scholars since time immemorial. The theoretical influences considered most relevant to the evolution of cognitive or mental ability theory (and especially learning potential) are highlighted below.

2.2.2 Plato (427-347 BC)

Plato believed that the human soul has three aspects. Firstly, it is made up of certain appetites or needs (hunger, thirst or sex) and satisfying these needs plays an essential part in daily motivation. Also, humans experience emotions (e.g. fear, anger, love etc) and to gain true knowledge, these needs and emotions must be suppressed in order to develop the rational component of the soul. Plato believed that the ultimate goal in life is to liberate the soul as far as possible from these bodily needs (Hergenhahn, 2005). According to Plato, one of the three components dominates the soul, essentially resulting in three types of individuals. Those who are dominated by the appetitive aspect of the soul are better suited to being workers or slaves; those whose emotions (courage) are dominant are best suited to being soldiers; and those individuals in which reason or rational thought is dominant are best suited to be philosophers or kings.

He further argued that few manage to suppress their bodily needs or emotions in order to pursue rationality. Plato believed that education has a limited influence on children with low aptitudes because, to a large extent, one's destiny in relation to character type, is merely a matter of inheritance (Hergenhahn, 2005).

2.2.3 Aristotle (384–322 BC)

When Aristotle was 17 years of age he became one of 60-year-old Plato's students. Aristotle continued to study under Plato until Plato's death 20 years later (Hergenhahn, 2005). Whereas Plato believed that true knowledge is only possible by suppressing nature through controlling biological needs and introspection, Aristotle believed that the mind and body must work together to gain knowledge (through the senses) (Hergenhahn, 2005).

Aristotle maintained four pillars to general thinking (De Beer, 2000a):

1) definition – the ability to define particular features that make classification possible
2) comparison – identifying differences and similarities
3) causal relationships – understanding the relationship between cause and effect
4) authority – the external view of experts, relating to feedback and training.

According to Verster (in Pelser, 2002), Cicero translated Aristotle's work and created the Latin word "*intelligentia*" (meaning intelligence).

2.2.4 The rise of psychological measurement

Around the late 1800s after the rise of experimental psychology (which saw great contributions to the field from Wilhelm Wundt, who strongly believed that psychology could be an experimental science), scientists researched the field of psychological assessment.

This occurred after Wundt (1832-1920) expressed his belief that reaction time can supplement the introspection technique for studying the workings of the mind (Hergenhahn, 2005).

2.2.4.1 Francis Galton (1822-1911)

Francis Galton, who was Charles Darwin's cousin, performed some of the earliest work on reaction time (Hergenhahn, 2005; Taylor, 1994). Both Galton and Darwin believed in the biological differences between individuals.

Galton assumed that because humans can only know the world through their senses, intelligence is a function of sensory acuity. In other words, the more acute the senses are (it was assumed), the more intelligent the individual is. He further believed that since sensory acuity is biologically endowed, intelligence is inherited (Hergenhahn, 2005). So great was Galton's conviction about the biological nature of intelligence that he encouraged eugenic (selective breeding) programmes in order to control reproduction and thus gradually improve the hereditary characteristics of the population (De Beer, 2000a; Hergenhahn, 2005; Weiten, 1989).

2.2.4.2 Alfred Binet (1857-1911) and Theodore Simon (1873-1961)

Binet and Simon, in the early 20th century, were the first researchers to use cognitive tasks instead of reaction time when measuring broad-based psychological constructs such as general abilities.

Simon, who worked as an intern at a large institution for mentally retarded children, asked Binet to supervise his doctoral research (Hergenhahn, 2005). In 1903 the French government appointed Binet and Simon to study the problems of retarded children in French schools, ascertaining which low-performing children could benefit from training and which could not (De Beer, 2006; Hergenhahn, 2005; Weiten, 1989).

At that time, variations of Galton's reaction time tests were being used to classify mental retardation, and Binet found as a result, some blind or deaf children were incorrectly classified as mentally retarded (Hergenhahn, 2005). In 1905, The Binet-Simon scale of intelligence was proposed as a valid method to distinguish between "normal" and retarded children. In 1908, Binet and Simon revised their tests in order to not only identify subnormality, but also to distinguish between the levels of intelligence of the normal children (Hergenhahn, 2005). Binet has been recognised as establishing the concept of "mental age", which refers to the level of difficulty of the problems a child at a particular age level can solve (Kail, 2002; Nevid, Rathus & Greene, 1997; Pelser, 2002).

Lewis Terman and David Wechsler continued to revise and expand on Binet's work, after his untimely death in 1911 (Weiten, 1989), resulting in the Stanford-Binet Intelligence Scale, from which William Stern developed the concept of the "intelligence quotient". This enables test takers to be assigned an intelligence quotient (IQ) score, which is a measure of actual performance as well as a comparison of chronological age compared to mental age (Ungerer & Theron, 2006; Weiten, 1989).

According to Binet, intelligence is changeable and all individuals can develop intellectually if they are properly stimulated. The ultimate use of the IQ score (developed from his initial work) is contrary to his belief that intelligence can be modified through intervention (De Beer, 2000a; Hergenhahn, 2005; Pelser, 2002; Sternberg & Grigorenko, 2002). It is this philosophy of Binet's that makes his theory relevant to this particular research project.

2.2.4.3 Charles Spearman (1863-1945)

Over a century ago, in 1904 Spearman published the results of his research on village children, in which he studied the correlation of sensory acuity with "cleverness in school" (Hergenhahn, 2005). His research laid the foundation for the present-day "factor analysis".

Spearman was convinced that intelligence is a unified capacity, which forms the basis of all intelligent behaviour, and he proposed the two-factor theory of intelligence. The first factor is "g" (general intelligence). The second factor is made up of several other specific factors (or "s" factors) that lead to excellence in specific areas (De Beer, 2000a; Hergenhahn, 2005; Pelser, 2002). Spearman described "general intelligence" or "g" as that which refers to the common variance shared by a battery of mental tests (Deary et al., 1996; De Beer, 2000a; Hergenhahn, 2005; La Grange & Roodt, 2001; Pelser, 2002;).

Spearman's belief in a general ability influencing specific areas of excellence is relevant to this research, because although he believed that intelligence is largely inherited ("g"), the other capabilities ("s") can be developed through focused mental effort.

2.2.4.4 James McKeen Cattell (1860-1944)

Cattell developed a theory based on Spearman's work in which he argued that general intelligence can be divided into two general abilities namely, fluid (g*f*) and crystallised (g*c*) intelligence (Cattell, 1963; De Beer, 2000a; Pelser, 2002; Stelzl, Merz, Ehlers & Remer, 1995; Taylor, 1994).

Fluid intelligence is developed through the growth and maturation of the biological structures and has little cultural or educational content, reaching biological maximum at about 15 years of age. Crystallised intelligence is the result of cultural learning and experience and may therefore increase throughout adulthood, depending on the opportunities for learning (Cattell, 1963; De Beer, 2000a; Stelzl et al, 1995; Taylor, 1994). Cattell was interested in the measurement of individual differences of intelligence (Anastasi, 1988). He maintained that an individual's culture promotes certain specialised skills and knowledge required for functioning in that culture. These skills and knowledge are learned, internalised and are known as crystallised intelligence (Taylor, 1994).

In 1940, Cattell was one of the first to develop his culture-fair tests, which were designed to measure fluid intelligence (g*f*) (Anastasi, 1988; Taylor, 1994). Cattell also described causal relationships between fluid intelligence (g*f*) and crystallised intelligence (g*c*) with factor g*f* influencing g*c*, rather than the other way around (De Beer, 2000a). A distinction can therefore be drawn between ability and achievement, where ability implies that an individual has the ability or potential to achieve, and achievement indicates attainment (for which ability is a prerequisite). It is therefore evident that individuals' achievements are influenced by their ability as well as environmental factors (De Beer, 2000a).

The views on cognitive or mental ability evolved, and along with the developing theories, different methods of measurement were required. As noted above, despite the acknowledgement of contextual influences on one's cognitive ability, the cognitive tests that were developed focused mainly on the measurement of crystallised intelligence. Dynamic assessment has recently been introduced to assess learning potential.

2.2.5 Learning potential and dynamic assessment

Traditional cognitive tests have no intervention or training as part of the process and are therefore static. In dynamic testing, a learning experience is involved as part of the assessment in order to ascertain not only current or actual performance but also obtain information about potential future performance (De Beer, 2006; Sternberg & Grigorenko 2002; Taylor, 1994).

Dynamic assessment is grounded in the theoretical foundation of the zone of proximal development, as described by Russian psychologist, LS Vygotsky. Vygotsky is generally regarded as the founder of the learning potential concept and his zone of proximal development has become a key concept in learning potential assessment (De Beer, 2006; Hamers, Hessells & Pennings, 1996; Hamers & Resing, 1993). According to De Beer (2000a, p. 15), learning potential refers to "an overall cognitive capacity and includes both present and improved future performance".

This implies that cognitive ability is dynamic and changeable and can therefore be influenced. De Beer (2000b) developed a South African measure for learning potential called the Learning Potential Computerised Adaptive Test (the LPCAT) and this tool was the preferred instrument for this research project. The LPCAT as well as justification for its use in this study will be discussed in depth in chapter 4, section 4.4.1.

2.2.5.1 LS Vygotsky (1896-1934)

Vygotsky was particularly interested in the relationship between language and thinking and his work emphasised the roles of cultural, historical and social factors in cognition. He sought to understand the development of children and how this development was influenced and moulded by interpersonal communication. He believed that learning and instruction resulted in mental development. Vygotsky's collection of six major works spanned roughly 10 years, and covered diverse subjects from *Psychology of Art* (1925) to *Thought and Language* (1934) (www.Wikipedia.org). In the 1970's, some of his works were translated into English.

Vygotsky argued that children learn with the assistance of their parents or more knowledgeable peers (similar to Aristotle's authority pillar of general thinking). He maintained that learning occurs through cooperation and only later becomes incorporated into the learner as intrinsic. He believed in two types of higher mental functioning, namely that which is developed interpsychologically (between people) and that which is developed intrapsychologically (in the individual).

He maintained that children first learn what is taught to them by others (interpsychological form of higher mental functioning) and believed that these children eventually think about things in the way that it is taught to them. In other words, it becomes internalised as their method of processing information (an intrapsychological form of higher mental functioning) (Guthke, 1993; Vygotsky, 1978).

The dynamic assessment of cognitive abilities is the philosophy on which the instrument that was used in this research project is based. An understanding of the concept of learning potential and the dynamic assessment thereof is vital, and will be discussed in greater detail in sections 2.4.3 and 2.4.4.

It is crucial to understand cognition and how to measure it accurately. The measurement of cognitive or mental ability will now be discussed.

2.3 THE MEASUREMENT OF COGNITIVE ABILITY

2.3.1 Introduction

Thorndike is claimed to have stated: “Whatever exists at all exists in some amount” (Gregory, 2000, p. 31). The existence of cognitive ability in varying degrees in different individuals, leads to a need for psychological tests in an effort to measure those differences.

2.3.2 Psychological testing

Psychological tests have been in use from the turn of the last century and have been applied for numerous reasons. There are many uses for the information drawn from psychological assessments.

There are areas of assessment for differential fields of psychology namely, those focusing on the differences in individuals in order to understand behaviour. Clinical, career and business or consumer psychology all fall into this area. The aim of areas of study for psychological assessment, which has the most applied and practical value, is to define a profile for individuals and find the “best fit” in terms of, say, the study or career direction, job selection, promotion or placement, group member selection, determination of managerial, leadership or entrepreneurial attributes, training opportunities, establishing consumer behaviour, diagnoses of psychological disorders

and therapy or counselling (Bergh, 2006; Huysamen, 1980; 1996). The use of psychological tests is highly controversial and has been both criticised and lauded. The criticism of traditional psychological testing will be discussed in section 2.4.1.

There are numerous descriptions of the psychological test (see Bootzin & Acocella, 1988; Gregory, 2000; Lopez & Snyder, 2003; Weiten, 1989). De Beer (2000a, p. 28), who developed the assessment tool, the LPCAT, utilised in this research project, describes psychological testing as that which "refers to the use of psychometric instruments to obtain information about individuals or groups so that understanding of the people concerned and decision making that affects them can be improved".

According to Anastasi (1988), the knowledge, skill and integrity of the user determines the effectiveness of the psychological test utilised. It is essential for any test or assessment to be used with integrity. Its purpose should be clear and it should be structurally sound. Gregory (2000) maintains that tests always constitute a sample of behaviour and never the totality of that which the examiner seeks to measure. However, De Beer (2000a, p. 29) argues that the aim of intelligence tests should be to sample general cognitive skills that are generic to most cultures and found in most "activities and behaviour requiring cognition". A sample of these could be the four general thinking skills that Aristotle proposed.

When measuring cognitive ability, standard IQ tests were viewed as unfair because disadvantaged children, in terms of crystallised intelligence factors (language, arithmetic, education as a result of their culture, socioeconomic background, etc.), were being misdiagnosed as a result of their performance on the tests. A need was identified for tests that could identify both the current level of performance (actual) as well as the potential level of performance. It was felt that this would be a fairer evaluation of the testee's level of cognitive ability. This approach is known as dynamic testing and will be discussed in greater detail under section 2.4.

2.3.3 The basic requirements for psychometric assessments

The fundamental requirements for scientific psychometric assessment are that the tools should be reliable, valid and standardised, in the context in which they are used (Employment Equity Act 55 of 1998). The extent that the LPCAT meets these requirements will be discussed in chapter 4.

2.3.3.1 Reliability

Test reliability refers to the consistency of measurement of a test, that is, whether or not the test results will be consistent over several applications of the tool (Anastasi, 1988; Graham & Lilly, 1984; Gregory, 2000). Reliability is a key area of concern because of the errors involved in measurement. There are two forms of errors, namely random or systematic. Random errors refer to the random fluctuations in performance, while systematic errors refer to the nonrandom bias that impacts on the reliability of the measure. Systematic errors arise when a test consistently measures something other than what it was designed to measure (Gregory, 2000).

A number of techniques are available to test the reliability of a measure. Wolffaardt and Roodt (2005) refer to five types of reliability coefficients, which are now briefly discussed. These are test-retest reliability, alternate-form reliability; split-half reliability, coefficient alpha reliability and interscorer reliability.

a. Test-retest reliability

This method of determining reliability involves administering the test to the same group of testees on more than one occasion (usually two) (Anastasi, 1988; Wolffaardt & Roodt, 2005). Test-retest methods are designed to assess stability over time. The scores from the test and retest should strongly correlate with each other. The correlation obtained represents the reliability coefficient (also known as the coefficient of stability) (Graham & Lilly, 1984; Wolffaardt & Roodt, 2005).

Situational differences for the test taker (e.g. emotions and wellness) as well as the physical environment (e.g. venue change, variation in weather conditions or noise levels, etc.) may impact on the results. Other factors that may play a role are practice and memory in the retest (Wolffaardt & Roodt, 2005).

b. Alternate-form reliability

Another method of assessing reliability is the alternate-form method, which involves two equivalent forms of the same test administered to the same group on two occasions. There will therefore be changes in time as well in items. However, the tests must be truly equivalent on all levels (number of items, item content, difficulty, administration, etc.). The correlation between the scores represents the reliability coefficient and is also referred to as a coefficient of equivalence (Graham & Lilly, 1984; Wolffaardt & Roodt, 2005). This method is both time consuming and expensive.

c. Split-half reliability

After the initial administration of the test, this method involves splitting the assessment into two equal halves for difficulty and representation. The scores for these two equal halves are then correlated in order to assess whether they provide similar measures, resulting in the reliability coefficient (or coefficient of internal consistency) (Graham & Lilly, 1984; Wolffaardt & Roodt, 2005). The way in which the test is divided may influence the results.

d. Coefficient alpha reliability

The coefficient alpha is another measure of internal consistency and is based on the consistency of the item responses (also known as interitem consistency). It involves comparing the responses to items and is considered to be the average of all possible spilt-half reliabilities (Graham & Lilly, 1984; Wolffaardt & Roodt, 2005).

e. Interscorer reliability

This method of assessing reliability focuses on the raters of the assessment (especially in respect of open-ended questions, projective techniques, etc.) instead of on the assessments in which highly standardised procedures exist for administration and scoring. Interscorer reliability is determined when correlating the scores of two independent assessors of the same test, resulting in the interscorer reliability co-efficient (Wolffaardt & Roodt, 2005).

The reliability coefficient and the standard deviation are used to calculate the standard error of measurement (SEM). This is instrumental when determining the technical qualities of the tool (Graham & Lilly, 1984; Wolffaardt & Roodt, 2005).

According to Gregory (2000), the merit of a psychological assessment, is determined first by reliability and then ultimately by the validity of the instrument.

2.3.3.2 Validity

Validity refers to the extent to which a test satisfies its intended purpose (Anastasi, 1988; Graham & Lilly, 1984; Wolffaardt & Roodt, 2005). It is important to note that validity is not a specific property of a measure, but relates to the specific purpose of the instrument. According to Gregory (2000, p. 96), a test is valid “based on the extent that inferences made from it are appropriate, meaningful and useful”.

This implies that greater emphasis is placed on the inferences drawn from a test based on the test manual and other findings, rather than only on the actual test score.

Validity is determined by calculating the correlation between the test scores obtained and an independent objective performance measure (Graham & Lilly, 1984). There are various forms of validity, and the following will now be briefly discussed: face validity, content validity, criterion-related validity and construct validity.

a. Face validity

This form of validity refers to whether the test appears to measure what it intends to measure, that is, does it look valid or appropriate?

According to Gregory (2000), this is not a technical form of validity but more a matter of social acceptability because it relates to the subjective opinion of whether the test seems relevant.

b. Content validity

This type of validity is concerned with the content of the test and can be determined by the degree to which the test items are representative of the domain of interest. Content validity, like face validity, is a nonstatistical judgment of the tool, when considering whether the test items are closely related to the behaviour they are attempting to predict (Anastasi, 1988; Gregory, 2000; Wolffaardt & Roodt, 2005).

One of the more frequently used procedures to ensure high content validity is the use of a panel of subject experts for test item evaluation during the test construction phase (Wolffaardt & Roodt, 2005). Content validity is relevant for evaluating occupational or educational measures, but is not particularly appropriate for aptitude or personality tests (Graham & Lilly, 1984; Wolffaardt & Roodt, 2005).

c. Criterion-related validity (also referred to as criterion-prediction validity)

This method of validation is a quantitative procedure and involves calculating the correlation coefficient between one or more psychological measures (predictors) and a variable against which these predictor scores is measured (criterion) (Graham & Lilly, 1984; Wolffaardt & Roodt, 2005).

There are two types of criterion-related validity, namely predictive and concurrent validity.

- Predictive validity is determined by using the test scores to predict future behaviour or performance. The criterion measures are determined some time after the initial test scores are obtained (Gregory, 2000). The predictive validity of the instrument depends on how well the test can predict behaviour or performance in the future.
- Concurrent validation involves obtaining the test scores and the criterion measures at roughly the same time (Gregory, 2000).

The aim of this investigation was to determine the predictive validity of the learning potential scores as predictors of job performance. The criterion in this project was job performance (stated in terms of a ratio of number of promotions over the years of service, known as promotion ratio). The learning potential scores were used as the predictor.

2.3.3.3 Standardisation and normalisation (norms)

A standardised procedure is an essential feature of a measure or test. A test is standardised if the procedures for administering it are uniform from one examiner (and setting) to another (Gregory, 2000; Wolffaardt & Roodt, 2005). To guarantee uniform administration procedures, the test developer must provide comparable stimulus materials to all testers, in particular with considerable precision regarding oral instructions for each item, and also advise the examiner on a wide range of possible queries (Wolffaardt & Roodt, 2005).

When standardising an instrument, it is applied to a large and representative group of the population for which it was intended, in order to compile norm groups and tables. A norm group is a sample of testees, representative of the population for whom the test is designed and intended (Gregory, 2000).

Norms are essential when attempting to interpret test scores and evaluate an individual's performance in relation to the rest of the test population (Anastasi, 1988). Since these norms form the basis of interpretation of scores, attention will be focussed on the standardisation process as well as the norm groups of the LPCAT (ch. 4). This will ensure the fairness of the sample.

The issue of fairness of psychological testing in South Africa has received increasing attention. The change in the political situation of this country has resulted in changes in countless arenas, including that of psychological assessment and in particular, in terms of cognitive assessment.

2.3.4 Cognitive assessment in the context of a democratic South Africa

Psychological assessment has come a long way from the culturally biased tests developed and used during the apartheid years (Claassen, 1997; De Beer, 2000a; Foxcroft, 1997). During that period, when jobs were mainly reserved for certain race groups, in industry there was no need to develop tests for all South Africans because the different race groups were not competing (Claassen, 1997).

Nowadays, fairness in psychometric assessment in the multicultural context is crucial because the results of the assessments are used to secure opportunities, in industry. Local and international psychological associations and legislative statutes provide certain ethical guidelines. These include the following:

- the American Psychological Association (APA) Standards for educational and psychological testing (1999)
- the Society for Industrial and Organisational Psychology Inc. (principles for validation and use of personnel selection procedures 1987)
- the South African Board of Psychology's Ethics Code of Professional Conduct
- South African legislation, in particular the Employment Equity Act 55 of 1998; the Skills Development Act 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 primary aim of these guidelines and Acts is the ethical use and aim of any method of assessment, as well as the conduct of the assessment practitioner (Anastasi & Urbina, 1997).

According to Biesheuvel (1973), who investigated culture-fair testing in South Africa, because culture provides the context within which the individual exists, the focus should be on the measurement of individual differences, especially on the tests that study behaviour modification (which he referred to as adaptability). Taylor (1994, p. 193) indicated that the only way in which to address the inequalities of the South African past would be to place “more emphasis on potential rather than skill or specific ability” and that those with high potential should be afforded opportunities to develop.

Since Claassen (1997, p. 306) argues that all behaviour is affected by cultural context, and that the assessments are measures of behaviour, it would be realistic to construct tests “that presuppose only experiences that are common to different cultures”. This excludes any type of verbal material or material directly related to curriculum. According to De Beer (2000a), fluid intelligence measured through diagrammatical nonverbal content is deemed to be most culturally fair.

The psychometric instrument used in this project focuses on the potential (rather than the learnt skills) of individuals, and the sample used for the research is from different cultures which makes cross-cultural analyses possible.

2.3.5 Approaches to assessing cognitive ability

Authors draw a distinction between the following three main approaches to measuring cognitive abilities (De Beer, 2006; Taylor, 1994):

(1) the conventional or structural approach
(2) the information processing approach; and
(3) the learning or dynamic approach

The Piagetian approach has also been mentioned in some sources of literature (Saccuzzo, Johnson & Guertin, 1994), and will be briefly referred to in this section, before the more detailed discussion of the learning/dynamic approach which is most pertinent to this study.

2.3.5.1 The conventional or structural approach

The conventional or structural approach is referred to as the psychometric approach (cf. Hamers & Resing, 1993; Saccuzzo et al., 1994) and is based on data collected from individuals performing particular tasks (Hamers & Resing, 1993). Assessments or tests that have been developed according to this approach attempt to measure individual differences in actual performance along dimensions that are believed to be fundamental to the psychological domain in question (which may include cognition, interest, personality, etc.) (Pelser, 2002; Taylor, 1994). These tests are static and provide no feedback to the testee during testing (Grigorenko & Sternberg, 1998).

The aim of the tests produced in conventional psychometrics is to provide information on the testee's actual level of performance. These tests are retrospective (i.e. they assess what learning has been completed) (De Beer, 2006; Saarnio, 1994). A key part of this approach is the use of standardisation in the administration of the tests (Saccuzzo et al., 1994).

The individual differences in the cognitive domain have generally been measured with a power score (i.e. adding correct answers to problems of varying degrees of difficulty) and little attention has been paid to the speed of processing (Pelser, 2002; Taylor, 1994). Researchers using this approach have made extensive use of factor analysis and correlation when resolving issues (Taylor, 1994).

There are two main schools of thought in this approach. Firstly, intelligence is defined as a general, unified capacity for acquiring knowledge, reasoning and problem solving. Spearman and Cattell's theories resort under this approach. The general belief is therefore that individuals who perform well or poorly on IQ will perform well or poorly on a range of various intellectual tasks, and that cognitive ability tests can provide a single, global measure of intelligence (Hamers & Resing, 1993; La Grange & Roodt, 2001).

The second school of thought argues that intelligence is assumed to be composed of separate mental abilities that operate more or less independently (Hamers & Resing, 1993). These researchers, through multiple factor analysis, seek discrete definition of mental abilities (La Grange & Roodt, 2001).

The tests in this approach measure the products of prior learning (or Cattell's crystallised intelligence). They therefore rely on the assumption that all testees have had comparable opportunities to acquire that which is being measured (De Beer, 2006; Taylor, 1994). This approach therefore has limitations for use in a multicultural environment, unless norms are standardised for each different culture (Taylor, 1994).

Since this approach was not considered appropriate for the learning potential assessment required in this research, the tests that were developed in this approach were not utilised.

2.3.5.2 The information-processing approach

Subscribers to this approach describe how problems are solved by the way in which knowledge/information is collected and applied (Hamers & Resing, 1993; Pelser, 2002). Researchers attempt to analyse responses in terms of the basic component processes underlying them (Saccuzzo et al., 1994). This approach broadened the concept of intelligence by moving the focus from the end-products of problem solving to the cognitive processes involved, thereby enhancing the diagnostic value of the test (Hamers & Resing, 1993).

Two approaches developed in the information-processing approach. The aim of the first, known as the cognitive components approach is to uncover the components of cognitive thought (Pelser, 2002; Saccuzzo et al., 1994; Taylor, 1994). The second is known as the cognitive correlates approach and its aim is to uncover the critical processes that are fundamental to the performance on more complex measures such as verbal ability (Saccuzzo et al., 1994; Taylor, 1994).

Even though little cross-cultural research has been conducted on information-processing tests, the problems of cultural bias are likely to be relatively small because the constructs are delineated and the measures are simple (Taylor, 1994). However, one of the criticisms of this approach is that computer administration appears to be essential, and this tends to limit the number of testees who can be accomodated at a time (Taylor, 1994).

The test used in this study is not part of this approach.

2.3.5.3 The Piagetian approach

This approach is based on Piaget's theory of cognitive development and evaluates individuals at four different stages, namely sensorimotor thought; preoperational thought; concrete operational thought; and formal operational thought (Kail, 2002). Piaget ascertained that mental development through the four phases facilitates learning and this approach is useful for assessing pre-school children (Kail, 2002; Pelser, 2002).

Since this research compared adult differences and the development of cognitive abilities was not the focus of the project, the test used in this study does not resort under this approach.

2.3.5.4 The learning or dynamic approach

This approach is also referred to as the Soviet approach and is based on, Russian psychologist, Vygotsky's theory of the zone of proximal development (De Beer, 2000a, 2006; Guthke & Stein, 1996; Taylor, 1994). According to Taylor (1994), it is more useful as a basis for cross-cultural assessment than any of the other approaches.

While the aim of the information-processing approach is to measure cognitive processes, that of the learning or dynamic approach is to train cognitive processes. It focuses on increased speed and accuracy as a result of repeated mediation, in order to improve the measurement of intelligence (Hamers & Resing, 1993; Taylor, 1994). This approach views intelligence as the individual's capacity to adapt to the demands of the environment, and its aim is, therefore to determine how sensitive, if at all, an individual is to instruction, and how efficient the operations of cognitive processes are (Hamers & Resing, 1993). The basic principle of the learning potential or dynamic approach is that a test should also measure this ability to learn rather than only previously acquired knowledge and skills (as with traditional intelligence tests) (Hamers & Resing, 1993). These tests will provide information on why and how testees make mistakes; how individuals learn and how new knowledge can be integrated into and applied in new situations (Hamers & Resing, 1993; Taylor, 1994).

Vygotsky viewed the development of cognitive ability as a social phenomenon and defined the so-called concept "zone of proximal development" (ZPD) as acknowledgement of individuals' differing ability to profit from mediated learning (Vygotsky, 1978).

Adults and older peers transfer knowledge and skills required in a culture and this transfer of knowledge tends to assist them with problem solving, conceptualisation and interpretation of the environment (Pelser, 2002; Taylor, 1994). This echoes Aristotle's ideas on authority in his four general principles to thinking.

The ZPD describes the difference between potential performance with assistance, and actual performance (Taylor, 1994). Traditional static tests measure only actual unassisted performance, whereas dynamic testing is prospective and aims to investigate individuals' ability to acquire knowledge, and apply and transfer these methods to help with problem solving (Saarnio, 1994; Taylor; 1994).

There are two main approaches to dynamic testing: the clinical or enrichment approach and the measurement approach (De Beer, 2000a; Pelser, 2002).

In the clinical or enrichment approach, the focus is on the individual's learning outcome. Structured remedial intervention is provided at individual level in order to identify and improve underdeveloped cognitive areas (De Beer, 2000a; Pelser, 2002). The most widely recognised example of this approach is Feuerstein's Learning Potential Assessment Device (LPAD) (Owen, 1998).

The psychometrical or measurement approach to dynamic assessment focuses on the measurement of the change in performance. This approach endeavours to evaluate the capacity for learning new skills when training is provided, instead of effecting lasting changes in cognitive ability (De Beer, 2000a). The change in performance between the pre-test and post-test scores is an indication of Vygotsky's ZPD (Owen, 1998).

The psychometric assessment tool used in this research project, the LPCAT, resorts under the psychometric approach to dynamic assessment, its aim being to measure the capacity to learn new skills. It uses a test-train-retest approach, with the standardised training section incorporated into the test. This tool will be discussed in more detail in chapter 4.

2.4 DYNAMIC ASSESSMENT

Intelligence is measured distinctly as either an intelligence test score or as learning potential test scores (Hamers & Resing, 1993).

This essentially refers to traditional static tests and dynamic tests. 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.

The interest in learning potential assessment was partly sparked by the criticism of intelligence tests, a brief discussion of which follows in section 2.4.1 (Hamers & Resing, 1993; Taylor & Richards, 1990).

2.4.1 Criticism of the traditional testing method

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). Biesheuvel (1973) maintains that the traditional intelligence tests (regarded as static) measured only the learnt skill, whereas the adaptability tests assessed what individuals can learn to do.

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

(1) The testee's verbal abilities are (often unintended) presupposed.
(2) The test items may contain (often unintended) implicit references to the cultural background of (usually) the test composer.
(3) Test-wiseness, which refers to subsidiary skills that are essential to the problem-solving process (e.g. the skill to handle multiple-choice items or time limits in speed tests, etc.), are more often tested than cognitive ability per se.

De Beer (2000a) maintains that intelligence is reflected in the actual test scores and learning potential can only be measured if learning opportunities are provided as part of the assessment process.

This is especially true in the South African context. In South Africa, development opportunities for the various cultures have historically been vastly different.

According to De Beer (2000a), socioeconomic differences have an impact on performance on traditional intelligence tests in South Africa. Socioeconomic status is determined amongst other things by:

- educational attainment
- unemployment
- job type
- income
- water in the home (i.e. whether tap water is available in the home)
- toilet facilities

She found large discrepancies in the various cultures, taking into account the socioeconomic and educational indicators listed above. Sibaya, Hlongwane and Makunga (1996) 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.

These factors include cultural history as well as the degree to which the individual has been "acculturated" (Sibaya et al., 1996, p. 112). Hence when attempting to measure cognitive development, it is crucial, and would clearly be appropriate, to use tools that have been designed to preclude these developmental disadvantages (De Beer, 2000a).

2.4.2 Dynamic- versus traditional cognitive assessment

The aim of traditional assessment is to measure the actual or current performance of the testee as at that moment. The aim of dynamic assessment is to obtain a more realistic measurement of a person's cognitive ability by including training as part of the assessment process (Hamers & Resing, 1993).

According to Embretson (1987), there are three main aims in dynamic assessment:

(1) To provide a better estimate of the ability construct. Testees have varying degrees of experience in or exposure to taking tests. The training phase of the learning potential assessment may reduce these effects and may increase test validity, thus improving the comparability between testees (see Grigorenko & Sternberg, 1998)

(2) To measure new abilities. Change readiness can be measured by determing the amount of assistance required by the testee or the degree of improvement after training has been provided (Embretson, 1987)

(3) To assess and improve abilities. The dominant aim of dynamic testing is to change and improve cognitive performance, which can be achieved through extensive training (see Grigorenko & Sternberg, 1998).

Dynamic testing has all the psychometric properties of a static test (see sec 2.3.3) but involves the use of standardised objective intervention or training procedures designed to transfer to a criterion test (Carlson & Wiedl, 1979; Hamers et al., 1996; Hamers & Resing, 1993; Sternberg & Grigorenko, 2002). There are three major differences between static and dynamic testing (Sternberg & Grigorenko, 2002). Firstly, static testing measures products formed from developed skills and knowledge, whereas dynamic testing taps into developing processes quantified through the capacity to learn. Secondly, in static testing, the testee responds to a graded sequence of problems, and no feedback is given. In dynamic testing, either implicit or explicit feedback is given on the quality of performance on items. Thirdly, the relationship between examiner-examinee should be neutral and uninvolved in static testing, while in dynamic testing, the relationship is interactive with information and mediated learning occurring in the relationship (Sternberg & Grigorenko, 2002).

There are various approaches to dynamic testing, but two common formats emerge:

(1) instruction sandwiched between a pre-test and a post-test (for individuals or groups)

(2) instruction in response to the individual's solution to each test item (only individuals) (Sternberg & Grigorenko, 2002).

Because of its history and multicultural context, dynamic testing tends to be attractive in South Africa, as the individual historical differences can be reduced through repeated contact with the material in a teaching and supportive environment (Babad & Budoff, 1974).

2.4.3 Dynamic assessment theories and instruments

Thorndike defined intelligence as "the ability to learn" (Guthke, 1993; Guthke & Stein, 1996; Sternberg & Grigorenko, 2002). Learning potential is generally concerned with what could be developed and is based on the premise that ability (that which is available on demand, namely already developed) can change (De Beer, 2000a).

As discussed in section 2.3.5.4, Vygotsky is considered to be the founder of the learning potential concept, and what follows is a discussion of the learning potential concept as well as the various approaches to the assessment thereof.

2.4.3.1 Conceptualisation of learning potential

Vygotsky viewed the development of cognitive ability as a social phenomenon.

Adults and older peers transfer the knowledge and skills required in a culture (interpersonal thinking), and in this way assist with problem solving, conceptualisation and interpretation of the environment (Pelser, 2002; Taylor, 1994; Vygotsky, 1978). This echoes Aristotle's ideas on authority in his four general principles of general thinking.

According to Vygotsky there are two distinct levels when describing learning and development. The first is the learning that has already taken place, while the second can be achieved with assistance or guidance. The difference between potential and actual developmental levels is the ZPD (Brown & French, 1979; Frisby & Braden, 1992; Pelser, 2002; Vygotsky, 1978). The ZPD will be discussed further in section 2.4.3.2.

In Vygotsky's view, the intellectual environment can determine children's intellectual growth. This implies that the number and quality of the learning opportunities play a pivotal role in cognitive development (Boeyens, 1989; Vygotsky, 1978). He likened the measuring potential of an individual to a gardener judging the usefulness of an apple tree. He argued that the gardener should not only look at the ripened apples but also at the maturing tree and consider all aspects of it (e.g. its age, the thickness of the stem, the number of buds, etc.) (Guthke, 1993; Vygotsky, 1978; 1997).

When measuring or quantifying learning potential, actual performance is assessed and a score allocated. This first score (known as the pre-test score) represents the initial unassisted problem-solving attempt.

A training intervention is then provided and the testee attempts problem solving a second time, which is represented by the second score (or post-test score). The pre-test provides information on the current (actual) level of performance, whereas the post-test provides information on the potential future level of performance (that which may be attained after training can be provided). According to De Beer (2006), learning potential is a combination of the pre-test and post-test scores, as well as factoring in the magnitude of the difference between these two scores.

The intervention reduces the unfamiliarity of problem solving and therefore helps those testees from disadvantaged backgrounds to better understand the appropriate problem-solving strategies (Babad & Budoff, 1974). The mediated learning that occurs, aims at providing hints and guidelines that will assist the testee to solve similar problems (De Beer, 2006).

However, it is crucial to understand that a small difference or improvement score does not imply limited learning potential because all the scores (pre-, post- and difference) are relevant when determining learning potential (De Beer, 2006).

2.4.3.2 Vygotsky's zone of proximal development (ZPD)

Whereas the Piagetian approach proposes that cognitive development facilitates learning, Vygotsky argues that learning and instruction result in cognitive development (Boeyens, 1989). It was Vygotsky's view (1978) that individuals differ in the capacity to benefit from mediated learning. He (1978, pp. 86-87) termed the distance between the two distinct levels as the "zone of proximal development" and describes it as follows:

> the zone of proximal development defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state. These functions could be termed the "buds" or "flowers" of development rather than the "fruits" of development. The actual developmental level characterizes mental development retrospectively, while the zone of proximal development characterizes mental development prospectively.

This allows for the measurement of the potential a person may reach (De Beer, 2000a; Vygotsky, 1978).

In one approach, when measuring the width of an individual's ZPD, an indication is given of how many clues were necessary to solve the problem. This means that should individuals have wide ZPD scores, they would need fewer clues to solve problems after the training intervention, that is, they have learnt to transfer the new knowledge to other similar problems (Brown & French, 1979).

As noted previously, De Beer (2006) cautions against the misinterpretation of the ZPD as the potential of the testee. The difference score (ZPD) must be interpreted with reference to both the pre-test and the post-test scores in order to provide complete information on the testee's performance and potential performance.

However, generally, testees with larger ZPD scores are more likely to improve their performance, whereas those with smaller ZPD scores are more likely to remain at their present level (De Beer, 2006).

2.4.3.3 Other theorists' views on dynamic assessment

a. Feuerstein's Learning Potential Assessment Device (the LPAD)

Feuerstein viewed individuals as open systems amenable to cognitive change (De Beer, 2000a; Frisby & Braden, 1992). He did not view intelligence as static and believed that individuals learn through exposure to stimuli (either direct or mediated). According to him, through mediated learning experiences (MLE), individuals can improve their cognitive abilities at any point in their lives (Feuerstein, 1980).

He developed the LPAD when many World War II orphans, from over 70 countries, were sent to Israel. According to the traditional measures of intelligence, most of these children appeared to be extremely low functioning (De Beer, 2000a; Laughon, 1990). According to De Beer (2000a), the focus of his approach is the changeability of cognitive functioning, and it is also based on Vygotsky's ZPD principle. Feuerstein maintains that retarded performance is the result of the lack of mediated learning (Laughon, 1990). Hence the LPAD aims to measure the extent to which the individual's cognitive structures can be altered as a result of mediated learning experiences. This requires an intensive teaching phase (De Beer, 2000a; Laughon, 1990).

Feuerstein's (1980) dynamic approach represents an attempt to effect lasting and enduring change and therefore resorts under the enrichment approach of dynamic assessment. This differs from the approach in this research project, which aims to measure capacity for learning.

b. Budoff's learning potential procedure

Another pioneer in the development of dynamic assessment was Budoff, whose work was based on the assumption that some retarded students have a higher learning capability than their verbally based IQ score suggest (Laughon, 1990; Pelser, 2002). Budoff maintained the existence of a general ability that cannot be separated from the environment, and which is influenced by the testee's culture (Laughon, 1990; Pelser, 2002). He therefore views learning potential as a measure of general ability (De Beer, 2000a).

According to De Beer (2000a), Budoff's key contribution to dynamic assessment is his work on the standardisation of instructions. One of the tests that Budoff and his colleagues administered (but in a dynamic manner) was Raven's Progressive Matrices (De Beer, 2000a; Pelser, 2002) (other tests developed were an adapted version of Koh's Block design test; the Series Learning Potential Test and the Picture Word Game, [Hamers & Resing, 1993]).

Three types of data are obtained in the Raven's test-practice-retest methodology, namely pre-training (current ability), post-training (potential ability) and the "gain" scores (from pre- to post- training scores), which describe the testee's ability to benefit from training (De Beer, 2000a; Pelser, 2002). The attempt to measure the testee's capability to benefit from learning, places Budoff's approach in the psychometric approach to dynamic testing.

c. Brown and Campione's dynamic assessment

Campione and Brown (1979) argue that the structural features of ability are stable and untrainable, but the control processes are modifiable. Hence intelligence can be changed by training the cognitive processes involved.

Brown and Campione's approach is based on the information-processing theory of intelligence and focuses on the amount of assistance that should be rendered in order to change the level of performance, rather than how much improvement is measured (De Beer, 2000a; Laughon, 1990). Brown and Campione suggest that the amount of assistance needed to learn is a possible index of intelligence (Hamers & Resing, 1993; Laughon, 1990).

Like Budoff, the aim of Brown and Campione's assessment approach is to measure the changes in performance, - hence the approach is classified under the psychometric approach to dynamic testing.

d. Guthke

Guthke, a German psychologist, developed several learning potential tests comprising mostly a pre-test, a training phase and a post-test (Hamers & Resing, 1993). Based on the information provided in the training phase, he developed three types of tests, namely a long-term learning potential test, a short-term learning potential test (or train-within-test procedure) and an interval test, which includes a curriculum as part of the training phase (Hamers & Resing, 1993). In an attempt to increase the predictive validity of dynamic assessment, the training material of his tests is standardised and is in the form (where possible) of programmed instruction, which is task specific. The help or feedback in the form of hints is specifically task directed (Grigorenko & Sternberg, 1998; Guthke & Stein, 1996; Hamers & Resing, 1993).

Guthke's work inspired other researchers to develop further learning potential tests such as the four tests with different forms of training (e.g. positive feedback, structure and offering strategies) that Guthke, Hamers and Ruijssnaars developed (Hamers & Resing, 1993).

As discussed above, many tests have been developed on the basis of Vygotsky's learning potential concept, both internationally and nationally. For the purpose of placing this research in context, it is imperative to discuss the South African context.

2.4.4 Dynamic assessment in South Africa

Although this limited scope project is concerned with the validity of dynamic assessment for predicting performance, the research that will be discussed is selective, since much of the research performed in South Africa on the predictive or concurrent validity of dynamic assessment concerns selection. According to De Beer (2000a) and Pelser (2002), both Feuerstein and Budoff's approaches have been investigated successfully in South Africa.

Budoff's approach of administering a standardised measure in a dynamic test-train-test way, was researched by Shochet in 1986 and Zolezzi in 1995 (as cited in De Beer, 2000a and Pelser, 2002). Zollezi's research concluded that traditional tests, which are applied dynamically, yield a better predictor of academic performance than static cognitive measures (Pelser, 2002). The South African LPCAT is similar to Budoff's test but was specifically designed for dynamic assessment (De Beer, 2000b; Pelser, 2002). Both Budoff's approach and the LPCAT use nonverbal tasks to determine reasoning abilities.

Feuerstein's approach has also been investigated in South Africa, research being performed by Van Niekerk in 1991 and Shochet in 1986 (as cited in Pelser, 2002). Sibaya et al. (1996) also investigated the application of the LPAD for the assessment of giftedness, intelligence and other cognitive abilities.

On the basis of Shochet's research, training-enriched testing is supposed to help in the selection of disadvantaged students. However, Van Niekerk could not provide evidence that mediation improved performance on verbal or nonverbal reasoning, perceptual speed, mathematical applications, vocabulary or study habits (Pelser, 2002).

According to De Beer (2000a), there is no known South African research that uses Campione and Brown's approach.

A few dynamic tests have been developed and standardised in South Africa, namely:

(1) the Ability Processing of Information and Learning Battery (APIL-B), developed by Taylor (Taylor,1997; 2003)

(2) the Transfer, Automisation, Memory and Understanding Learning Potential Battery (TRAM-1 and TRAM-2) developed by Taylor (Aprolab, 1998; Taylor, 1999)

(3) the LPCAT developed by De Beer (2000b)

The battery developed by Taylor (viz. TRAM-1, TRAM-2 and APIL-B) is a pen-and-paper application. These assessments are timeous whereas the LPCAT is computer based and the time taken to complete the assessment is roughly 30 to 45 minutes. The marking of the LPCAT is automatic and eradicates marker error.

The rationale for using the LPCAT instead of the Taylor battery for this research is discussed further in chapter 4, section 4.3.2.1.

2.5 CHAPTER SUMMARY

In this chapter, the focus was on the concepts of cognitive or mental ability, intelligence and learning potential, as well as the measurement thereof. Reference was made to the evolving influences on cognitive ability, and the various theories were presented. The arena of psychometric testing, including its requirements, was discussed and the traditional versus dynamic assessment methods elucidated.

The main criticism of traditional psychometric tests is that they assume that the opportunities for learning have been similar across cultures, which in South Africa is clearly not true. It was therefore essential for dynamic tools to be utilised that measure learning potential rather than products of learning.

As this study aims to explore the relationship between 2 variables, learning potential and job performance, the next chapter is devoted to explicating the construct of job performance.

CHAPTER 3
JOB PERFORMANCE

3.1 INTRODUCTION

The survival of organisations depends on the performance of their workforce. The greatest cost to most companies is labour which directly affects the profit margin. It is in organisations' best interest to optimise their human capital in order to obtain greater gains in terms of this margin. However, encouraging employees to perform effectively, measuring and managing their job performance remains a grave concern.

The purpose of this chapter is to provide a literature review focusing on conceptualising job performance, by first describing the South African challenges in the changing work environment. Job performance is then defined and its measurement discussed. Finally, job performance management, and the various approaches to it, are highlighted and the approach to job performance in the research organisation discussed. The chapter concludes with a summary.

3.2 CONCEPTUALISING JOB PERFORMANCE

3.2.1 Challenges in the South African context

Political, economic, cultural and technological changes are having a profound impact on the changing world of work - commitment to lifelong employment in one's organisation is a diminishing, if not an extinct, reality and the responsibility of job security has shifted from organisations to individuals (Aryee & Debrah, 1993; Furnham, 2000; Greenhaus & Callanan, 1994; Hall & Mirvis, 1995; Otte & Kahnweiler, 1995; Schein, 1988). Organisations are staffed by more diverse groups of employees, manifesting a particular challenge in terms of performance management.

In the South African context, the following changes facilitate diversity in the workplace: globalisation, privatisation and fierce competition as well as legislation dictating the advancement of previously disadvantaged individuals resulting in black empowerment waves in the corporate world. HIV/Aids, and living and working in a context in which team members may be living with the virus, is a looming reality in the new world of work.

Strategic human resource management must accommodate these challenges by predicting trends and proactively putting plans and systems in place to deal with any organisational challenge facing it. The principal challenge remains to ensure that the performance of employees will result in the effectiveness and success of any organisation. Hence there is currently enormous interest in integrating performance management and strategic planning in order to develop employees' performance to ensure business optimisation. However, few organisations fail to assess the contributions their employees make to overall effectiveness, that is, the employees' job performance (Orpen, 1986; Pickett 2000; Suliman, 2001).

3.2.2 Definition of job performance

There are many definitions of job performance in the literature (see Campbell, 1990; Cascio, 1998; Gerber, Nel & Van Dyk, 1999; Hunt, 1996; Ivancevich & Matteson, 1996; Landy & Farr, 1983; Pickett, 2000; Stacey, 1996; Suliman, 2001; Thompson & Strickland, 2001; Usher, 2005; Wright & Noe, 1996). The definitions generally concur that in order to understand job performance, one needs to observe both the actions of the employees as well as the results or outcomes of these actions. It is vital to understand the counterproductive behaviours (e.g. absenteeism) because these reflect employees' attitudes, which in turn, influence the overall performance outcome.

According to Usher (2005), when considering employees' job performance, it is critical to focus on the behaviours as well as the outputs or results of behaviour.

She illustrates this when considering performance in a sales environment, where the behaviours of employees (e.g. politeness to customers) have an immediate link to the outputs (e.g. sales figures for the department). Usher (2005) argues that employees can be held individually accountable for the behaviours, which are in their control, as opposed to their limited accountability for the department's sales figures. Also, should the employees only be held accountable for results (e.g. sales figures) certain behaviours (e.g. politeness) may be compromised in order to achieve those results (e.g. forcing sales) (Usher, 2005).

Tying in well to Usher's (2005) argument that some behaviours are not within the control of the individual, employees' job performance should also be understood in the organisational context in terms of resources, policies, and so forth, which are made available to employees to perform their tasks. According to Ivancevich and Matteson (1996), job performance descriptions should include the quality and quantity of employees required to meet both the objectives and the standards that are required to do a task. Job performance can then be viewed in terms of the systems approach, as described by Coetzee (cited in Van der Linde, 2005). The systems approach includes inputs (personality, experience, knowledge, behaviours, etc.), organisation (processes, resources available to do the work, etc.) and outputs (job performance). The systems approach to job performance is indicated in figure 3.1 below.

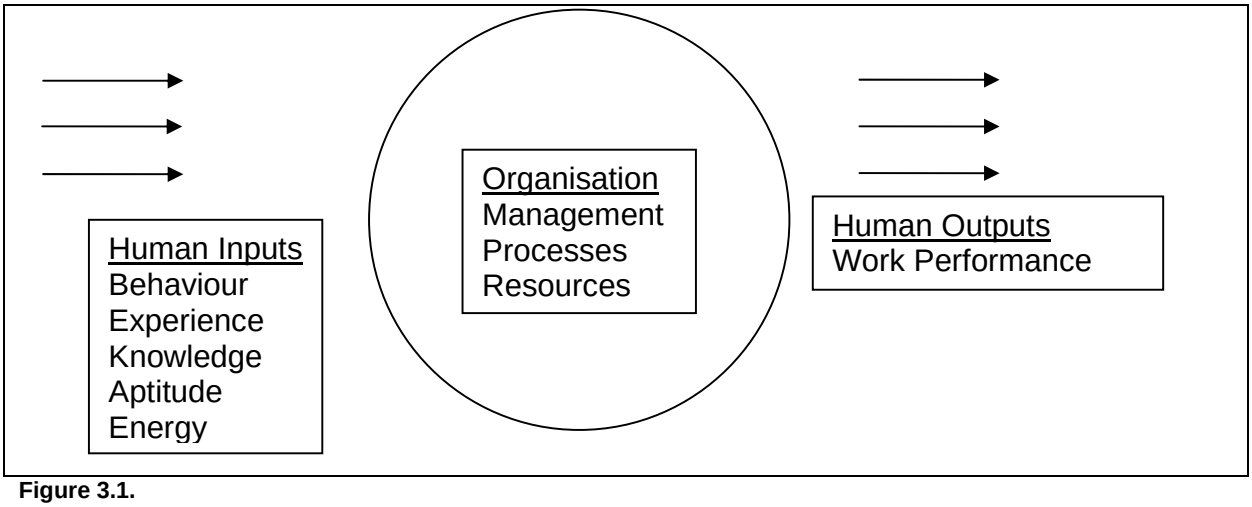

Figure 3.1.

The systems approach to job performance **Source:** Van der Linde (2005 p. 27)

The systems approach to performance management systems (PMS) will be referred to again in section 3.5.1.

For the purpose of this study the researcher has accepted the behaviour and outcome as well as the systems approach to job performance. However, in terms of the measurement approach followed, the scope of the study only included measurement of the objective criteria.

3.3 MEASURING JOB PERFORMANCE

The measurement of job performance remains a concern because inaccurate assessments of outputs and inputs - or setting up inaccurate measurement criteria – can have disastrous effects on individuals and organisations as a whole. There are various approaches to measuring job performance, but, in essence, performance measures should be reliable, valid and accurate as well as being practical and useful (Landy & Farr, 1983).

To ensure accurate measurement, the purpose and criteria of measurement should be clarified. The sections below (sec. 3.3.1 – sec. 3.3.5) will be devoted to this.

3.3.1 Purposes of measuring job performance

Organisations collect performance data for several reasons, that is, administrative, guidance, counselling and research purposes (Armstrong, 1996; Cascio, 1998; Gerber et al., 1999). Administrative purposes include employee movements such as promotions, demotions, transfers, retention decisions, training and developmental needs analyses. Guidance and counselling uses include supervisory feedback on strengths and weaknesses, and this information may in turn be used in, say, career planning. Research reasons may be to track the job satisfaction index of employees or evaluate a training programme.

The data may also be utilised to audit departmental or organisational improvements or to assess how a department or organisation is progressing according to current targets (Amaratunga & Baldry, 2002; Landy & Farr, 1983).

Obviously these data must be accurate and relevant to ensure that all the processes involved (i.e. administrative, human resources and research) maintain integrity – hence the need for initial recognition of the correct measurement criteria.

3.3.2 Measurement criteria

Measurement criteria can be divided into two broad categories namely objective (also referred to as nonjudgmental) measures of performance and subjective (or judgmental) measures of performance (Cascio, 1998; Landy & Farr, 1983).

Ratings (supervisor, peer or self) are examples of subjective criteria, and this process requires one individual to make a judgment about another's performance level. Objective criteria consist of measures that do not require a judgment, and these data consist of "anything that can be counted, seen, and compared directly from one employee to another" (Landy & Farr, 1983, p. 27). Objective measures can be directly related to job performance. Examples of such measures have traditionally been production output, scrap rate, time taken to complete the task, and so forth. There are less obvious objective measures that can still directly influence performance, and examples of these are absenteeism, turnover, job knowledge, accidents or grievances (Bommer, Johnson, Rich, Podsakoff & MacKenzie, 1995; Landy & Farr, 1983).

Objective and subjective measurement criteria are discussed next in more detail.

3.3.3 Judgmental or subjective measurement criteria

Subjective measurement criteria involve ratings, rankings and paired comparisons of employees (Landy & Farr, 1983).

The process involves collecting information, considering its value and using it to draw conclusions about the ratee's performance. It is therefore based on perceptions. Individuals' perceptions of their own and their colleagues' work-related competences have a huge impact in this process. Arnold and Davey (1992) found that employees continuously rated themselves far higher than their supervisors' rating of them.

There are several criticisms of the use of ratings as the only measurement when assessing employees' performance. Bommer et al. (1995) contend that ratings as a performance measure are subject to systematic bias and random error, which objective measures seem to be less prone to. Posthuma (2000) maintains that supervisors' subjective evaluations may by clouded by interpersonal behaviour and employees may therefore be able to influence the supervisors' opinions of their performance without increasing their workload. For example, employees with positive willing attitudes, who work after hours, may not necessarily be highly productive, but they may be rated higher on their performance appraisals than sullen, quiet employees who are productive, but because of their lack of interpersonal skills, scored lower on their performance ratings.

Armstrong (1996) argued that owing to the subjective nature of these criteria, achieving consistency is a concern. Because of the multidimensionality of performance, he also highlights the danger of oversimplification by summing up an employee in a single rating. Supervisor ratings call for judgments about potential, and he believes that labelling employees can be both dangerous and demeaning.

Fink and Longenecker (1998) maintain that performance measurement fails in most companies because of poor rater skills. Hence to ensure efficient use of judgmental measurement criteria, rater skills should be refined. They concluded that there are four basic appraisal stages to performance management, and they link certain rater skills to each. Table 3.1 illustrates the key competencies necessary for each of the four stages.

Table 3.1
Rater skills required per stage in performance management

Performance planning	Performance management and ongoing coaching	The written appraisal	The appraisal review
Key Competencies	Key Competencies	Key Competencies	Key Competencies
1. Knowledge of rating forms and procedures	1. Observation/work sampling skills	1. Knowledge of rating forms/ procedures	1. Specific knowledge of review procedures
2. Ability to clarify and communicate expectations	2. coaching skills	2. Effective decision making/sound judgment	2. Coaching skills
3. Delegation/ empowerment skills	3. conflict resolution/problem-solving skills	3. Effective writing communication skills	3. Conflict resolution/ problem solving
4. Knowledge of legal/compliance issues	4. knowledge of legal/compliance issues	4. Knowledge of legal/compliance issues	4. Employee development/ career counselling
			5. Knowledge of legal/ compliance issues
← EFFECTIVE TWO-WAY COMMUNICATION SKILLS →			

Source: Fink and Longenecker, 1998, p. 249

Despite all the arguments against judgmental criteria, the use of subjective measuring is a convenient way of summing up judgments of behaviour, which otherwise may not be discussed openly. These criteria provide a method of identifying and putting in place plans, for both exceptional performers and under-performers (Armstrong, 1996).

3.3.4 Nonjudgmental or objective measurement criteria

Objective measurement data are generally more accessible and readily available. These data can be collected and discrete comparisons made.

However, Bommer et al. (1995) argue that performance constructs that can be measured objectively tend to be narrow in focus and are typically low-order organisational goals. The higher up in the organisation the employee is, the more difficult it is to measure relevant goals objectively.

Some of the variables that lend themselves to objective measurement are absenteeism, turnover and job knowledge.

3.3.4.1 Absenteeism

Absenteeism can be measured individually or organisation-wide. When measuring it in the broader organisational perspective, it is viewed as a "cost" and must be reduced because it has a significant impact on overall labour costs. At this level, the reasons for absence are less important than the cost thereof. There are various methods of measuring absenteeism, but generally organisations tend to devise formulas that calculate productivity or similar ratios (Landy & Farr, 1983).

When viewing absenteeism at individual level, the duration and reasons for absenteeism become paramount because most organisations make inferences about employees' character on the basis of the pattern of absence. There are concerns about the reliability of using such a measure to classify an employee's character. However, the reliability of the data should increase if the period of time over which the data are collected also increases (Landy & Farr, 1983).

3.3.4.2 Turnover

Turnover is relatively easy to measure. The philosophy behind measuring turnover is that it is expensive to recruit, select and train individuals to replace employees who have left. The literature advises caution when using this objective measure because it is crucial to interpret the data accurately.

For example, when scrutinising employee termination data, there is a significant difference between voluntary and compulsory termination of service. The interpretation depends on whether the employees' services were terminated because of resignation, retirement, dismissal, ill-health or disability or death, and this interpretation may impact on the reporting of data (Landy & Farr, 1983).

According to Cotton and Tuttle (1986), some criteria have a strong correlation with turnover. These are union presence, age, pay, and overall job satisfaction and employment perceptions. They conclude that task repetitiveness and intelligence are weakly (if at all) related to turnover.

3.3.4.3 Job knowledge

Ivancevich and Matteson (1996) maintain that effective employees have substantial knowledge about the company for which they work. They argue that effective leaders extend this knowledge from the organisation to industry-wide knowledge and technical knowledge. Schuitema (2000) suggests that employees who pursue task excellence (referred to as "virtuoso" employees) value job knowledge and actively pursue learning through many work activities. Job knowledge is also regarded as one of the elements required when empowering employees to become optimised in their roles in the organisation (Coetsee, 2003; Schuitema, 2000).

Job knowledge is a quantifiable objective criterion, that can be measured through on-the-job questionnaires. However, situational constraints should be controlled and examination conditions constant for all employees (e.g. all employees should be examined at the beginning of the shift and not after a night shift).

When deciding on performance measures it is crucial to identify the correct criteria. Armstrong (1996) provides the following guidelines on the definition of performance measures:

- The criteria should relate to results and not employees' efforts.
- These results should be within the employee's control.
- The measures should be objective and observable.
- The measurement data should be readily available.
- Existing measures should be utilised where possible.

For the purposes of this limited scope project, the researcher considered the guidelines listed and the job performance criteria were defined utilising both the job knowledge and tenure of the employee. The job knowledge of the employee, in the research organisation used in this study, is measured by means of job knowledge examinations that are formalised via a career development route for each department (these routes are discussed further in ch. 4, sec. 4.4.2). These results are within the employee's control in respect of learning for and voluntarily writing the examinations for each of the sections of the plant. This measure is objective because the examinations are standardised. The results are observable and the data readily available. All the existing results of previous examinations are available for use.

Although there are concerns about both objective and subjective measurement criteria of performance management, it remains imperative to measure performance accurately. Some positions require subjective measures and others objective measures. Brommer et al. (1995, p. 602), states "it is better to imperfectly measure relevant dimensions than to perfectly measure irrelevant ones".

3.3.5 Sources of variance in job performance measurement

The literature concurs that job performance is a multidimensional concept with many factors influencing it. When measuring job performance it is essential to heed the various sources of influence. Landy and Farr (1983) report there are major groups of factors that influence the measurement of job performance. Figure 3.2 illustrates the interaction between the various groups.

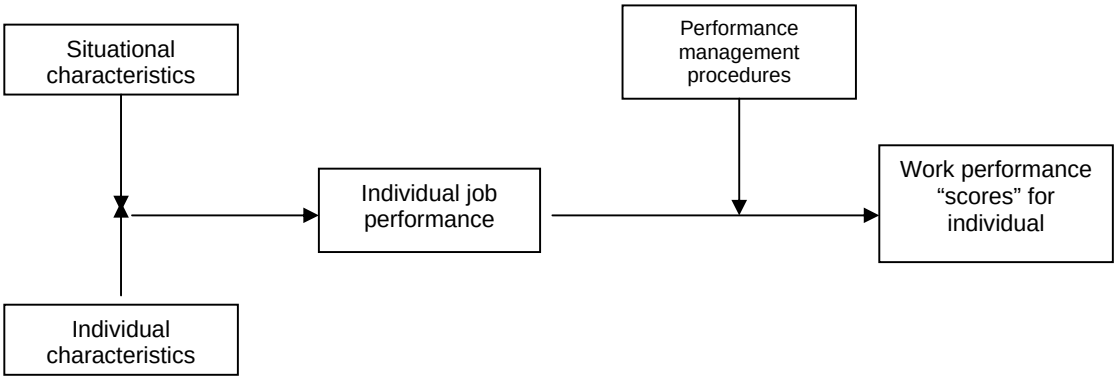

Figure 3.2.

*Factors influencing job performance measurement***. Source**: Landy and Farr (1983, p. 8)

If the measurement of performance is to be managed fairly, employees should only be measured against goals for which they can be held accountable, and which are relevant and feasible to achieve (Armstrong, 1996; Kane, 1997). When considering accountability, recognition should be given to the fact that circumstances beyond the employees' reasonable control may have limited their performance and resulted in performance below the agreed targets.

These circumstances (see fig. 3.2 above) are generally referred to in the literature as situational constraints and include circumstances such as insufficient time, lack of essential assistance from others, resource shortages, inadequate information or equipment and unforeseeable crises (Kane, 1997; Landy & Farr, 1983). The individual characteristics illustrated in figure 3.2 can include ability (cognitive, physical, social or emotional), experience, education and motivation, as well as what the individual believes constitutes effective performance in that particular role (Landy & Farr, 1983).

The model presents a distinction between the job performance and the score obtained through the use of the performance measurement procedure. The performance measurement procedures or systems act as translators of the employees' behaviour into some quantified index of work performance. The fundamental aim of performance measurement should be to keep any imperfections in this translation to a minimum (Landy & Farr, 1983).

3.4 MANAGING JOB PERFORMANCE MEASUREMENT

Performance measurement is crucial to employee optimisation – hence the need to manage it effectively. Traditionally, this process has been one of control and authoritarian actions that may result in disciplinary action or, in some extreme cases, termination of the employee's services (Amaratunga & Baldry, 2002; Tangen, 2004). Contemporary performance management processes include the measurement of behaviour as the key to change, and this is no longer used to influence employees negatively.

There is agreement in the literature that most performance management processes include translation of overall company vision and mission into the smallest individual goals and measures. This ensures that each employee has the relevant resources, current policies and procedures to support the acquisition of goals and sharing of results. Hence the performance management information can subsequently be utilised to effect positive change in the culture and practices of the organisation in order to achieve the shared targets (Becker, Huselid & Ulrich, 2001; Gerber et al., 1999; Van der Linde, 2005).

According to Pickett (2000, p. 228), performance management, in its broadest context, is a "managerial process that links strategic planning, performance standards, individual objectives, performance evaluation, training and individual development". Underlying this definition is the assumption that if the performance management of an organisation includes elements of control, feedback and improved communication, optimised business performance will ultimately result.

In order for performance management to be effective, each organisation should have a framework in place to provide guidance. The performance management system (PMS) as a framework will be discussed in the section below.

3.4.1 The performance management system (PMS)

Various authors use different terms to describe the performance management process, but generally they concur that there are four stages: planning, monitoring (through coaching), review and reward (see Armstrong, 1996; Cascio, 1998; Fink & Longenecker, 1998; Landy & Farr, 1983; Spangenberg, 1994). In order to be effective, performance needs to be monitored across all facets of the organisation, from the broadest (organisation-wide) view right through to the individual view. The PMS in place should be able to support this. According to Tangen (2004) a PMS should do the following:

- Support strategic objectives. A PMS should be derived from the overall organisational objectives and strategies. As these change, the PMS should respond accordingly.
- Have an appropriate balance. Performance should be viewed from various perspectives, not only financial. Many contemporary systems include quantity, quality, cost, people and environment measures. The organisation in this research project included these five measures in their PMS.
- Guard against suboptimisation. The assertion “you get what you measure” applies here because the goals and targets that are put in place have a huge impact on the behaviour of the employees being measured. Hence the correct measurements should be put in place to ensure that employees perform optimally.
- Have a limited number of performance measures. Employees function better if their targets are focused and not diluted. It is therefore crucial for the measurement criteria to be specific and relevant to the desired outcome.
- Be easily accessible. One of the main goals of a PMS is to relay relevant and important information, and it should therefore be designed in such a way that this information is available and understood by those who require it.
- Contain performance measures that have comprehensible specifications. The purpose of the measures should be defined in such a way that the relevant

parties understand them. There should be clarity on the collection of data, the frequency of collection and the use of information. Furthermore, it is vital for each measure to be understood in terms of how to act in order to achieve the measure, the impact of not achieving target and the timeframe within which the targets should be reached.

To ensure effectiveness, there are various different theoretically based approaches to performance management. A discussion of some of the most commonly used approaches follows.

3.5 DIFFERENT APPROACHES TO JOB PERFORMANCE MANAGEMENT

Job performance is influenced by, and in turn influences, many factors apart from only the actual work performed. In understanding job performance, it is crucial to grasp the interdependency of these factors. Many of the various approaches to performance management take cognisance of all the factors involved, and a discussion of five well known approaches follows.

3.5.1 The systems approach to job performance management

According to Spangenberg (1994), the importance of the systems approach to performance management cannot be overemphasised. The aim of this approach is to describe performance management in its entirety, including the relationships between the various elements. The systems approach makes provision for those factors that can make or break the system. Figure 3.3 illustrates the systems approach to performance management.

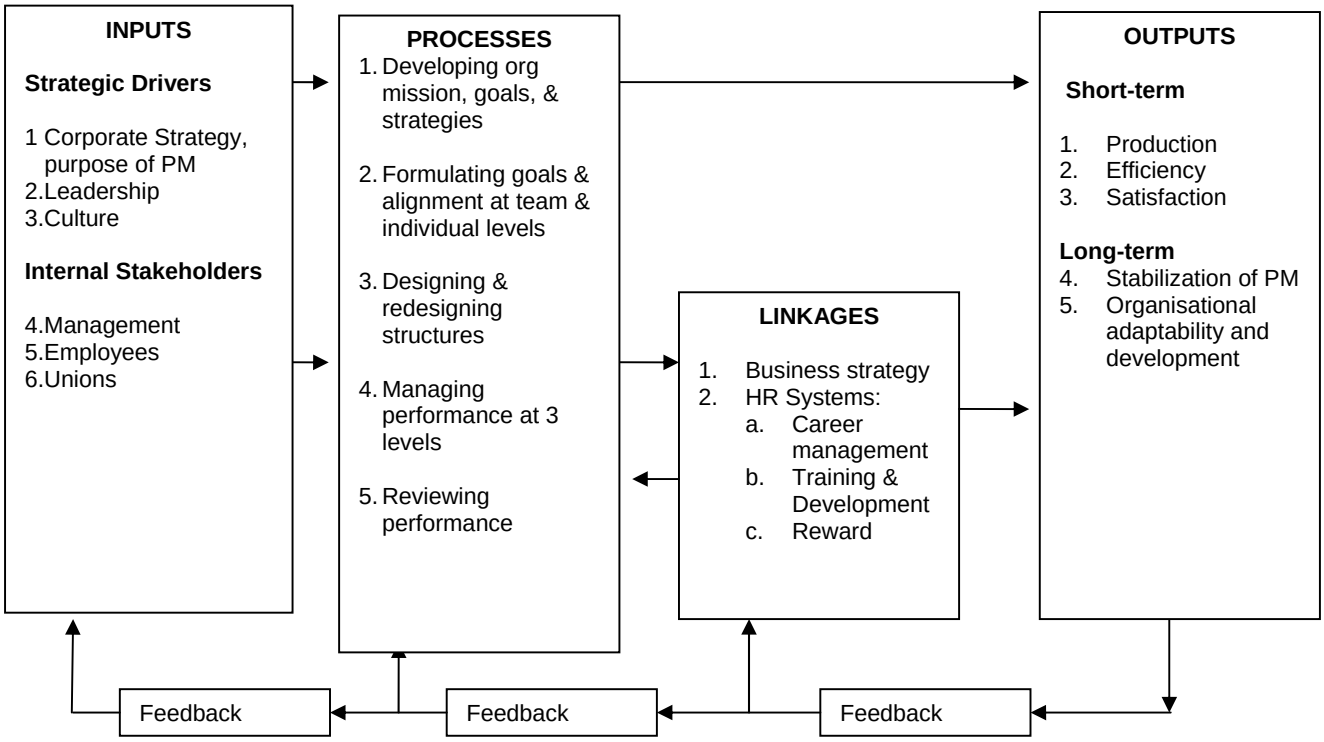

Figure 3.3.

The systems approach to performance management **Source:** Spangenberg (1994, p. 39).

This approach is comprehensive and illustrates the many elements that influence the implementation and effectiveness of a PMS. It takes into account all the possible areas which, if not designed accurately, may cause the system to fail, and emphasises that it is crucial to consider not only financial results when assessing performance (Spangenberg, 1994).

3.5.2 Sink and Tuttle's approach to job performance management

According to Sink and Tuttle (Tangen, 2004; Van der Linde, 2005), organisational performance is a complex interrelationship between seven performance criteria. These criteria are as follows:

(1) Effectiveness involves "doing the right things, at the right times, with the right quality", and is expressed as a ratio of actual versus expected output.

(2) Efficiency involves “doing things right” and is expressed as a ratio of expected resources consumed versus actual resources consumed.

(3) Quality is measured at six checkpoints in order to make an extremely broad concept more tangible.

(4) Productivity is expressed as the ratio of output versus input.

(5) Quality of work life is essential to ensure the success of the system.

(6) Innovation is an element that is crucial for sustainable performance and improvement.

(7) Profitability is the goal of any organisation.

The seven elements are important in any organisation. However, according to Tangen (2004), there are several limitations to this approach, including the lack of attention to the need for flexibility and consideration of the customers’ perspective. Figure 3.4 illustrates Sink and Tuttle’s approach.

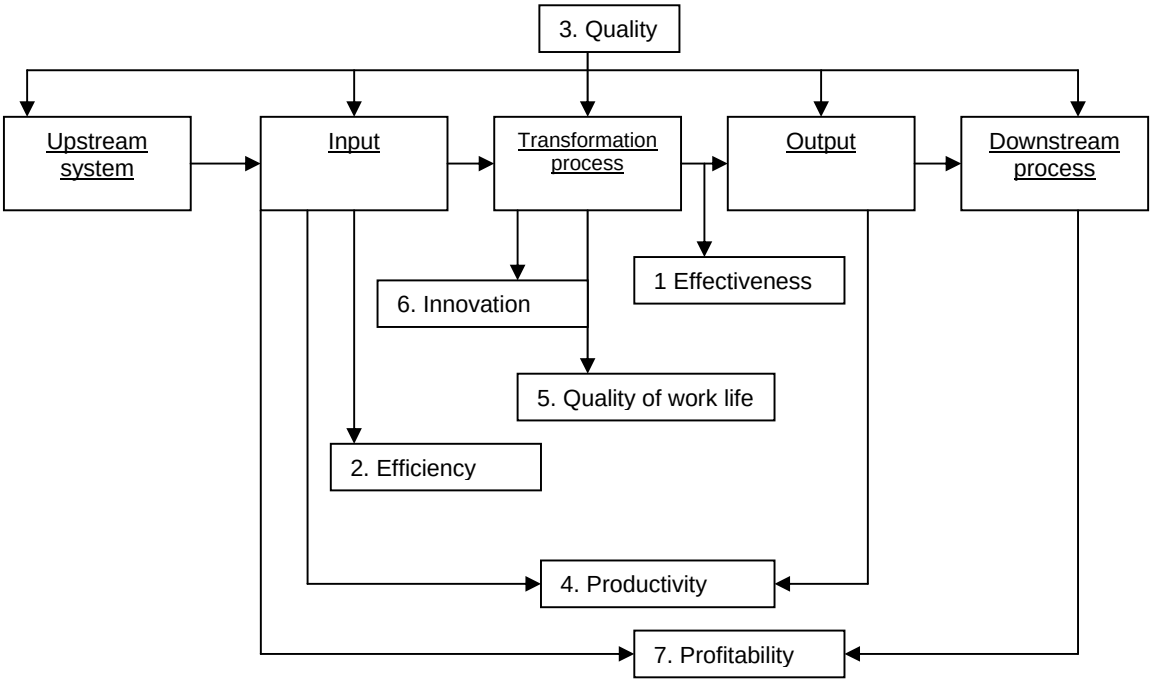

Figure 3.4

*Sink and Tuttle’s approach to job performance management***. Source**: Tangen (2004, p. 730)

3.5.3 The balanced scorecard approach to job performance management

The balanced scorecard framework was developed by Kaplan and Norton (Becker et al., 2001; Maylor, 2003). This framework incorporates measures that describe an actual value-creation process instead of focusing on only the financial results. This approach suggests that organisations should utilise a balanced set of measures that allows a succinct view of the business. A key feature of the balanced scorecard is that it is tailored to what employees can control (Chase, Aquilano & Jacobs, 2001). These measures should stem from four perspectives and provide answers to the following questions (Tangen, 2004):

- Financial perspective: How do we look to our shareholders?
- Internal business perspective: What must we excel at?
- Customer perspective: How do our customers see us?
- Innovation and learning perspective: How can we continue to improve and create value?

The balanced scorecard approach limits the number of measures and therefore provides a focused view of critical areas, thereby limiting information overload (Becker et al., 2001). According to Tangen (2004), it compels managers to consider all four perspectives, and not only focus on one. The main limitation to this approach is that it has been designed for use by managers and does not prove useful to the organisation's lowest level employee. It has also been criticised because it has been designed to monitor and control, rather than to be used as an improvement tool. Also, it does not provide sufficient guidelines on how to identify, introduce and ultimately use measures to manage the business (Tangen, 2004).

3.5.4 The performance pyramid of job performance management

Cross and Lynch (in Tangen, 2004) proposed an approach that clearly links the performance measures at the various hierarchical company levels to ensure that each facility in the organisation works towards the same ultimate goal.

This approach is also referred to as the SMART system. According to Tangen (2004), it translates the organisation's objectives from the top down, and then measures them from the bottom up to ensure that all targets are met, culminating in the eventual satisfaction of the overall business plan.

Four levels of objectives that address external effectiveness and internal efficiency are included and illustrated in figure 3.5 below. The organisation's vision is at the first level, and is then translated into relevant objectives for each of the levels below. Each level is essential, and the targets build up from the day-to-day measurement (at the lowest level) to the longer time-span measurement (at the higher levels).

According to Tangen (2004), the strength of the model lies in the integration of the vision with the lowest operational objective. The chief limitation, however, is the failure to include any mechanism, neither to identify key performance indicators nor to integrate the concept of continuous business improvement.

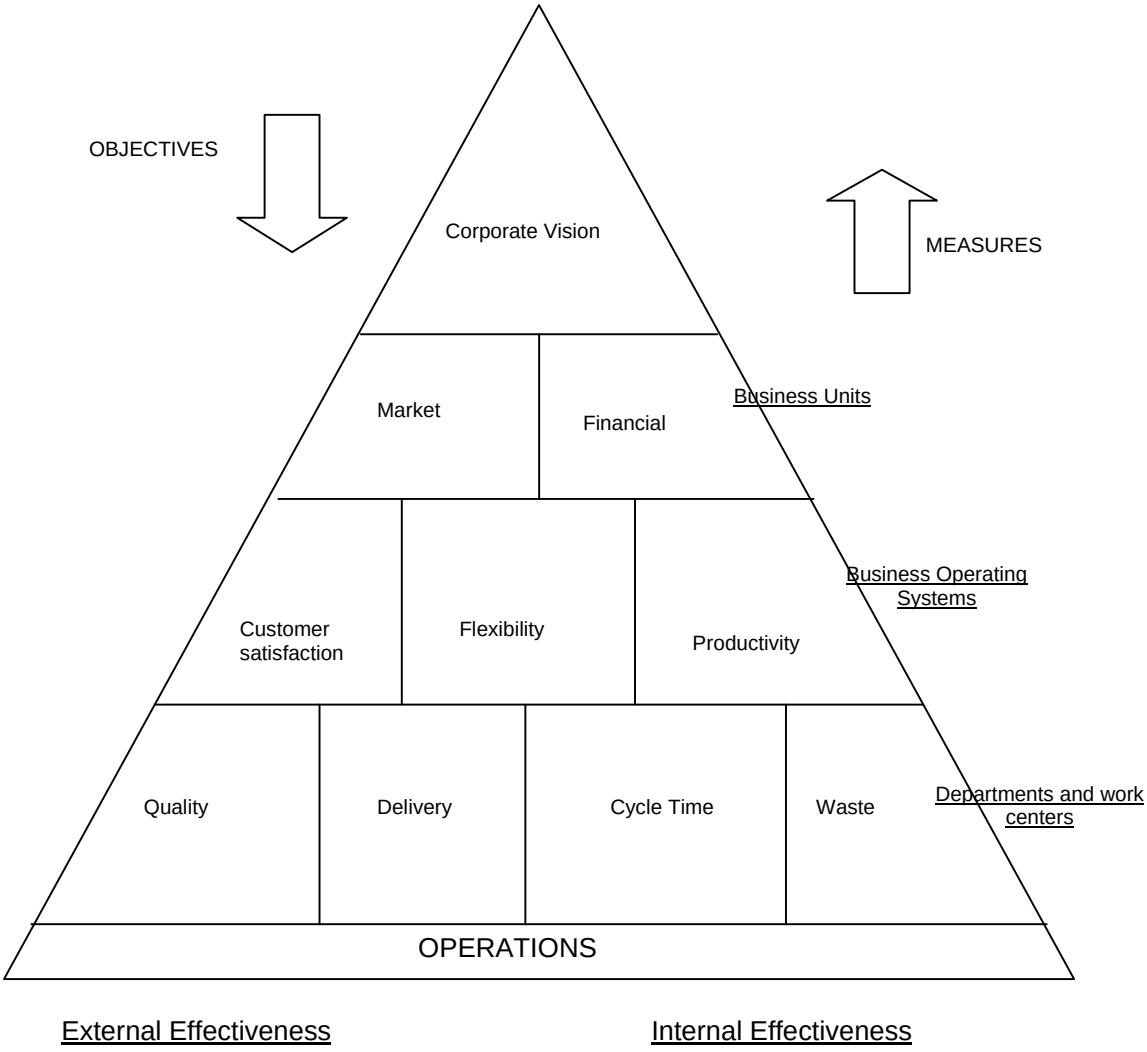

Figure 3.5:

The performance pyramid approach to job performance management. **Source:** Tangen (2004, p. 733)

3.5.5 Medori and Steeple's approach to job performance management

According to Tangen (2004), Medori and Steeple's approach consists of six detailed stages (illustrated in fig. 3.6) and is an integrated framework for auditing and enhancing performance management systems. A description of the stages follows:

- Stage 1 involves the definition of the organisation's strategy and success factors.
- Stage 2 involves matching the strategic requirements with six defined priorities (quality, cost, flexibility, time, delivery and future growth).
- Stage 3 involves selecting suitable measures through the use of checklists.

- Stage 4 involves an audit of the existing measures in order to ascertain which, if any, should be transferred to the new PMS.
- Stage 5 involves the implementation of the new measures, where each measure is described in terms of title, objective, benchmark, equation, frequency, data source, responsibility and improvement.
- Stage 6: involves the periodic review of the organisation's PMS.

A strong advantage of this approach is that it can be designed as a new PMS or to exploit an existing system, and also contains descriptions of how measures should be identified and realised. According to Tangen (2004), a limitation of this approach is that little guidance is given on how the performance measurements grid is created, as well as the fact that only six priorities are used in the construction of the grid. There are many other categories into which measures can be divided.

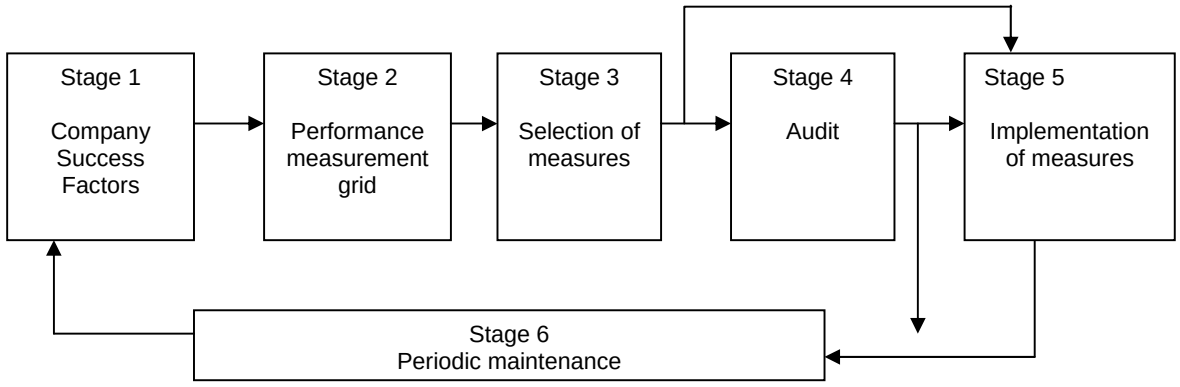

Figure 3.6

Medori and Steeple's approach to job performance management. **Source**: Tangen (2004, p. 735)

Since the various approaches to performance management have been presented and discussed, it is necessary to now explore how job performance is managed in the research organisation. This will be discussed in the next section.

3.6 PERFORMANCE MANAGEMENT IN THE RESEARCH ORGANISATION

The organisation, of which the research plant forms part of, prides itself on its overall performance in meeting various targets set internally as well as economic, legislative and social targets. The performance targets for each of the subsidiary plants and mines are aligned with the overall organisational business plan, which is driven by shareholder expectations.

The research organisation is a precious metal refining plant. The plant was designed as a continuous operation (24-hour per day, 7 days per week, and 365 days per year) and runs on a four-shift cycle. To cover all the operational needs, the employees are divided into two groups, namely those who work on a rotating shift cycle (shift workers) and those who permanently work during the day (day shift workers). Since the shifts are interdependent to produce outputs, it is difficult to choose measures for which individuals are solely responsible. The complexity, and sheer number (there are over 800 processes involved) of the various processes at the plant, which are used to ultimately refine the different precious metals and produce them in their relevant end states, does not lend itself to defining ownership and accountability per shift or per individual. In addition, these refining processes are timeous, with many of them being longer than the eight-hour shifts employees work. It is therefore complicated to ensure that the individuals have complete control over the production performance measures because the various processes disallow one shift to be held primarily accountable for the end state of the batches of material the employees treat.

However, the organisation's performance is managed by aligning the various sections, departments and business units with the overall corporate vision. It would therefore appear that the research organisation subscribes to a pyramid approach to performance management (discussed in sec. 3.5.4).

Much research has been done in the domain of job performance and the measurement and management thereof. Regardless of which approach is followed in designing, maintaining and improving the organisational PMS, the pivotal action is to choose relevant measurement criteria correctly, for which employees can be held accountable. Owing to the difficulties mentioned above in defining the employees' accountability, in the context of this study, the job performance criterion for this study has been defined, taking job knowledge and tenure into account. Job knowledge is measured objectively by the number of standardised examinations the employees have passed. At the research organisation, a pass on the job knowledge examination will involve progression along the formalised career development path (CDP) and will result in a promotion (CDP is discussed further in ch. 4, sec. 4.4.2).

3.7 CHAPTER SUMMARY

This chapter provided a description of the concept of job performance. A literature review of job performance was presented, and the importance of accurate job performance measurement was described. Attention was focussed on the classification of judgmental and nonjudgmental measurement criteria, and the various approaches to the management of performance were discussed. The following chapter focuses on the empirical study.

CHAPTER 4
EMPIRICAL STUDY

4.1 INTRODUCTION

In chapter 2, learning potential was discussed as a measurement construct relevant to this research project while in chapter 3, job performance was critically reviewed from a theoretical perspective. In this chapter, the operationalisation of the research is discussed, including an explanation of the process and methodology followed. This includes a description of the population and sample, the research methodology, including the evaluation of the feasibility of the study, the measuring instruments utilised for learning potential and job performance constructs, the strategies employed to ensure the reliability and validity of the study, data gathering and data-processing approaches, the level of significance utilised and the formulation of a hypothesis. An overview of the research design is attached in appendix 1.

This research project can be described as a criterion validation study. As mentioned in chapter 2, this type of study calculates the correlation coefficient between variables (Graham & Lilly, 1984; Wolffaardt & Roodt, 2005), in this case learning potential and job performance. The correlation approach has proven useful because with knowledge of only one variable, the prediction of the effect on the dependent variables should be possible (Christensen, 1997).

4.2 POPULATION AND SAMPLE

The sample of this research study consisted of 135 employees. At the time these employees were employed in a full-time capacity, in a precious metal refinery, which is a subsidiary of a large mining house. As with most companies, the mining house places a high premium on the development of its people and as a standard, the organisation expects each of its subsidiary plants to have formalised its employee development through human resource policies.

At the refinery where the sample was drawn, the human resource department has formalised departmental progressional routes for each area in the plant, affording employees the opportunity to progress through the ranks of the hierarchal structures at their own pace. Participation in the relevant departmental progressional route is voluntary, and for various personal reasons, not all employees choose to participate. These progressional routes will be described in greater detail in section 4.4.2.

For this research project, the candidates' data in the Engineering, Production and Laboratory Departments were utilised for comparison. The Human Resource, Safety and Finance Departments were excluded from this study because the progressional routes were not considered to be as discrete as those for the technical departments. Copies of the progressional routes per department are provided in appendices 2 to 4.

At the refinery, the population consisted of 479 technical employees, representing the entire technical workforce of the research organisation. These departments remain male dominated, probably as a result of the physically challenging nature of the work. In the mining industry, several initiatives have been identified to better represent the demographics of the communities in which the various mines are developed.

The sample of 135 employees was not distributed throughout all the mining and refining plants, but selected only from the technical departments (i.e. Production, Engineering and Laboratory) at the precious metal refinery in the North West Province (see tab. 4.1). This can be classified as a sample of convenience rather than a random sample (see Christensen, 1997; Cooper & Schindler, 2001).

Table 4.1:
Research Sample

Sample Size	Gender	Department	Type of Sampling
n=135	Male, n=129 Female, n=6	Production, n=41 Engineering, n=72 Laboratory, n=22	Convenience

The sample will be described in more detail in section 5.2.1.

4.3 RESEARCH METHOD

With regard to the methodology followed in this research project, the evaluation of the feasibility of the study, the rationale for the utilisation of the measuring instruments, the strategies to ensure reliability and validity, and the way in which the data were gathered, are presented in the sections that follow.

4.3.1 The evaluation of the feasibility of the study

According to the Society of Industrial and Organisational Psychology in South Africa (SIOPSA) (2005), four considerations should be taken into account when conducting a criterion-related validity study in order to evaluate the feasibility of the study. These considerations are the stability of the job measured, the evaluation of the criterion, the representativeness of the sample and the statistical power of the study.

4.3.1.1 Job stability

SIOPSA (2005, p. 12) refers to the fact that the job under scrutiny must be “reasonably stable”. In this research study, the departmental career development paths were scrutinised. These formalised career paths had been part of the organisation‘s human resource development plan since 1991 (Van der Merwe, 2004). These paths have therefore been stable for the past 16 years.

4.3.1.2 Evaluation of criteria

The criterion should be relevant, reliable and uncontaminated (SIOPSA, 2005). The criterion in this study is the promotion ratio (see sec’s 1.7.2.2 & 4.3.2.2). The promotion ratio is analysed and the results reported in chapter 5.

4.3.1.3 Sample representativeness

The sample should reasonably represent the larger work population. The sample drawn from the research organisation (n=135, out of a possible 479 technical employees) will not be generalised to the entire mining group as these employees were drawn from only one site in the North West Province.

4.3.1.4 Power of the study

According to SIOPSA (2005, p. 12), statistical power refers to the "probability of detecting a relationship between predictor and criterion in a sample if such a relationship exists in the population". Power is probably more easily understood as the probability of rejecting a null hypothesis when it is, in fact, false. Borenstein, Rothstein and Cohen (2001) maintain that power together with the sample size, the significance level (discussed in sec. 4.6) and the effect size of the research project form a closed system. In other words, once any three values are known, the fourth can be calculated. The aim of a power analysis is to find a balance between these factors, taking cognisance of the resources available and the purpose of the research. The power of a study increases as sample size (n) increases, as alpha (significance) increases and as the magnitude of the effect in the population (effect size) increases (Cascio, 1998).

According to Wilcox (2003), the higher the number of candidates in the sample pool (i.e. the bigger the sample), the higher the power of the study will be. Although effect size was not calculated, this study utilised all the candidates partaking in the progressional route in the technical departments. In other words, the maximum possible number of candidates, according to convenience sampling, was utilised for this study, thus ensuring that the sample was as large as it could possibly be. Further strategies employed to ensure reliability and validity of this study are discussed in section 4.3.3.

4.3.2 Rationale for the utilisation of the measuring instruments

4.3.2.1 Measurement of the predictor variable

When choosing the predictors for research purposes, several factors should be taken into consideration. According to the SIOPSA guidelines (2005), predictors should

- have an empirical, logical or theoretical foundation
- be valid and reliable
- be as objective as possible
- be chosen on the basis of scientific knowledge, and not on mere expedience

In this research project, learning potential was chosen as the independent variable or predictor. The LPCAT was the instrument chosen to measure learning potential for several reasons. These reasons include the intrinsic psychometric properties of the instrument (see sec. 4.4.1) and several practical purposes.

As previously stated, the research organisation forms a part of the mining industry, which is governed by several legislative requirements (see sec. 2.3.4*)*. Before recruiting externally it has become crucial for the mining industry to identify and develop talent from within the South African community, and more so, within the current workforce. In order to develop its employees, and to achieve stringent targets set by interested players, the research organisation sets out to test each employee's potential to develop periodically, rather than only at entry into the company (i.e. the recruitment stage).

According to the SIOPSA guidelines (2005), criteria should be chosen on the basis of their relevance, freedom from contamination and reliability rather than availability. Furthermore, the purpose of the validation study should be clearly stated, supportive of the organisation's needs and acceptable in the social and legal context.

The research organisation's recruitment battery included the TRAM1, TRAM2 and APIL-B for measuring learning potential. Owing to the numbers to be assessed, the company required an instrument that could be administered to a group; is standardised; has South African norms; can be administered to differing levels of education; and is relatively quick to complete. Because of the differences in properties between the TRAM1; TRAM2 and APIL-B battery; and the LPCAT (see sec. 2.5.4), the latter was chosen as the preferred method of assessing learning potential. The LPCAT was utilised in the study for the practical reason that the research organisation was using this instrument, at the time, and had the facilities to administer it (group settings with computers etc.).

Regarding the importance of having a clear reason for the validation study which supports the organisation's needs (see SIOPSA 2005), in this research project, no empirical evidence (with in-house data) existed in the research organisation that supported the use of the LPCAT for development purposes. Therefore acquiring such data became crucial for the organisation.

4.3.2.2 Measurement of the criterion variable

The dependent or criterion variable chosen for this study is job performance. Although several ratings of job performance exist in the research organisation, under scrutiny many of these measures could not be proven to be absolutely objective.

Since the criterion needs to be relevant and free of contamination, an objective and reliable method of measuring job performance was sought. In this research organisation, it is possible to perform well in the various sections and be promoted by passing objective written technical examinations, based on the knowledge of the plant. It was initially thought to use the number of promotions as a guideline on job performance; because the promotions are not vacancy driven (i.e. employees need not apply for promotions only once they become available).

This means that employees may be promoted as often as they succeed in the requirements for the various sections, as stipulated in the relevant department's career development path (see sec. 4.4.2). However, on closer investigation, the employees' tenure was identified as a moderator variable. In order to eradicate this contamination of the variable and to normalise the effects of years of service on the number of promotions, it was decided to convert the measure of job performance into a ratio. This ratio of the number of promotions, divided by years of service, is subsequently known as "promotion ratio" and is used as the measure of job performance in this study.

4.3.2.3 Measurement of the moderator variables

It has become common in applied practice to investigate the effects of biological variables such as race, gender and age because these may have a moderating effect on the relationship between the criterion and the predictor (Cascio, 1998). In this study, all the biological data were scrutinised as moderator variables.

4.3.3 Strategies employed to ensure the reliability and validity of the study

According to Mouton and Marais (1992), various factors can influence data integrity. These include the researchers, the participants, the measuring instruments and the research context. During the study cognisance was taken of these influences and an attempt made to address them.

4.3.3.1 Researcher influence

The researcher influence was minimised by the researcher acting in accordance with ethical guidelines on research (see Christensen, 1997; Psychological Society of South Africa (PSySSA), 1996; The SA Board of Psychology's Ethical Code of Professional Conduct, 2006). In this regard, the purpose and benefits of the project were communicated to all parties involved. Permission to perform the study was received in writing from the research organisation and was disclosed to the candidates.

Confidentiality was maintained at all times, the integrity of the candidates and the data was respected and the research executed for the intended purpose. The research results are presented and discussed in chapter 5.

4.3.3.2 Participant influence

Roughly four years ago, the research organisation made a policy decision to assess all employees to ascertain their learning potential in order to accurately identify developmental needs. This decision was made in an effort to maintain mining rights by adhering to relevant government targets (as discussed secs 1.2 & 2.3.4). Although the policy decision resulted in all employees being required to undergo an LPCAT assessment, all the sampled employees were informed of the research project and requested to complete their assessment to the best of their ability. The sample was drawn from all the employees, who were part of the CDP programme and had valid LPCAT results. Assessments were scheduled and performed on those employees with outstanding results. To facilitate the audit process, each step of the study was documented. The confidentiality of the candidates and integrity of the process were maintained at all times. The informed consent of each candidate and the research organisation was gained in order to ensure validity (cf. Christensen, 1997; Cooper & Schindler, 2001; Mouton & Marais, 1991). This was done to minimise the participant influence.

4.3.3.3 Measurement instrument influence

The measurement instrument influences for the predictor variable were controlled by investigating the LPCAT for reliability and validity. The suitability of this instrument is enhanced because it reports evidence confirming it to be culture fair (De Beer, 2000a; 2000b; 2000c). The properties of the LPCAT are reported in section 4.4.1. The measurement process was evaluated for fairness and objectivity.

The criterion variable measurement influence was minimised by normalising the job performance measurement into a ratio. As noted previously, the ratio encompasses the number of promotions over years of experience. The number of promotions can be viewed as objective because the promotion is in no way influenced by subjectivity of any third party. The denominator of the ratio (i.e. years of service) is a measure of the entire tenure of each employee and negates any sundry influences such as absences due to illnesses, leave, and so forth.

4.3.3.4 The research context

As far as contextual influences are concerned, comprehensive biographical data were collected in an attempt to identify any moderator variables

4.3.4 Data gathering

The data were gathered in three phases:

(1) data on the independent or predictor variable, that is, learning potential data
(2) data on the dependent or criterion variable, that is, job performance data
(3) biographical data

4.3.4.1 Learning potential data

The LPCAT scores were available from the research organisation's registered psychometrist, for research purposes. The LPCAT scores were recorded as a result of a company decision to assess all employees' for developmental purposes. The assessments took place over a year, on the company premises, and in accordance with the company's psychometric assessment policy and procedures.

4.3.4.2 Job performance data

The sample data were drawn from the Human Resource Department's records on which technical employees were enrolled in the Career Development Path (CDP) Programme. The sample's job performance data, which measured the number of promotions after the date of engagement and years of service were gathered from the Employee Benefits Department (the custodians of SAP (R4) HR) in the form of spreadsheets. This information was audited and verified by the Human Resource Department (the custodians of the CDP information).

4.3.4.3 Biographical data

To facilitate data manipulation, the biographical data of the sample were made available from the Employee Benefits Department, through the SAP (R4) HR Module and downloaded into Excel spreadsheets.

Three instruments were used to gather data. Each of these will be discussed separately in the following section below.

4.4 MEASURING INSTRUMENTS

The predictor variable was measured by the LPCAT and the criterion variable by the promotion ratio, for which the Career Development Path (CDP) was utilised to collect data. The biographical database was utilised to obtain information on the moderator variables.

4.4.1 The LPCAT

The LPCAT is an instrument developed to measure the learning potential of candidates, within the ambit of general nonverbal reasoning ability (De Beer, 2000c).

4.4.1.1 Main features of the LPCAT

This instrument is intended to balance diverse differences in backgrounds, in the multicultural South African context, and consists only of nonverbal figural items.

The LPCAT uses the test-train-retest format of dynamic testing (dynamic testing is discussed in ch. 2 and the various formats thereof in sec. 2.4.2 & 2.4.3). This approach allows for a period of learning, and the instrument also permits the measurement of current performance and of evaluating learning that has occurred. An indication of learning potential can then be measured. The psychometric approach to dynamic assessment of learning potential was utilised when the LPCAT was developed and the focus placed on the standardisation of the procedures and properties of the instrument (De Beer, 2000c). The various approaches to assessment are discussed in section 2.3.5 in chapter 2.

The LPCAT is based on the philosophy of dynamic testing, which was founded in Vygotsky's ZPD (discussed in sec. 2.4.3.2). The ZPD refers to the difference between two levels of performance, namely the current and the potential levels. By focusing on the potential and not isolating the actual, the disadvantages of background are levelled (De Beer, 2000c). Within this school of thought, a larger ZPD indicates a probable increase in future performance, whereas a smaller ZPD may be an indication that the candidate will probably continue to function close to or at the current level of performance (De Beer, 2000c).

The LPCAT is highly standardised and item response theory (IRT) and computerised adaptive testing (CAT) were used to construct the instrument, which go a long way in eradicating measurement problems. IRT-based scoring allows for accurate detection of the difference between the pre- and post-test scores. In CAT, items are selected from an item bank, which has been precalibrated, to constantly match the candidates' estimated level of ability (De Beer, 2000c).

The LPCAT is standardised and culture fair, and has proven to be valid and reliable (see De Beer, 2000a; 2000b; 2000c)

4.4.1.2 Culture fairness of the LPCAT

When developing the LPCAT, it was imperative to ensure that the test was as culture fair as possible. To achieve this, the following factors were considered: language, prior school education; the dynamic nature of the test; nonverbal versus verbal items; IRT-based items; and power-versus timed testing (De Beer, 2004).

Language was omitted in the development of the test in order to concentrate on testing level of ability and not language proficiency. Also, the instructions are available in all 11 official South African languages (De Beer, 2004). Content relating to prior school learning (e.g. mathematics items, number series, language, etc.) was excluded from the assessments (De Beer, 2004)

Dynamic assessment was utilised to allow the candidates to display current and potential future levels of performance, with the test-train-retest method of assessment (De Beer, 2004). This approach focuses on fluid intelligence rather than crystallised abilities (cognitive ability is discussed in ch. 2). The items in the assessment are figural nonverbal material that taps into generic reasoning skills, while minimising the effect of prior learning and language proficiency (De Beer, 2004).

IRT-based item analysis was based on information obtained from over 2 000 candidates when developing the LPCAT. This analysis scrutinised data for possible bias favouring any subgroup. Any item found to exceed a preset level in terms of bias was discarded from the item bank (De Beer, 2004). No overall time limit is set for the overall testing time, which affords candidates the opportunity to attempt each item presented to them. The only time limit is that the item only appears on the computer screen for a maximum of three minutes.

Should this item not be answered within three minutes, it is removed and replaced with another (easier) item, assuming a lack of response as an indication that the item was too difficult (De Beer, 2004).

4.4.1.3 Reliability and validity of the LPCAT

As reported in chapter 2, reliability is concerned with the accuracy of measurement and how consistently the instrument will measure on different occasions. A summary of the internal consistency reliability values (alpha coefficient) for the different groups of the standardisation sample, for two forms of the instrument is provided in table 4.2 (as cited in De Beer, 2004, p. 11).

Table 4.2:
Reliability data for LPCAT

	Form A		Form B	
Group	n	alpha	n	alpha
Total Group	1277	0.981	1173	0.987
African	639	0.975	554	0.971
Coloured	303	0.969	296	0.970
White	335	0.925	323	0.926
Male	636	0.975	589	0.979
Female	640	0.980	584	0.978

Validity, as discussed in chapter 2, refers to the extent to which the instrument measures what it has been designed to measure. The construct and predictive validity data are summarised in table 4.3 for the five sample groups representing varying ability and education levels (as cited in De Beer, 2004, p. 12).

Table 4.3:
Validity data for LPCAT

Description of group	Construct validity using LCPAT pre-test, post-test and composite scores	Predictive validity
Group 1 : Technikon first year students (n=92)	Compared to the GSAT, correlations from 0.533-0.713, with verbal & non-verbal & total scores (all correlations highly significant i.e. p<0.01)	Statiscally significant correlation of r=0.230 for LPCAT post-test and first-year average. Correlations of LPCAT with grade 12 results from 0.207 – 0.450 and all highly significant
Groups 2: First year Technikon students (n=223)	Compared to the GSAT, 0.563 – 0.645, (all correlations highly significant i.e. p<0.01)	R=0.158 – 0.213 with first-year average (pre-test and composite score correlations with average significant)

Group 3: Grade 9 pupils (n=37)	Not available	Correlations with term results from 0.550 – 0.659 (all highly significant i.e. p<0.01)
Group 4: Adult learners (n=194)	Correlations with PPG verbal, non-verbal and total scores ranged from 0.400 – 0.645 with all correlations highly significant (p<0.01)	Correlations with ABET literacy and numberacy results ranged from 0.398 – 0.492 with all correlations highly significant (p<0.01)
Group 5: Grade 8 pupils (n=144)	Corrleations with GSAT ranged from 0.567 – 0.691 with all highly significant (p<0.01)	Correlations with school term results from 0.439 – 0.543 – all highly significant (p<0.01)

4.4.1.4 Measuring learning potential with the LPCAT

The LPCAT measures the difficulty of the items chosen and the candidate's ability level, allowing for interactive selection of items during the test administration. The scores are reported in terms of T-scores, stanines and percentiles (De Beer, 2000c). There are four different scores, namely:

(1) the pre-test score (T-score, percentile score and stanine)
(2) the post-test score (T-score, percentile score and stanine)
(3) the difference score (T-score)
(4) the composite score

The pre-test score is a representation of the actual level of performance at which the candidate is currently performing, whereas the post-test score is a representation of the future or potential performance level. The difference between these two scores represents the ZPD. According to De Beer (2000c), the composite score (which is the indication of learning potential) is a combination of the pre-test performance level and a proportional credit for the ZPD (depending on the level of performance). The four scores allow for an interpretation of potential that has not yet been possible with the conventional assessments.

4.4.1.5 The LPCAT for the purpose of this research

The complete set of LPCAT scores (raw and interpreted) was available to the researcher for analysis.

The LPCAT assessments were administered over a period of a year by a trained psychometrist and test administrator licensed to utilise the instrument within the research organisation (see HPCSA guidelines for professional conduct; PSySSA ethical code; LPCAT user manual; in house psychometric assessment policy and procedure). The learning potential composite score interpretation scale is provided in table 4.4.

Table 4.4:

The LPCAT Composite score interpretation

Composite Score	Interpretation in terms of learning potential
<34	Low
35 to 43	Below average
44 to 48	Low average
49 to 53	Average
54 to 58	High average
59 to 69	Above average
70 to 81	High

The composite score as indicated above was utilised as the measure for learning potential, and the results pertaining to it are reported in chapter 5.

4.4.2 Career Development Paths (CDPs)

The research organisation has approximately 600 employees in the refining plant, fulfilling various roles required to ensure that the business plan is met. The work is organised into departments, with the achievement of plans in mind as well as how to best utilise the workforce. These departments fulfil various roles in the organisation. The departments in which technical skills are required (Laboratory, Production and Engineering) are separated from those in which more people-oriented skills are required (Human Resources, Administration, Finance and Safety).

As discussed in chapter 3, job knowledge is a nonjudgmental measurement criterion for job performance. The research organisation's measurement of job knowledge is formalised in each department, but more discretely in the technical departments.

The technical nature of the job lends itself to setting and evaluating the skills required, more so than in the “softer” skills departments, in which it is more difficult to quantify and evaluate practical skills. Hence in this limited scope research project, the evaluations for the nontechnical departments were excluded because they are not as formalised as those for the technical departments.

In the technical arena, each department has documented and accepted developmental paths for its employees, known as Career Development Paths (CDPs). These are easily described as a route of courses and examinations to follow in order to be promoted in the hierarchal structure. These specified requirements are set out in fine detail in the CDPs (the Production, Engineering & Laboratory Progressional routes are attached as appendices 2, 3 & 4 respectively). The Engineering Department has detailed its paths per artisan position and appendix 3 is an example of one of the artisan routes. Owing to the non-technical nature of the work the Human Resources, Safety and Finance Departments cannot formalise their progression to these discrete lengths.

The CDPs are formalised for the junior (up to Patterson B7) and senior level (Patterson C-level up to Patterson D1) staff. The D2 Patterson grade is viewed as management and the CDPs will not formalise a path through the management ranks because these positions are generally vacancy driven. These CDPs enable employees to develop their careers at their own pace by acquiring job knowledge of the various sections of the refining plant.

Success in the job knowledge examinations results in the employees being promoted through the ranks. Without the successful completion of the relevant examinations, promotions (up to a certain level) are not possible. In this progressional route approach, employees can drive their own careers (up to a certain level), and the progress that has been made in accordance with these CDPs is a point of discussion with each employee at the annual career development panel, also viewed as performance review.

For the purpose of this study, job performance is measured by the number of promotions received as a direct result of success in job knowledge examinations. This ratio was termed the “promotion ratio” (see sec. 4.3.2.2).

4.4.3 Biographical Data

The SAP (Revision 4) HR Module is the relevant section of the operating system that houses the biographical data. This was accessed to report and download all relevant biographical data for the study.
The information extracted was length of service, date of engagement, age, employment history (including number of promotions) since date of engagement, gender and race.

4.5 DATA PROCESSING

The data analyses were done using descriptive statistics, correlations, regression, t-tests and analyses of variance. These methods will be discussed in the sections below.

4.5.1 Statistical data processing program

The LPCAT, job performance and biographical information were analysed using the STATISTICA program. Some of the tests utilised (t-test, sign test & factor analysis) were analysed using EXCEL in the Windows package.

4.5.2 Descriptive statistics

Descriptive statistics of the sample, the predictor variable (learning potential), the criterion variable (job performance) and the moderator variables were obtained in order to better understand their nature. These statistics seek only to describe the data and are reported in terms of the minimum and maximum values, means, standard deviations, skewness and kurtosis.

The descriptive statistics are reported in section 5.2.2.

4.5.3 Correlations

Correlation consists of measuring two variables and determining the strength and direction of the relationship that may exist between them (Cascio, 1998; Christensen, 1997). The correlation coefficient (denoted as *r*) is a measure of this relationship and varies between 1 and -1. The direction of the relationship is denoted by the positive or negative sign and the strength of the relationship by the numerical following the sign. If *r* is close to 1, it is an indication of a strong positive relationship existing between the two variables (e.g. if variable x increases, variable y will also increase). If *r* is close to -1, it is an indication of a strong negative relationship between the two variables, (e.g. if x increases, y will decrease). Should *r* be zero, it indicates that no linear relationship exists between the variables.

The results of the correlations are reported in section 5.2.3.2.

4.5.4 Analysis of variance

In this research study, the data are termed ordinal data and thus have order (e.g. low, below average, average, etc.) (Christensen, 1997). In order to evaluate the relationship between the two variables, analysis of variables (ANOVA) was utilised. For the purpose of extrapolating whether or not a relationship exists between the independent variable (learning potential) and the dependent variable (job performance), the means of the following data combinations were analysed:

- the various learning potential scores among and between each other (post-test, pre-test and composite test scores)
- the promotional ratio analysed in relation to race, gender, grade, pre-test, post-test and LPCAT composite score

The results of the ANOVA's are reported in section 5.2.3.4.

4.5.5 Regression analysis

Correlation is useful when assessing the strength and direction of the relationship between variables. However, in isolation, correlation does not allow for the prediction of the outcome of the dependent variable when the values of the independent variable are known. This prediction can be accomplished through regression analysis (Cascio, 1998).

The results of the regression analysis are reported in section 5.2.3.3.

4.5.6 T-test

A t-test is utilised to analyse the data obtained from two different groups in order to scrutinise whether the group mean difference score is so large that it cannot reasonably be the result of chance (Christensen, 1997). The t-test was used to investigate the mean difference scores of the white and other subgroups regarding age and composite score.

The results of the t-test are reported in section 5.2.3.5

4.6 LEVEL OF STATISTICAL SIGNIFICANCE

In testing the null hypothesis, two types of errors can be made. These are rejecting the null hypothesis when it should be accepted (type-1 error) and accepting the null hypothesis when it should be rejected (type-2 error).

According to Spiegel (1988), the only way to reduce both types of error is to increase the sample size. The power and sample size of this research project are discussed in section 4.3.1.4.

In testing a hypothesis, the maximum probability with which the researcher is prepared to risk a type-1 error is referred to as the level of significance (Spiegel, 1988). Conventionally, most researchers use levels of significance of 0.05 and 0.01. A 0.05 level of significance was chosen for this research project.

4.7 HYPOTHESES

For this research project, the following two hypotheses were formulated:

H0: There is no statistically significant relationship between the learning potential and job performance of technical employees

H1: There is a statistically significant relationship between the learning potential and job performance of technical employees.

4.8 REPORTING OF RESULTS

In chapter 5, the results are presented in various formats for interpretation purposes. The results are summarised, discussed and interpreted, and then used to identify limitations and make recommendations (see ch 6).

4.9 CHAPTER SUMMARY

In this chapter the empirical study was explained by highlighting the sample constitution, the measurement instruments used and the methods used to minimise external moderating influences. Data processing was discussed and the hypothesis and null hypothesis formulated. The results of the research study will be discussed in the next chapter.

CHAPTER 5
RESULTS AND DISCUSSION

5.1 INTRODUCTION

In this chapter, the research results are presented and discussed. The research sample is described in relation to the population, and in terms of gender, race, age, job level and department in the organisation. The descriptive statistics of the sample (regarding the pre- and post-test, as well as the promotion ratio) are documented in terms of the mean and standard deviation. The analyses results are presented and discussed, and the chapter concludes with a summary.

5.2 RESEARCH FINDINGS

5.2.1 Biographical profile of the research sample

In order to comprehensively describe the sample (n=135), analyses in terms of frequencies and percentages were performed in terms of gender, race, age, level as denoted by a Patterson grade and department in the organisation. See table 5.1 below.

Table 5.1
Biographical details of the research sample

Variable	N	Percentage (%)
Population		Of population
Total population	479	100
Total sample	135	28.18
		Of sample
Gender		
Male	129	95.56
Female	6	4.44
Total	135	100.00
Race		
White	60	44.44
African	73	54.07
Coloured	2	1.48
Total	135	100.00

Age		
29-29	27	20.00
30-39	61	45.19
40-49	36	26.67
50-59	10	7.41
60+	1	0.74
Total	135	100.00
Job Level		
B2	5	3.70
B3	2	1.48
B4	12	8.89
B5	3	2.22
B6	21	15.56
B7	30	22.22
C2	8	5.93
C2AR	38	28.15
C2CH	3	2.22
C5	8	5.93
D1	3	2.22
D2	2	1.48
Total	135	100.00
Department		
Production	41	30.37
Engineering	72	53.33
Laboratory	22	16.30
Total	135	100.00

5.2.1.1 Total population

The research organisation is divided into various departments mainly described by two fields, namely those requiring technical skills and those requiring what have become known as the “softer” skills used in the non-technical departments. These departments (Human Resources, Finance & Administration, Stores etc.) were not included in the scope of this project because of the lack of formalized career progressional routes.

The technical departments (Production, Laboratory and Engineering) were utilised in this project because of their discrete career routes. At the time of the study, there were 479 employees in the technical departments of the research organisation.

In this organisation, employees may choose to participate in the scheme, which involves learning various sections of the plant, writing the examinations and if successful, enjoying promotions. For various reasons (not explored in this limited scope project) a number of employees chose not to participate in the learning scheme.

From the information listed above, it is clear that the sample represents 28.18% of the total population of employees employed in the technical fields of the research organisation. The number of technical employees who chose to take part in the progressional route encapsulates the entire sample - in other words, all of the possible candidates who took part in the progressional route had been sampled for this research project.

5.2.1.2 Gender

From table 5.1 it is apparent that the majority of the sample (95.56%) was male. This is possibly attributed to the physical nature of the work in the technical departments represented in the study. Although the research organisation is actively attracting females into the mining industry with various initiatives, it currently remains male dominated.

5.2.1.3 Race

With regard to the race distribution across the sample size, the majority of the sample was African (54.07%), followed by 44.44% white and the minority (1.48%) coloured. Only two coloured employees formed part of the sample.

Since this subset was too small to render valuable information, for the purposes of analyses reported further in the study, the coloured results were included in the African subset. This subset was referred to as “Other”.

5.2.1.4 Age

From table 5.1 above it is clear that the majority of the sample (45.19%) was aged between 30 and 39 years old, with the minority (less than 1%) being over the age of 60 years old. The retirement age in the research organisation is 62-and-a-half years of age, and it is therefore improbable that employees close to retirement would seek to enter into a scheme, where learning results in promotion, such as the one the organisation has in place. The descriptive statistics of age as a moderator variable will be presented in section 5.2.2.

5.2.1.5 Job level

The research organisation utilises the Patterson grading method of job levels for its employees, dividing employees into Patterson bands denoting position or rank in the organisation. The bands are alphabetised with the A-Band being the entry level and F-Band the executive level. These bands are then, in turn, categorised into numerical subsections, and the higher the numerical denotation, the more junior the position in the band is. In other words (for example), an A3 position is more junior to an A1. As soon as the pinnacle of the band has been reached (i.e. the numerical 1 position), the next promotion will ensure entry into the next alphabetical band (e.g. A1 will be promoted to B7). Since the entry level at this particular refinery is in the Patterson B-Grade, there are no A-occurrences.

Patterson D2 is considered junior management and the progressional route (as discussed in ch. 4) does not make allowances for higher than this level. In the C-Band, artisans (i.e. engineering tradesmen such as electricians, boilermakers, and so forth) are pegged at a C2 level.

Other employees in the organisation, who are not artisans, may also be C2 (such as administrators, or shift supervisors, etc.). However, because of retention strategies, the artisans are paid at a higher monetary rate and in order for the operating system (SAP R/4) to pay employees correctly, artisans are defined as C2AR in order to differentiate them from other C2's. Furthermore, for each section in the Engineering department that requires artisans (e.g. boilermaking, rigging, etc.) a chief artisan (known as a chargehand) is appointed to manage the logistics of the team such as rosters, overtime, and so forth. This chargehand is paid a premium monthly for doing the additional work, but is not given promotion. He therefore remains on the artisan Patterson grade, but is denoted as C2CH to facilitate the SAP R/4 system. For the purposes of this section, the chargehands will be included in the artisan band.

Despite the cells of information being exceedingly small (because the number of occurrences on each grade is few), the artisan band (artisan C2AR and chargehands C2CH) is in the majority, which totals 30.37% (28.15% artisans plus 2.22% chargehands). This is followed by the B7 (22.22%) and the B6 (15.56%) categories. These two Patterson bands make up the first level of supervisors on the shift cycles.

5.2.1.6 Departments

As mentioned previously, only the technical departments of the research organisation (Engineering, Laboratory and Production) were represented in the study, excluding the service departments (Human Resources, Finance, Stores and Safety).

The profile of the sample illustrates that 53.33% of the participants were from the Engineering Department, followed by the Production Department (30.37%), and the minority from the Laboratory (16.30%).

5.2.2 Descriptive statistics

The aim of descriptive statistics is only to describe or analyse data, and not to draw conclusions or make inferences about the larger group (Foxcroft & Roodt, 2006; Spiegel, 1988). In table 5.2, below, the research results are described in terms of mean, minimum and maximum values and standard deviation. Values for skewness and kurtosis are also described.

Skewness and kurtosis are measures of the shape of the curve, which describe the departure from symmetry of a distribution and the relative “peakedness” or “flatness”, respectively (Cooper & Schindler, 2001). According to Spiegel (1988), kurtosis is the degree of “peakedness” of a distribution, usually taken relative to a normal distribution. A very peaked distribution is referred to as leptokurtic, a very flat distribution as platykurtic and an intermediate curve, which is neither too peaked nor too flat, as mesokurtic (Cooper & Schindler, 2001; Spiegel, 1988).

If the data are normally distributed, the values of skewness and kurtosis should be zero. Positive values of the skewness indicate the occurrence of more scores to the lower end (left) of the distribution, while negative values of skewness indicate the occurrence of more scores to the higher end (right) of the distribution (Huysamen, 1987). Positive values of kurtosis therefore indicate leptokurtic distributions, while negative values of kurtosis indicate platykurtic distribution (Huysamen, 1987).

Table 5.2 illustrates the statistics for the variables of age, pre-test scores; post-test scores; difference (between pre- and post-test); composite score; years in the company; the promotion ratio and number of progressions since engagement, across the sample size. Since the years in the company varied between the participants they were normalised by dividing the number of promotions received by years of experience in the company, resulting in a ratio that is comparable.

Table 5.2
Descriptive Statistics across all variables

	Descriptive Statistics						
Variable	Valid N	Mean	Minimum	Maximum	Std deviation	Skewness	Kurtosis
Age	135	36.93	21.00	60.00	8.46	0.469	0.10
Pre-test	135	52.79	34.00	64.00	7.73	-0.671	-0.62
Post-test	135	53.79	34.00	65.00	7.51	0.690	-0.58
Difference	135	1.00	-7.00	21.00	3.15	1.802	11.40
Composite Score	135	53.05	34.00	67.00	7.67	-0.644	-0.57
Years in Company	135	9.16	1.00	19.00	4.99	0.238	-1.18
Promotion Ratio	135	0.18	0.00	1.50	0.27	1.989	4.62
Number of progressions or promotions since engagement	135	1.18	0.00	6.00	1.38	0.916	0.09

From the data above, it is clear that none of the values for kurtosis or skewness were zero and it was therefore necessary to test for normal distribution of data. This will be discussed further in section 5.2.3

5.2.2.1 Age

From the information listed in table 5.2 above, it appears that the majority of the sample was young with the mean age being 36 years old (this echoes tab. 5.1). The positive value for skewness indicates a greater number of occurrences on the left of the mean, indicating a greater number of younger employees.

5.2.2.2 Pre- and post-test data

The pre- and post-test score data indicate that the mean scores were extremely close; with the pre-test mean equaling 52.79 (interpreted on the LPCAT scale as “average”) and the post-test mean being on average higher than the pre-test mean, and equaling 53.79 (interpreted as being on the cusp of “high average”). A test to ascertain whether the LPCAT actually behaved as expected was applied, and is discussed in section 5.2.3 (i.e. a higher post-test score).

5.2.2.3 Difference in pre- and post- test scores

The data on the difference in scores between the pre-test and post-test of the sample is an example of a leptokurtic distribution (very peaked, with a positive value of 11.40). In the majority of observations falling into the +5 points category (i.e. the majority of the participants did better in the post-test with between 0 and 5 points), only one employee scored between 20 and 25 points higher on the post-test than the pre-test.

The histogram in figure 5.1 below illustrates this leptokurtic distribution curve.

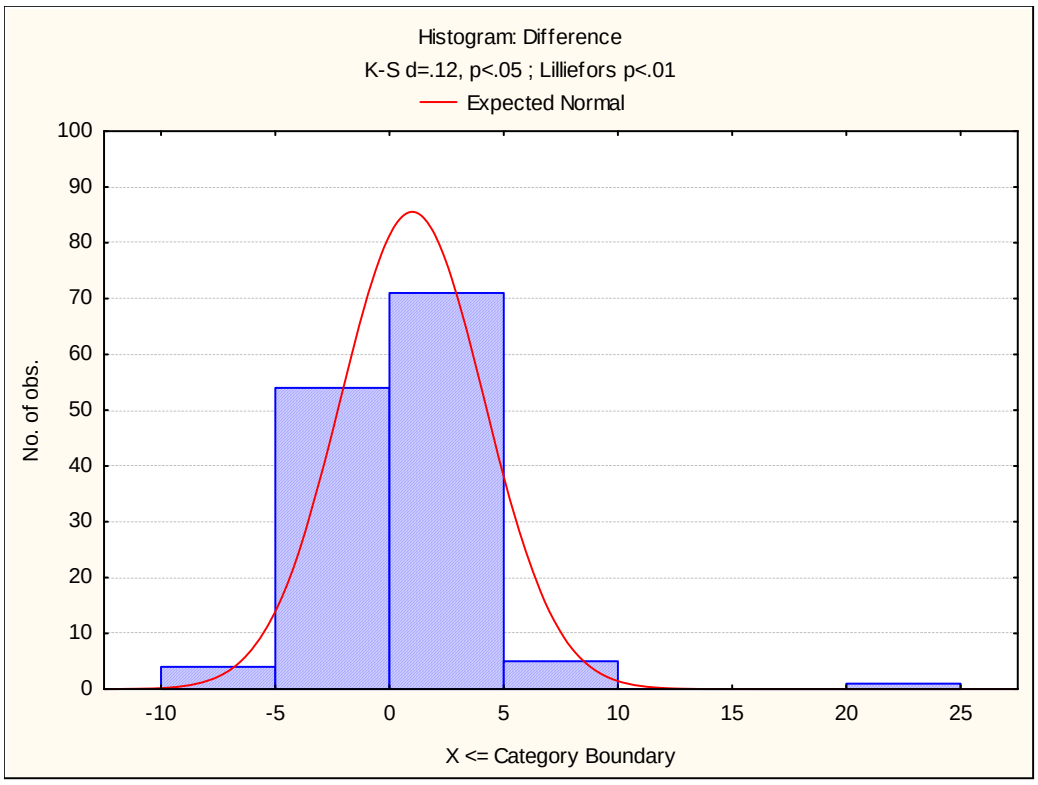

Figure 5.1:
Histogram of difference scores

5.2.2.4 Composite scores

The composite score (for a full description of the composite score, see ch. 4) data indicated that on average the respondents fared quite well on the LPCAT (mean = 53.05, on the cusp of "high average") with the minimum score being 34 (on the cusp of "low") and the maximum score 67 ("above average").

5.2.2.5 Years of service and number of promotions

According to table 5.2 the mean number of years in the company was 9.16 years, the minimum being one year and the maximum 19 years. This could correspond to the relatively young workforce (mean 36 years) with an average of 10 years' working history in the company. The mean number of promotions, since date of engagement, was 1.18. This indicates, on average, a relatively slow progression through the company. To better be able to equate and compare the employees' experience and promotion, the number of promotions since date of engagement was divided by the number of years in the company (experience), which resulted in a ratio that is more comparable (termed "promotion ratio").

Having described the data, analyses and interpretation can now be done. What follows is a presentation of the analyses performed on the data.

5.2.3 Data analysis

5.2.3.1 Validation of the LPCAT

Before analysing all the information collected, it was necessary to test whether or not the LPCAT responded as designed or expected. Figure 5.2 briefly illustrates the main features of the LPCAT.

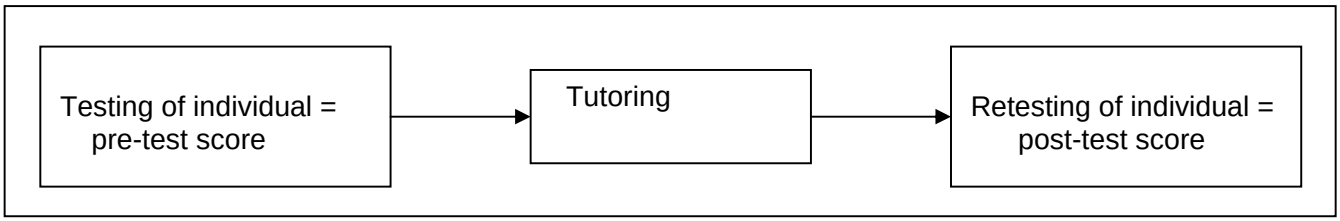

Figure 5.2:
Main features of the LPCAT

It was found that the pre- and post-test scores of the sample were not normally distributed. This was assessed by using distribution tests such as the Kolmogorov-Smirnov test, Lillifors and the Wilcoxon signed-rank test. All of these tests indicated that these distributions were abnormal (at a p-level = 0.05). When the distribution cannot be assumed to be normal, some advise the use of nonparametric methods to analyse data (Kerlinger & Lee, 2000).

It was therefore decided to abandon the t-test (parametric) method for testing differences in the means of pre- and post-test scores and use the nonparametric sign test instead (see Kerlinger & Lee, 2000; Wilcox, 2003).

a. The sign test

The sign-test method is a nonparametric technique used to test for "successes" and "failures". The following descriptions became relevant:

- A "success" is described when a candidate's post-test score is more than the coinciding pre-test score (i.e. learning has occurred).
- When the candidate's post-test score equals the coinciding pre-test score, this event is termed a "tie" or "tied value".
- A "failure" happens when the candidate's pre-test score is more than the coinciding post-test score.

The test statistic “p” (in this instance, “probability of success”, and should not be confused with the p-value for significance) was calculated simply by summing up the successes, and dividing the sum by the total number of events, subtracting the tied values. The main assumption is that the number of successes and failures follows a binomial distribution, which is appropriate because there are two mutually exclusive outcomes, namely “success” and “failure” after excluding the “tied” values (Wilcox, 2003). A confidence level of 0.01 was chosen.

The pre- and post-test scores were plotted, and are illustrated in figure 5.3 below. Essentially, the scatterplots above the line are “successes”, and those below the line are termed “failures”. The points on the line are the “tied values” where the two sets of scores are equal.

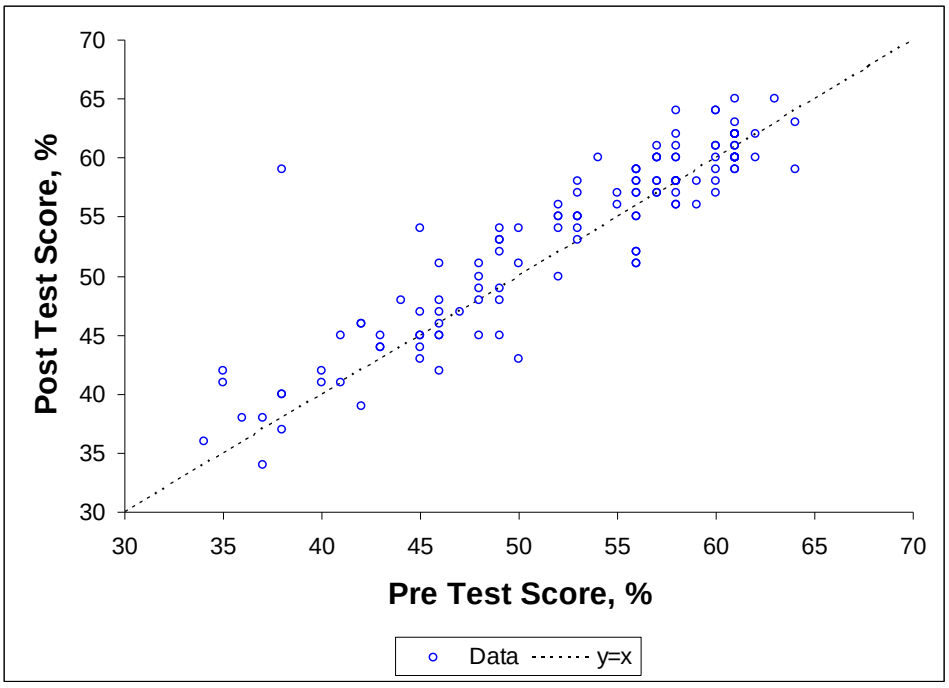

Figure 5.3:

Successes, failures and tied values for the sign test

The null hypothesis for the sign test is that if there is no difference between the pre- and the post-test scores, a 1 in 2 chance would exist of obtaining success (i.e. probability = 0.5, which is equal to 50%).

To test this hypothesis a confidence interval was calculated on the data set and the two sets of scores (pre- and post-test scores) were grouped and compared with each other. Should this confidence interval of p (at a chosen significance of 0.01) not contain the value of 0.5, it is said that the groups (pre- vs post-test score) differ with 99.9% certainty. If the confidence interval contains the 0.5 value, it can be concluded that the groups do not differ. If the groups differ, a p>0.5 implies that success is more probable than failure (i.e. the post-test score is higher than the pre-test score).

Table 5.3, below describes the profile of successes and failures. It is clear from the data below that the confidence interval value was not 0.5, at the upper or lower limit, which implies that the groups differed with 99.9% certainty. In addition, the confidence interval value was greater than 0.5 which indicates that success was more probable than failure. In this particular test, the probability of success (i.e. learning taking place when the post-test score is greater than the pre-test score) was 66%, which was statistically significant at a p=0.001 level.

Table 5.3:
Sign test profile

Number of successes	77
Number of tied values	19
Number of failures	39
Total	135
Probability	0.66
Alpha	0.001
Critical value (CV)	3.29
Standard error (SE)	0.044
Confidence interval upper limit (UL)	0.808
Confidence Interval lower limit (LL)	0.519

The sign test thus renders the LPCAT successful in terms of providing a measure of ability to learn.

In order to ascertain whether relationships exist between and within the data, correlations analyses were performed.

5.2.3.2 Correlations

The aim of correlation is to describe the strength and direction of the linear relationship that exists between two measured variables (Christensen, 1997; Cooper & Schindler, 2001).

A correlation matrix was drawn up. It was decided to include the various subtest scores (pre-, post-, difference and composite scores) as a test of the internal reliability of the LPCAT (for a complete description of the various scores see ch. 4). Table 5.4 below describes the results (p>0.05). The values that indicate statistically significant relationships are printed in red.

Table 5.4

Correlations

N=135

Variable	*Age*	*Pre-test score*	*Post-test score*	*Difference score*	*Composite score*	*Promotion ratio*
Age	1.000	-.03854	-0.3893	0.0171	-0.4189	-0.4384
	p=---	p=0.000	p=0.000	p=0.844	p=0.000	p=0.000
Pre-test score		1.000	0.9150	-0.2710	0.9906	0.2494
		p=---	p=0.00	p=0.001	p=0.00	p=0.004
Post-test score			1.000	0.1405	0.9390	0.2010
			p=---	p=0.104	p=0.00	p=0.019
Difference score				1.000	-0.1906	-0.1323
				p=---	p=0.027	p=0.126
Composite score					1.000	0.2373
					p=---	p=0.006
Promotion ratio						1.000
						p=---

In statistical terms, internal consistency reliability relates to how large the intercorrelation is between the subtests. The closer the correlation coefficient is to 1 or -1, the more reliable the instrument is. From the table above it is clear that the sub-tests (pre-test and post-test) are closely correlated with the co-efficients being very close to 1 (0.915). This implies reliability of the test.

a. Age

From table 5.4 above, it is apparent that age had a statistically significant negative relationship with all the subtest scores, barring the difference score. This means that as the age of the employees increased, it seemed likely that their test scores would decrease. This echoes the regression analysis results for “years of service” discussed in section 5.2.3.3.

b. Pre-test score

The pre-test score appeared to have significant relationships with all the other variables. There was a negative correlation between the pre-test scores with age as well as the difference scores. In other words an increase in the pre-test scores was associated with a decrease in both age and in the difference scores. Positive significant relationships were reported for the post-test as well as for the composite scores, which implies that as the pre-test score increased, so too did the post-test and the composite scores. This confirms that the LPCAT had internal consistency. The positive significant correlation between the pre-test and the promotion ratio implies that as the pre-test scores increased, so too did the promotion ratio, giving an indication that a relationship existed between learning potential and promotion ratio.

c. Post-test score

The results reported for the post-test scores were fairly similar to those reported for the pre-test scores. However the single difference was that there was no statistically significant relationship between the post-test and the difference scores.

d. Difference score

From the results above, it would appear that the difference score had a significant relationship with the pre-test scores and the composite scores only. Both of these are in a negative direction, which implies as the difference between the pre- and post test scores increased the pre-test and the composite scores decreased. It is important to remember that the difference score on its own is not an indication of potential, as discussed in 4.4.1.

e. Composite score

The composite score (in this project, the indication of learning potential) could be strongly associated with all the listed variables. However, the results for age and difference scores indicated a negative direction, which may imply that as the composite score increased, the younger the candidates were and the smaller the difference between post and pre-test scores became.

f. The promotion ratio

The promotion ratio (per definition previously in text, the ratio constitutes the number of promotions since date of engagement divided by years of experience) had a statistically significant relationship with all the variables, except the difference score. The relationships were positive except for the results for age. This means that the older the employees became, the less likely they were to be promoted at the research company (this echoes the regression analysis results, in sec. 5.2.2.3). The other variables were all indications of scores on the learning potential instrument which implies that there was a positive correlation between measures of learning potential and promotional ratio (in this case a measure for job performance).

The results of the correlation studies seemed to indicate that many statistically significant relationships ($p>0.05$) existed in the research study. In summary, these relationships were between:

- age and pre-test scores
- age and post-test scores
- age and composite scores
- age and promotion ratio
- pre-test score and post-test score
- pre-test score and difference score
- pre-test score and composite score
- pre-test score and promotion ratio
- difference score and composite score
- post-test score and composite score
- post-test score and promotion ratio
- composite score and difference score
- composite score and promotion ratio

These results support the notion that there is definitely a relationship between learning potential and job performance.

Correlations assist in detecting the existence of a relationship between two variables. When attempting to assess whether the relationship is predictive, regression can be used. Hence to further investigate whether these scores (learning potential scores) could be used to predict job performance (in terms of promoting individuals), regression analyses were performed.

Regression analysis was performed in order to single out which variable, if any, could predict the promotion ratio.

5.2.3.3 Regression analysis

Various arguments are in favour of using parametric methods when assumptions cannot be made about the normal distribution of the data, because these techniques are deemed robust enough to deliver substantive results, regardless of the distribution profile (see Kerlinger & Lee, 2000).

In order to assess the influence of the various variables (composite score, race, years in service and job grade) on promotion ratio, regression analysis was utilised to interpret the data. Multiple regression can be used to test hypotheses as well as to deduce what influence the predictor variables will have on the response variable (Kerlinger & Lee, 2000).

A standard linear regression was used to evaluate the relationship between independent variables and the dependent variable. Those moderator variables (i.e. race and job grade) with a non-numeric value were arbitrarily assigned values ranging from -1 to 1. Appendix 5 shows the values that were assigned. The tables below (5.5, 5.6 & 5.7) show the results of the regression analysis with a brief discussion of each.

a. Regression

Table 5.5

Regression Statistics

R-squared	0.1946
Adjusted R-square	0.1824
Correlation p-value	0.0000
Standard error	0.2439
Observations	135

The R-square value in table 5.4 indicates that this linear model explained roughly 19.5% of the variation in the promotional ratio measurements. This highlights the fact that these variables could be used for relative interpretation rather than exact predictions of job performance. For example, it cannot be said that if an employee scores a “high average” test score, he/she will be promoted “x” number of times.

Rather it can be interpreted as (e.g.) on average employees who score in the high average range are more likely to be promoted.

The correlation p-value was extremely small and was significant at 0.01 significance level which indicates a strong correlation between the mentioned variables and the promotion ratio.

b. Analysis of variance of regression model

Table 5.6
ANOVA

	df	*SS*	*MS*	*F*	*p-value*
Regression	4	1.90	0.47	7.98	0.00001
Residual	132	7.86	0.06		
Total	134	9.75			

The analysis of variance (ANOVA) shows that the regression model predictions did not add any additional variance to the information and did not show the correlation simply by chance (p-value is significant at 0.01 level). Additional ANOVAs will be discussed in section 5.2.3.4.

c. Regression analysis

Table 5.7
Regression analysis

	bi (Reg)	*Std E*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
x1 (Test score)	0.0066	0.00332	1.999	0.048	0.0001	0.0132
x2 (Years in service)	-0.0160	0.00484	-3.307	0.001	-0.0256	-0.0064
x3 (Race)	-0.0235	0.02472	-0.951	0.343	-0.0724	0.0254
x4 (Job grade)	-0.1709	0.06017	-2.840	0.005	-0.2899	-0.0519

According to the regression analysis, all the variables, excepting race, showed significance (p-value < 0.05). From the regression line, which indicates direction, it is apparent that “years in service” as well as “job grade” negatively affected promotion ratio. In other words, the longer the employees work at this refinery, the less likely they would be to be promoted. Also, the higher their Patterson grading becomes, the less likely they would be to receive promotion.

The regression analysis also shows that the test score (composite score) was positively associated with the promotional ratio, which means that the higher the test score, the more likely promotions would occur.

These results appear reasonable and relevant, for the higher the grade, the more complex the role of the employee becomes and the more ardent the technical examinations are. Also, the longer the years of service are (this may imply an increase in age), the less inclined the employees are to study with younger employees. It may be relevant to research the motivational factor involved in the drive to study.

Finally, it was deemed necessary to ascertain whether the relationships that did exist did so by chance. The data were therefore subjected to various analyses of variance.

5.2.3.4 Analysis of variance (ANOVA)

In order to describe possible differences between groups, the means were compared. Since the data from this sample were continuous, this comparison was done by applying an analysis of variance (ANOVA) and also because only one independent variable was present (learning potential), one-way ANOVA was the preferred method of the analysis (Christensen, 1997; Kerlinger & Lee, 2000). The purpose of using ANOVA is to deduce to what extent the differences between two (or more) groups occur by chance, which is done by pitting the variances of the groups against each other (Christensen, 1997; Foxcroft & Roodt, 2006; Kerlinger & Lee, 2000; Spiegel, 1988).

Table 5.8 below presents the univariate results for the pre-test, post-test, and promotion ratio when pitted against the composite score means. These three sets of data (i.e. pre- and post-test scores and promotion ratio) were compared separately with the composite score means. Table 5.8 below reports that the resulting F-values for pre-and post-test scores were statistically significant at a $p<0.01$ level; and therefore that these differences could not be attributed to chance.

These results are an indication of the internal validity of the instrument. Validity and reliability are discussed in chapter 2 and the internal properties of this instrument in chapter 4.

The promotion ratio F-value was significant at a $p<0.05$ level; and this was an indication that the mean differences between the composite score and the promotion ratio did not occur by chance and can therefore be used to predict future relationships.

Table 5.8
ANOVA results of composite versus pre-test and post-test score and promotion ratio

Effect	Pre-test F	Pre-test p	Post-test F	Post-test p	Promotion ratio F	Promotion ratio p
Interpretation of composite score	479.49	0.00	195.30	0.00	2.57	0.04

To better illustrate the mean differences between the pre-test scores, the post-test scores as well as the promotion ratio with the composite scores, figures of the linear relationships are provided (see figs 5.4; 5.5 & 5.6 below).

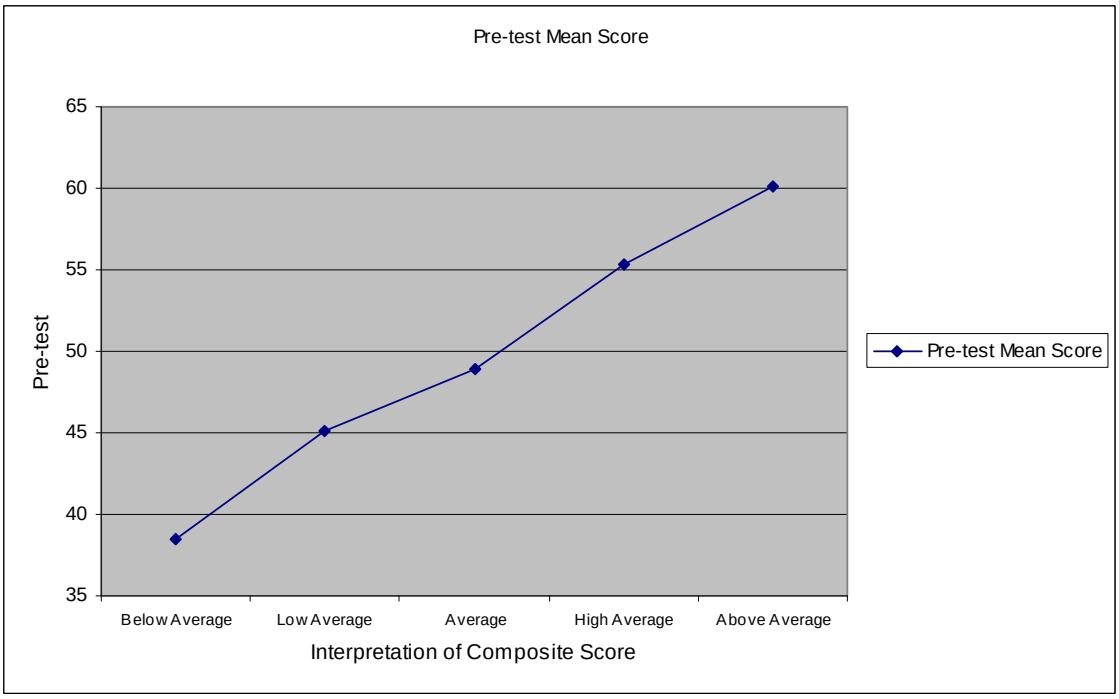

Figure 5.4:
Pre-test mean score

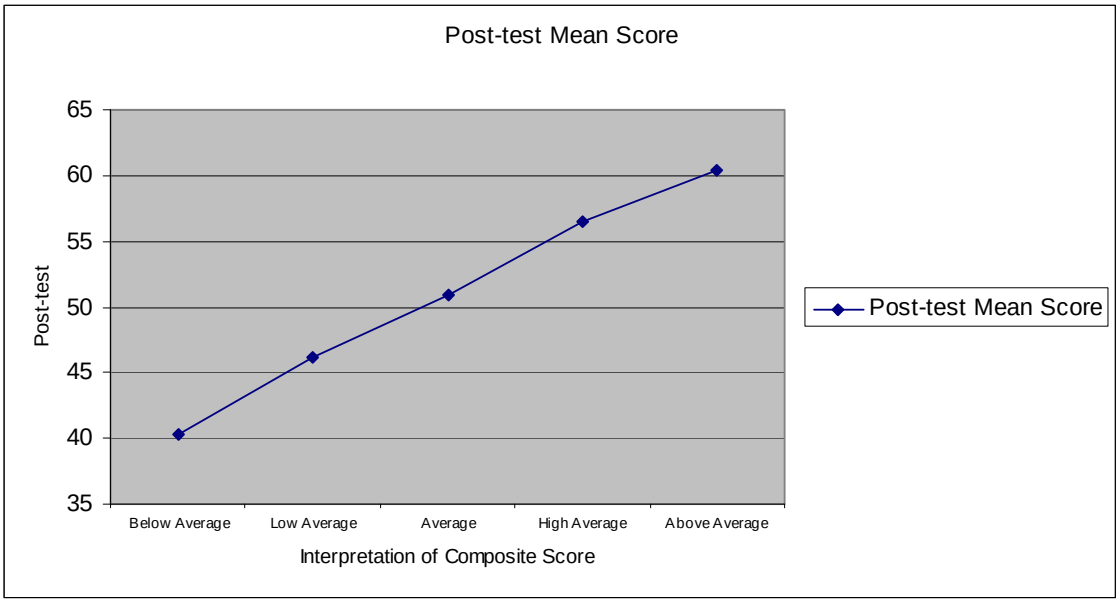

Figure 5.5

Post-test mean score

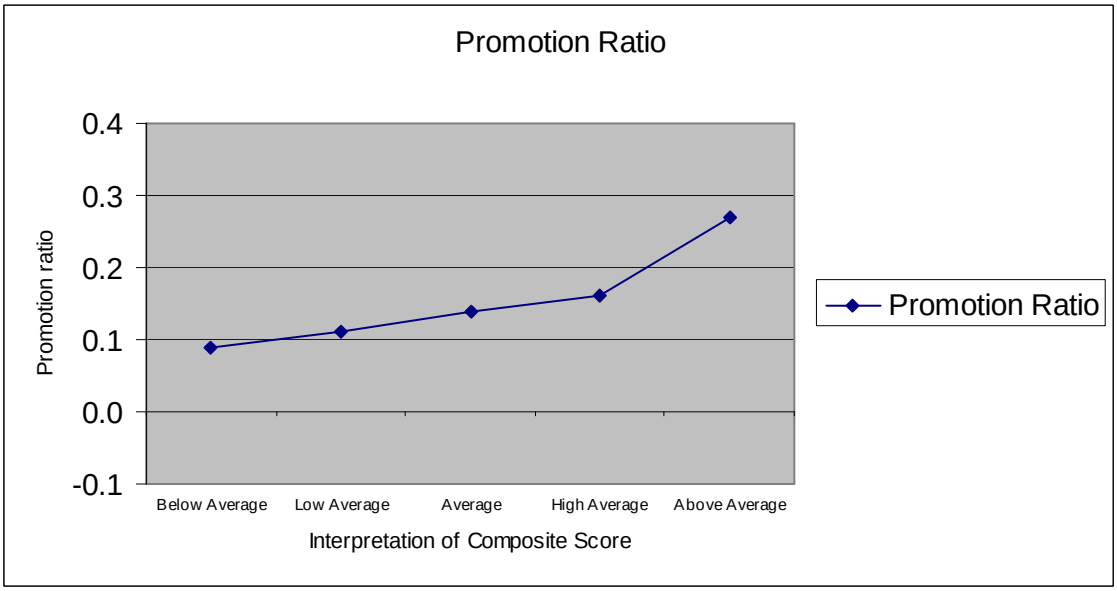

Figure 5.6

Promotion ratio

To investigate the moderator variables, further analyses were performed. In order to ascertain whether or not the different races were treated differently in terms of promotions, the group (race) was pitted against the promotion ratio. Also, the various Patterson grades were compared to the promotion ratio. The results are indicated in table 5.9 below.

It indicates that there was no statistical difference between the promotion ratio of the two race groups (p=0.531, which was greater than 0.05 and therefore not statistically significant because p would be significant at <0.05).

Table 5.9
ANOVA results promotion ratio versus race and grade

Effect	Other/white F	Other/white P	Grade F	Grade p
Promotion ratio	0.39	0.531	2.23	0.02

Table 5.9 indicates a statistically significant difference between promotion ratio and grade (p=0.02 which was significant at the p<0.05 level).

From the results provided, it appears that the research organisation did not discriminate between the race groups as far as the promotion ratio is concerned. To further investigate this, it was deemed important to compare the two groups' composite scores (other and white) separately pitted against promotion ratio. As expected, the results were not significant (p>0.05). Table 5.10 below indicates these results.

Table 5.10
ANOVA results of composite versus promotion ratio of other and whites subsamples

Effect	Other subsample N	Other subsample F	Other subsample p	White subsample N	White subsample F	White subsample p
Composite score vs promotion ratio	N= 75	1.62	0.18	N=60	1.38	0.252

This implies that there was no significant difference in the manner in which the different race groups performed regarding the comparison of their composite scores and promotion ratio.

It was deemed interesting to investigate whether the groups, on average, performed similarly on the LPCAT. Hence the means of the two race categories (white and other) were compared through the use of a *t*-test.

5.2.3.5 T-test

T-test was used to determine the statistical significance of the differences between the means of the two independent race groups' performance on the composite score. Table 5.11 below provides the results.

Table 5.11

T-test results of the composite scores of the race groups

Variable	Valid N White	Valid N Other	Mean White	Mean Other	Std deviation White	Std deviation Other	t-value	p	Degrees of freedom
Composite scores	60	75	54.57	51.84	6.86	8.11	2.08	0.04	133

The results of the t-test across the race groups indicate that the white subsample scored significantly higher than the other subsample ($p=0.04$, which is significant at a $p<0.05$ level). At first glance, this finding may appear to be cause for concern, but it is necessary to consider the context of the research organisation.

The standard deviation for the other subsample (8.11) was higher than that of the white subsample (6.86), which indicates that more variance occurred in the other subsample scores. It was deemed necessary to consider the distributions of the two subsamples. Because the distribution of the entire sample was scrutinised through rigorous analysis, a quicker, less rigorous method was utilised to simply "eyeball" the two distributions. A QQ-plot was utilised for this purpose. Figures 5.7 and 5.8 below clearly illustrate the deviations from the norm.

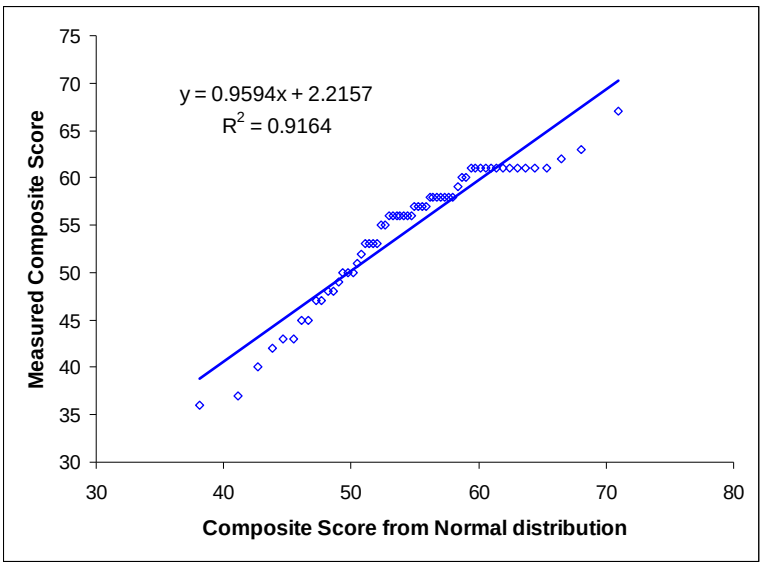

Figure 5.7:

QQ plot indicating deviation from normal distribution for the white subsample

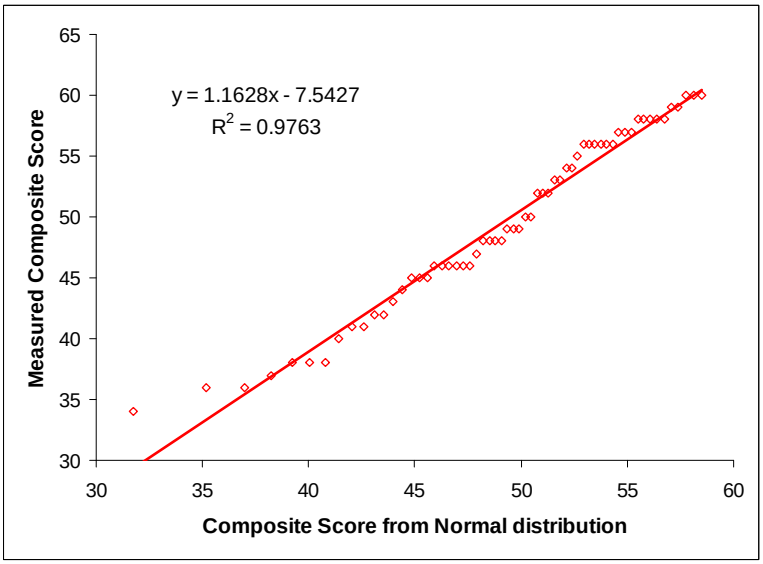

Figure 5.8

QQ plot indicating deviation from normal distribution for the other subsample

The QQ plots give an indication of what the normal distribution of scores would be like, depicted as a straight line in the figure. The scatterplots are the scores of the incumbents. From this quick assessment, one can easily tell that there was more of a spread of scores for the other subsample than for the white subsample, in terms of composite score. This could possibly be the result of the recruitment history of the research organisation.

Owing to more recent legislation, recruitment policies have subsequently changed, and a more standardised approach followed when recruiting. The shapes of the distribution of the composite scores (as seen in the figures above) show that the distribution for the other subsample was more normally distributed than that for the white subsample. This may be an indication that, on average, a select group of whites was recruited whereas the other subsample varied more normally in terms of their learning potential.

Once this difference was highlighted between the ethnic groups, it was deemed interesting to investigate whether any other moderating variable would result in significant results. The difference in "age" was significant for the two race groups. See table 5.12 below.

Table 5.12:
T-test results of age of the race groups

Variable	Valid N White	Valid N Other	Mean White	Mean Other	Std Deviation White	Std Deviation Other	t-value	p	Degrees of freedom
Age	60	75	38.83	35.40	8.71	7.98	2.38	0.019	133

The age profile for the two race groups indicates a significant difference, with the white subsample, on average being older than the other subsample. Although this is considered to be significant statistically, it is more likely to be the composition of the sample rather than the functioning of the test that could have led to the differing scores because the LPCAT was designed to negate any test bias (see ch. 4, sec. 4.4.1.2). For the purpose of this research project, the manner in which the composite score can be used to predict the job performance was of importance and that was confirmed in this chapter. One of the recommendations in chapter 6 is that more research should be conducted to investigate the differing ethnic results.

5.3 INTERPRETATION OF THE RESULTS

The research data were described and robustly analysed. The sign test reported that the LPCAT behaved as designed, with the learning opportunity providing positive learning events for the candidates.

The results were scrutinised to ascertain whether the various variables impacted on the promotion ratio. The researcher also investigated whether strong relationships existed between the various variables and whether these relationships had occurred by chance. Various conclusions can be drawn from the data manipulations.

Firstly, the analyses reported that the promotion ratio and the composite test scores (significant at $p<0.05$ level) were correlated and that this relationship was not the result of chance. These results are encouraging and allow one to infer that learning potential is an appropriate measure to predict job performance, in this sample. The null hypothesis could therefore be confidently rejected.

Secondly, the analyses reported that the various subtests were statistically related to each other with the pre- post and composite scores being strongly correlated. This is indicative of the internal reliability of the LPCAT itself. Also, the pre- post and composite scores were significantly correlated to the promotional ratio. This demonstrates a high level of criterion-related validity (as discussed in ch. 2) and is offered as support for learning potential being a predictor of job performance.

Finally, these analyses reported that no statistically significant difference could be found between the way the employees from the various race groups were treated regarding their composite score and promotion ratio. This infers that all employees who participate in the progressional route are treated equally. The research organisation has panels in place which meet annually to discuss each employee's progression through the system. Each session is minuted and open to scrutiny by the Employment Equity Committee (committee comprising of employee representatives and management) to ensure that all employees are treated fairly and equitably.

5.4 CHAPTER SUMMARY

The results of the research project were documented and reported in this chapter. The biographical sample profile and the descriptive statistics were presented. The results of the correlation studies, the regression analysis and the ANOVA analyses were explained.

The results of the analyses indicate that a significant relationship exists between learning potential scores (composite scores) and job performance (promotion ratio) in the research organisation's sample.

CHAPTER 6
CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

The objective of this research was to ascertain whether there is a relationship between learning potential and job performance. In chapters 1 and 4, the research problem was posed and the context of the problem and the research methodology discussed. A literature review on learning ability and job performance was provided in chapters 2 and 3. The empirical results were presented and discussed in chapter 5. Finally, in this chapter, conclusions are drawn on the basis of the findings of the literature, as well as the empirical studies in the context of the aims posed in chapter 1. The limitations of this limited scope project are presented before making recommendations for possible future research.

6.2 REVIEW OF AIMS

As presented in chapter 1, section 1.4.1, the general aim of this study was to determine whether a measure of learning potential is a valid predictor of employee job performance. The specific aims were categorised under the aims of the literature review and the specific aim of the empirical study. The theoretical aims where threefold: firstly, to gain an understanding of the various learning potential theories and to conceptualise how learning is operationalised as a measurement construct; secondly, to explore job performance in terms of the various models and measurement thereof; and thirdly, to provide clarity on the LPCAT as an assessment tool. The specific aim of the empirical study was to determine whether learning potential can predict job performance.

In chapter 2 of this research, gaining a deeper understanding of learning potential and the measurement thereof, was achieved.

LS Vygotsky is generally considered to be the father of learning potential and his zone of proximal development (ZPD) is integral in learning potential assessment. Learning potential can be understood as the combination of current performance and improvement shown of an individual. The measurement of the future (fluid intelligence) as well as the current (crystallised intelligence) is what separates dynamic assessment from traditional methods of cognitive assessment, where predominantly, the crystallised intelligence is measured. The instrument utilised in this research project, the LPCAT, follows the dynamic assessment philosophy of test-train-retest. In chapter 4, section 4.4.1 the third aim of investigating the LPCAT as a measurement tool, was achieved. The LPCAT was developed in South Africa to provide a selection tool that would not be influenced by the historical differences in the multicultural environment, but rather provide a measurement of the current and potential cognitive performance of candidates, and an indication of the difference between these measurements. In this research project, a measure that includes aspects of the current, future and difference (in relation to the two levels of performance) was utilised as an indication of the research participants' learning potential.

Chapter 3 fulfils the second theoretical aim of exploring the various models of job performance and measurement thereof. In the literature consulted, there are many different definitions of job performance. Generally, it is agreed that job performance needs to be viewed in terms of outcome as well as the process of doing the job. For the purposes of this study, while the behaviour and outcome approaches as well as the systems approach to job performance was taken into account, it focussed on an objective measurement of job performance, relating more to outcomes, than behaviours.

When measuring job performance, it is essential to have criteria that are both relevant and objective. In this study, job performance was measured through job knowledge. In the research organisation there is a scheme that rewards employees with promotions, affecting both salary and benefits, for passing relevant job knowledge examinations.

These progressions are formalised in a Career Development Path (CDP) which is documented and audited in the various technical departments. This measure (number of promotions based on job knowledge examinations) was normalised by dividing the number of promotions by the employees' tenure. This was termed the "promotion ratio".

The empirical aim of the study was fulfilled in chapter 5, in which the research data were analysed, presented and discussed. The data were analysed using various methods including correlations (to ascertain the direction and strength of the relationship between the variables), regression (to explore the predictability of the independent variable), ANOVA (to investigate whether the differences in the means of the grouped data were the result of chance) and t-tests (to further investigate the possible effect of moderator variables).

The majority of the sample was African men, aged between 30 and 39 years of age, who worked in the Engineering Department as artisans (C2AR Patterson grade). Their pre-test and post-test mean scores were close and they could be interpreted as having between an "average" and "high average" level of cognitive performance.

A sign test was performed on the LPCAT data in order to confirm whether the LPCAT performed as it was designed to perform, that is, that the candidate's post-test score would indeed be higher than the pre-test score after a learning experience has taken place. The sign test confirmed, with a 66% probability, that this did occur (see ch. 5, sec. 5.2.3.1).

Various significant relationships were confirmed through the correlation analyses of data (see ch. 5, sec. 5.2.3.2). Essentially, these relationships confirm the internal reliability of the LPCAT as well as giving an indication that a strong significant relationship exists between learning potential and job performance, as expressed through a ratio.

In order to ascertain the predictability of the independent variable, regression analysis was performed on the data.

It was discovered that the linear model used explained roughly 19.5% of the variance in the work performance. It was concluded that variables such as learning potential, job grade and tenure play significant roles when predicting job performance (see ch. 5, sec. 5.2.3.3).

The study concludes that learning potential (as measured by the composite scores of the LPCAT) appears to be an appropriate predictor of job performance when job performance is expressed as a promotional ratio (i.e. number of promotions since date of engagement divided by tenure) (see ch. 5).

Because the scope of this project was limited, certain limitations were encountered. These will be discussed in the section below.

6.3 LIMITATIONS OF THE RESEARCH STUDY

Since this study was a criterion validity study and the data collected belonged to the employees of the research organisation who were registered for the CDP programme at the time of the study, pre-selection of the candidates occurred. This may have resulted in a certain amount of restriction of range within the scores. Restriction of range occurs when the variances on the variables are unrepresentatively small (Kerlinger & Lee, 2000). The sample was also one of convenience and therefore could not be generalised to the wider South African population or even within the company. The study was limited to the technical departments in the research organisation, which is only one of the many business units of a large mining house.

Historically, the recruitment procedures may have varied for the different levels and positions in the organisation and the various profiles of groups of employees may have differed. Because all the testees were employed in the organisation at that time and had therefore all successfully passed the various recruitment processes, there could again have been a restriction of range of scores for some of the ethnic groups.

Since some information (e.g. education level) for all the incumbents was not available, this restriction could therefore not be further investigated. Furthermore, regarding the results of the study, as discussed in chapter 5, there were no scores that fell within the "high" or "low" ranges for learning potential. This led the researcher to believe that restriction of range could well have been present.

Furthermore, the motivational aspects for the employees to participate in the CDP were not investigated as a possible influence of job performance. Because the sample consisted of employees currently registered for the CDP programme, as stated above, all the employees sampled were motivated to take part. As the programme was voluntary, the employees who chose not to enrol, for various reasons, were automatically disqualified from the study. Motivation (or other reasons) not to enrol in the CDP programme may have had a moderating effect on job performance as measured in this study.

As far as the literature review is concerned, the researcher experienced difficulty finding information available in terms of the use of job knowledge as a measurement of job performance. It appears that little research has been done locally and abroad using this criterion as a measure. Supervisory rating seems to be one of the preferred criteria used in job performance studies (see Usher, 2005).

Despite these identified limitations, the researcher believes that the research field will still benefit from the project because it provides evidence of the existence of a relationship between learning potential and job performance. It also provides an innovative and practical way to apply job performance as criterion, especially because agreeing on objective performance measures have always been a difficult undertaking for many researchers. Recommendations can be made for any future research in this area, and these will be discussed in the section below.

6.4 RECOMMENDATIONS

The researcher recommends that an attempt should be made to extend the findings of this research in the same research company by using other possible measures of the criterion, perhaps the mean percentage obtained in the formal examinations. Future researchers may also wish to improve on the measurement of job performance (dependent variable) by redefining the measuring instrument thereof. This could be done by designing an objective measure of performance for all employees with six-monthly performance reviews.

The nonunionised management band of the organisation has formalised individual performance agreements (IPAs) in place that are compiled at the beginning of each year and reviewed quarterly. These IPAs include goals and objectives with targets in place for each objective set. The targets are monitored and measured quarterly and a numeral (0 – 2) is assigned for each target for the achievement or nonachievement of the plan. The Patterson bands, which were researched in this study, do not have such formalised agreements in place. These bands are unionised and all the parties concerned have struggled to provide one method of setting and measuring the targets. Once these IPAs are in place for the lower Patterson bands, this criterion measure could easily be utilised for further comparison of learning potential and job performance.

In order to widen the variability in the data, the sample should be drawn to include individuals who are possibly not motivated to enrol in the CDP programme in order to receive promotion. This could be done by using the assessment data of employees obtained during selection and/or a different job performance measure. In addition, future research in extending this study should include a greater sample from other business units in both technical and nontechnical fields, in the organisation, or across organisations. This will make possible greater generalisation of results. Further, not all the population details were available for this study and the researcher recommends that an investigation regarding the sample representativeness of the population (i.t.o. gender, race and department) be completed.

It is also recommended that the study be expanded to include the management bands. In addition, the researcher recommends that the findings could be extended by investigating the employees' motivation or personality regarding job performance. These scores could then be compared with the learning potential results for a more holistic view of employees.

6.5 CONCLUSIONS

This research study dealt with the possible relationship between learning potential and job performance. It compared the various subtests of the LPCAT (i.e. pre-test scores, post-test scores and composite scores) with the criterion variable and the moderator variables. Several significant relationships were discovered, as reported in section 6.3 above.

From the data, it is evident that a statistically significant negative relationship exists between the two age and job level moderator variables and job performance. Age is also negatively related to learning potential. Regarding the moderator variable of race, no statistically significant relationship exists between this variable and job performance, even though the data showed that the two races performed significantly differently as far as learning potential is concerned. The data encouragingly supported the positive relationship between the learning potential measure and job performance. The internal reliability of the LPCAT was also investigated and confirmed.

Finally, in order to satisfy the general aim of this research project, as stated above in section 6.2, the hypotheses were formulated as follows:

H0: There is no statistically significant relationship between the learning potential and the job performance of technical employees.

H1: There is a statistically significant relationship between the learning potential and the job performance of technical employees.

The results of the research (as presented in ch. 5) provide support for rejecting the null hypothesis and accepting the alternate hypothesis. In conclusion, H0 is rejected and H1 is accepted because the relationship between learning potential and job performance in the research organisation is indeed significant.

6.6 STRENGTHS OF THE STUDY

This research study yielded encouraging results in terms of learning potential as a predictor of job performance, as well as reporting significant results in terms of internal reliability of the measurement instrument for learning potential. In the researcher's opinion, this study may be useful in the research organisation and in the wider mining industry, to provide justification for further utilisation of the measurement instrument (the LPCAT) as identification of talent, as well as a selection tool. The developer of the LPCAT may be interested in the results because this study confirms the internal consistency of the instrument, in addition to the other findings, as discussed in chapter 5. Considering the limitations and recommendations, in the researcher's opinion, this study could be utilised as an incentive for further research on learning potential in the field of organisational and industrial psychology.

6.7 SUMMARY

In this chapter, the aims of the research project were revisited prior to a discussion of the limitations, recommendations and conclusions of the study. The strengths of the study were presented and the chapter concluded with a summary.

REFERENCES

Amaratunga, D., & Baldry, D. (2002). Moving from performance measurement to performance management. *Facilities*, *20* (5/6), 217-223.

American Psychological Association. (1999). Standards for educational and psychological testing [online] available: http://www2.apa.org/ethics.

Anastasi, A. (1988). *Psychological testing* (6th ed.). New York: McMillan.

Anastasi, A., & Urbina W. (1997). Psychological testing (7th ed.). Englewood Cliffs, NJ: Prentice Hall.

Aprolab. (1998). *Tram-2 Learning Potential Battery for Literates*. Johannesburg: Aprolab.

Armstrong, M. (1996). *A handbook of personnel management practice (*6th ed*.)*. London: Kogan Page.

Arnold, J., & Davey, K. (1992). Self-ratings and supervisor ratings of graduate employees' competences during early career. *Journal of Occupational and Organizational Psychology*, *65*, 235-250.

Aryee, S., & Debrah, Y.A. (1993). A cross-cultural application of a career planning model. *Journal of Organizational Behavior, 14*, 119-127.

Babad, E., & Budoff, M. (1974). Sensitivity and validity of learning potential measurement in three levels of ability. *Journal of Educational Psychology, 66,* 439-447.

Basic Conditions of Employment Act, 75 of 1997 [online] available: http://www.acts.co.za

Becker, B.E., Huselid, M.A., & Ulrich, D. (2001). *The HR Scorecard: linking people, strategy, and performance.* Boston: President and Fellows of Harvard College.

Bergh, Z. (2006). Personality: Individual differences in work performance. In Z. Bergh & A. Theron (Eds.), *Psychology in the work context* (3rd ed., pp. 135-154). Cape Town: Oxford University Press Southern Africa.

Biesheuvel, S. (1973). Adaptability: Its measurement and determinants. In L. J. Cronbach & P. J. D. Drenth. (Eds.), *Mental tests and cultural adaptation* (pp. 47-61). The Hague: Mouthon.

Boeyens, J. C. A. (1989). Learning potential: A theoretical perspective. *Report PERS, 432*. Pretoria: Human Sciences Research Council.

Bommer, W. H., Johnson, J., Rich, G. A., Podsakoff, P. M., & MacKenzie, S. B. (1995). On the interchangeability of objective and subjective measures of employee performance: A meta-analysis. *Personnel Psychology, 48*, 587-605.

Bootzin, R. R., & Acocella, J. R. (1988). *Abnormal psychology current perspectives* (5th ed.) USA: McGraw-Hill.

Borenstein, M., Rothstein, H., & Cohen, J. (2001). *Power and precision.* Engelwood, N.J. : Biostat

Brown, A. L.,& French, L. A. (1979). The zone of potential development: implications for Intelligence testing in the Year 2000. In R. J. Sternberg & D. K. Detterman (Eds.). *Human intelligence perspectives on its theory and measurement* (pp. 217 – 236). New Jersey: Ablex.

Campbell, J. P. (1990). Modeling the performance prediction problem in industrial and organizational psychology. In M. D. Dunnette & L. M. Hough (Eds.), *Handbook of industrial and organizational psychology (*2nd ed., Vol. 1, pp. 687-731). Palo Alto, CA: Consulting Psychologists Press.

Campione, J. C. & Brown, A. L. (1979). Toward a theory of intelligence: Contributions from research with retarded children. In R. J. Sternberg. & D. K. Detterman, (Eds.), *Human intelligence perspectives on its theory and measurement* (pp. 139-164). New Jersey: Ablex.

Carlson, J. S., & Wiedl, K. H. (1979). Toward a differential testing approach: Testing-the-limits employing the Raven matrices. *Intelligence 3*, 323-344.

Cascio, W.F. (1998). *Applied psychology in human resource management* (5th ed.). Upper Saddle River NJ : Prentice-Hall.

Cattell, R. B. (1963). Theory of fluid and crystallized intelligence: A critical experiment. *Journal of Educational Psychology, 18*, 165-244.

Chase, R. B., Aquilano, N. J., & Jacobs, F. R. (2001). *Operations management for competitive advantage (*9th ed.). USA: McGraw-Hill/Irwin

Christensen, L. B. (1997). *Experimental methodology* (7th ed.). Boston: Allyn-Bacon.

Cilliers, F. (2004). *Paradigms in psychology*. Industrial and Organisational Master's Study School Handout. Pretoria: University of South Africa.

Claasen, N. C. W. (1997, 4th trimester.). Cultural differences, politics and test bias in South Africa. *European Review of Applied Psychology, 47* (4), 297-207

Coetsee, L. D. (2003). *Peak performance and productivity: A practical guide for the creation of a motivating climate.* South Africa: Ons Drukkers.

Cooper D. R., & Schindler P. S. (2001). *Business Research Methods* (International ed.). Singapore: McGraw-Hill Higher Education.

Cotton, J. L.,& Tuttle, J. M. (1986). Employee turnover: A meta-analysis and review with implications for research. *The Academy of Management Review, 11* (1), 55-70.

De Beer, M. (2000a). *The construction and evaluation of a dynamic computerised adaptive test for the measurement of learning potential.* Pretoria: University of South Africa

De Beer, M. (2000b*). LPCAT Learning Potential Computerised Adaptive Test User's Manual.* Pretoria: Production Printers University of South Africa

De Beer, M. (2000c). *Learning Potential Computerised Adaptive Test technical manual.* Pretoria: Production Printers University of South Africa

De Beer, M. (2004). *Learning Potential Computerised Adaptive Test installation and use of the LPCAT.* Training Manual, February 2004.

De Beer, M. (2006). Dynamic testing: Practical solutions to some concerns*. South African Journal of Industrial Psychology*, *32* (4), 8-14.

Deary, I. J., Egan, V., Gibson, G. J., Austin, E. J., Brand, C. R., & Kellaghan, T. (1996). Intelligence and the differentiation hypothesis. *Intelligence 23*, 105-125.

Employment Equity Act 55 of 1998. Retrieved from Data 9000 on 13 September 2004.

Embretson, S. E. (1987). Towards development to a psychometric approach. In C. S. Lidz (Ed.), *Dynamic assessment: An international approach to evaluating learning potential* (pp. 141-170). New York: Guilford Press.

Feuerstein, R. (1980). *Instrumental enrichment: An investigation program for cognitive modifiability.* Baltimore: University Park Press.

Fink, L. S., & Longenecker, C. O. (1998). Training as a performance appraisal improvement strategy. *Career Development International, 6(3*), 243-251.

Foxcroft, C.D. (1997). Psychological testing in South Africa: Perspectives regarding ethical and fair practices. *European Journal of Psychological Assessment, 13* (3), 229-235

Foxcroft, C. D., & Roodt, G. (2006) *An introduction to psychological assessment in the South African context* (2nd ed.), Cape Town: Oxford University Press Southern Africa.

Frisby, C. L., & Braden, J. P. (1992). Feuerstein's dynamic assessment approach: A semantic, logical, and empirical critique. *The Journal of Special Education, 26* (3), 281-301

Furnham, A. (2000). Work in 2020: Prognostications about the world of work 20 years into the millennium. *Journal of Managerial Psychology, 15* (3), 242-254.

Gerber, P. D., Nel, P. S. & Van Dyk, P. S. (1999). *Human resources management* (4th ed.). Cape Town: Oxford University Press.

Graham, J. R., & Lilly, R. S. (1984). *Psychological testing.* Englewood Cliffs, N.J.: Prentice-Hall.

Greenhaus, J. H., & Callanan, G. A. (1994). *Career management* (2nd ed.), Orlando, Fla: Harcourt Brace.

Gregory, R. J. (2000). *Psychological testing history, principles, and applications (*3rd ed.). Wheaton. Il: Allyn & Bacon

Grigorenko, E. L., & Sternberg, R. J. (1998). Dynamic testing. *Psychological Bulletin, 124* (1) pp. 75-111.

Guthke, J. (1993). Current trends in theories and assessment of intelligence. In J. H. M. Hamers, K. Sijtsma, & A. J. J. M Ruijssenaars,. (Eds.), *Learning potential Assessment: Theoretical, methodological and practical issues* (pp.13-20). Amsterdam: Swets & Zeitlinger.

Guthke, J., & Stein, H. (1996). Are learning tests the better version of intelligence tests? *Psychological Assessment, 12* (1), 1-13.

Hall, D. T., & Mirvis, P. H. (1995). The new career contract: Developing the whole person at midlife and beyond. *Journal of Vocational Behavior, 47*, 269-289.

Hamers, J. H. M., Hessells, M. G. P., & Pennings, A. H. (1996). Learning potential in ethnic minority children. *Pschological Assessment, 12* (6) 183-192.

Hamers, J. H. M., & Resing, W. C. M. (1993) Learning potential assessment: Introduction. In J. H. M. Hamers, K. Sijtsma, & A. J. J. M. Ruijssenaars. (Eds.), *Learning potential assessment:Ttheoretical, methodological and practical issues (*pp. 23-41). Amsterdam: Swets & Zeitlinger.

Hergenhahn B. R. (2005) *An introduction to the history of psychology* (5th ed.). Canada: Wadsworth.

Hunt, S. T. (1996). Generic work behavior: An investigation into the dimensions of entry-level, hourly job performance. *Personnel Psychology, 49*, 51-83.

Hunter, J. E. (1986). Cognitive ability, cognitive aptitudes, job knowledge, and job performance. *Journal of Vocational Behavior 29*, 340-362.

Huysamen, G. K. (1980). *Psychological testing in South Africa*. Pretoria: Academica.

Huysamen, G. K. (1987). *Introductory statistics and research design for the behavioural Sciences, Volume 1:* Cape Town: H&R Academica.

Huysamen, G. K. (1996). *Psychological measurement. An introduction with South African examples* (3rd rev. ed.). Pretoria: Van Schaik.

Ivancevich, J. M., & Matteson, M. T. (1996). *Organizational behaviour and management* (4th ed.). Toronto: McGraw-Hill.

Kail, R. V. (2002). *Children*. Englewood Cliffs, NJ: Prentice-Hall.

Kane, J. S. (1997). Assessment of the situational and individual components of job performance. *Human Performance, 10* (3), 193-226.

Kerlinger, F. N., & Lee, H.B. (2000). *Foundations of behavioral research* (4th ed.). U.S.A; Wadsworth Thomson Learning

La Grange, L., & Roodt, G. (2001). Personality and cognitive ability as predictors of the job performance of insurance sales people. *Journal of industrial Psychology*, *27* (3), 35-43.

Landy, F. J., & Farr, J. L. (1983). *The measurement of work performance methods, theory, and applications.* New York: Academic Press.

Laughon, P. (1990). The dynamic assessment of intelligence: A review of three approaches. *School Psychology Review, 19* (4), 459-470.

Lehrl, S., & Fischer, B. (1990). A basic information psychological parameter (BIP0 for the reconstruction of concepts of intelligence. *European Journal of Personality*, *4*, 259-286.

Lopez, S. J., & Snyder, C. R. (Eds.). (2003). *Positive psychological assessment A handbook of models and measures.* Washington D.C.: American Psychological Association.

Mauer, K. F. (2000a). *An appraisal of psychological tests and other assessment devices used in the various divisions of AMPLATS.* Unpublished document.

Mauer, K. F. (2000b). *Psychological test use in South Africal.* [Retrieved 30/08/2002: http://www.pai.org.za/board.html]

Maylor, H. (2003). *Project management* (3rd ed.) London: Prentice-Hall

Morgan, G. (1980). Paradigms, metaphors, and puzzle solving in organizational theory. A*dministrative Science Quarterly, 25* (4)*,* 605-622.

Mouton, J. (2001). *How to succeed in your master's and doctoral Studies.* Pretoria: Van Schaik.

Mouton, J. (2002). *Understanding social research.* Pretoria: Van Schaik.

Mouton, J., & Marais, H. C. (1991). *Basic concepts in the methodology of the social sciences* (rev.ed.). Pretoria: Human Sciences Research Council

Mouton, J., & Marais, H. C. (1992). *Basic Concepts in the methodology of the social sciences.* Pretoria: Human Sciences Research Council

Nevid, J. S., Rathus, S. A., & Greene, B. (1997). *Abnormal psychology in a changing world*. Englewood Cliffs, NJ: Prentice-Hall.

Orpen, C. (1986). Appraisal and job performance: A theoretical integration. *Journal of Industrial Psychology, 12* (1), 1-2.

Otte, L., & Kahnweiler, W. M. (1995, January-February). Long-range career planning during turbulent times. *Business Horizons,* 2-7.

Owen, K. (1998) *The role of psychological tests in education in South Africa: Issues, controversies and benefits.* Pretoria: Human Sciences Research Council.

Pelser, M. K. (2002). *The concurrent validity of learning potential and psychomotor ability measures for the selection of haul truck operators in an open-pit mine.* Pretoria: UNISA Press.

Pickett, L. (2000). People make the difference*. Industrial and Commercial Training, 32* (6), 225-229.

Posthuma, R. A. (2000). The dimensionality of supervisor evaluations of job performance, *Journal of Business and Psychology, 14*, (3), 481-487.

Psychological Society of South Africa (1996). *Ethical code for psychologists.* Pretoria:

Reber, A. S. (1995) *The Penguin dictionary of psychology* (2nd ed.). London, Penguin.

Saarnio, P. (1994). A comparative study of dynamic and static testing in abstinent alcoholics. *Journal of Clinical Psychology, 50* (2), 272-280.

Saccuzzo, D. P., Johnson, N. E., & Guertin,T. L. (1994). Information processing in gifted versus nongifted African American, Latino, Filiipino and White Children: Speeded versus nonspeeded paradigms, *Intelligence, 19,* 219-243.

Schein, E.H. (1988) *Organizational psychology* (3rd ed.). Englewood Cliffs NJ: Prentice-Hall.

Schmidt, F. L., & Hunter, J. E. (1998). The validity and utility of selection methods in personnel psychology. *Psychological Bulletin, 124* (2), 262-274.

Schuitema, E. (2000). *Leadership: The care and growth model*. Paarl: Ampersand Press.

Sibaya, P. T., Hlongwane, M., & Makunga, N. (1996). Giftedness and intelligence assessment in a Third World country: Constraints and alternatives. *Gifted Education International, 11*, 1107-1113

Skills Development Amendment Act No 31 of 2003 [online] available http://acts.co.za

Society for Industrial and Organisational Psychology Inc. (1987). Principles for validation and use of personnel selection procedures, [online] available http://siop.org

Society for Industrial & Organisational Psychology of South Africa. (2005). *Guidelines for the validation and use of assessment procedures for the workplace.* Pretoria: SIOPSA

South African Employment Equity Act 55 of 1998 [online] available: http://www.acts.co.za

South African Qualifications Authority Act 58 of 1995 [online] available: http://acts.co.za

Spangenberg, H. (1994). *Understanding and implementing performance management.* Kenwyn: Juta.

Spiegel, M. R. (1988). *Theory and problems of Statistics* SI (metric ed.). Singapore: McGraw-Hill.

Stacey R. D. (1996). *Strategic management & organisational dynamics* (2nd ed.). Washington D.C.:Pitman.

Statsoft (1996). *Quick reference guide to accompany STATISTICA* (Student ed.). Tulsa OK : Statsoft

Stelzl, I., Merz, F., Ehlers, T., & Remer, H. (1995). The effect of schooling on the development of fluid and crystallized intelligence: A quasi-experimental study. *Intelligence*, *21*, 279-296.

Sternberg, R. J., & Grigorenko, E. L. (2002). *Dynamic testing: The nature and measurement of learning potential.* UK: Cambridge University Press.

Suliman, A. M. T. (2001, 06 September). Work performance: Is it one thing or many things? The multidimenstionality of performance in a Middle Eastern context. *International Journal of Human Resource Management, 12*, 1049-1061.

Tangen, S. (2004). Performance measurement: From philosophy to practice. *International Journal of Productivity and Performance Management, 53* (8), 726-737.

Taylor, R. L., & Richards, S. B. (1990). Validity of the estimated learning potential and other measures of learning potential. *Perceptual and Motor Skills 71*, 225-229.

Taylor, T. R. (1994). A review of the three approaches to cognitive assessment, and a proposed integrated approach based on a unifying theoretical framework. *South African Journal of Psychology, 24*, 184-193.

Taylor, T. R. (1997). *Administrator's Manual for APIL BATTERY*. Parktown: Jetline.

Taylor, T. R. (1999). *Administrator's manual for TRAM-1 Battery: Assessment of learning potential for semiliterates*. Johannesburg: Aprolab.

Taylor, T. R. (2003) *Apil information request*. Unpublished Document

The South African Board of Psychology Ethic Code of Professional Conduct (2006) [online] available: http://www.hpcsa.co.za/professional-boards/Psychology/Documents/F208.pdf

Theron, A. L. (2003). Perspectives on general and work behaviour. In Z.C. Bergh & A.L. Theron (Eds.), *Psychology in the work context* (2nd ed.). Cape Town: Oxford University Press.

Thompson, A. A., & Strickland, A. J. (2001). *Strategic management concepts and cases* (12th ed.) Boston: McGraw-Hill/Irwin.

Ungerer, L., & Theron, A . (2006) Cognition. In Z. C. Bergh, & A. L. Theron (Eds.) *Psychology in the work context* (3rd ed.) (pp. 135-154). Cape Town: Oxford University Press.

Usher, K. V. (2005). *The relationship between ego strength and work performance in the sales environment.* Pretoria: UNISA Press.

Van de Vijver, F. J. R. (1993) Learning potential assessment from a cross-cultural perspective. In J. H. M.Hamers, K. Sijtsma, A. J. J. M. & Ruijssenaars (Eds.), *Learning potential assessment: Theoretical, methodological and practical issues (*pp. 313-340). Amsterdam: Swets & Zeitlinger.

Van der Linde, E. K. (2005). *The relationship between personality traits and work performance of call center agents.* Pretoria: UNISA Press.

Van Der Merwe, A. (2004). Personal correspondence, 09 September, 2004

Vygotsky, L. S. (1978) *Mind in society: The development of higher order psychological processes.* Cambridge, MA: Harvard University Press.

Vygotsky, L. S. (1997). *Educational psychology*. USA: CRC Press LLC

Weiten, W. (1989). *Psychology themes and variations,* Pacific Grove CA: Brooks/Cole

Wilcox, R. R. (2003). *Applying contemporary statistical techniques*. USA: Elsevier.

Wolffaardt, J. B., & Roodt, G. (2005). Basic concepts. In C. Foxcroft, & G. Roodt (Eds.), *An introduction to psychological assessment in the South African context* (2nd ed.). Cape Town : Oxford University Press Southern Africa.

Wright, P. M. & Noe, R. A. (1996). *Management of organizations*. USA: McGraw-Hill

www.wikipedia.org

APPENDICES

Appendix 1 – outline of research study

	Learning Potential	Job Performance	Biographical Data
Sample and population	n = 479 Sample size = 135 Unit of Analysis : Technical Employee LPCAT scores for 135 Technical employees	n = 479 Sample Size = 135 Unit of Analysis : Technical Employee Performance criteria, in terms of promotions and job knowledge exams, of 135 technical employees	n = 479 Sample size = 135 Unit of Analysis : Technical Employee Biographical data of 135 technical employees.
Measuring instrument	LPCAT scores of 135 technical employees Pre-test, post-test and composite-test scores: Interpretation scale of composite score: <34 – Low 35 to 43 – Below Average 44 to 48 – Low Average 49 to 53 – Average 54 to 58 – High Average 59 to 69 – Above Average 70 to 81 – High	Job performance objective criteria for 135 Technical employees Criteria as follows: Number of job performance exams successfully passed resulting in number of promotions received in accordance with formalized career development path (CDP) as laid out in the departmental progressional routes.	Biographical information drawn from SAP (R4) HR Module Age Gender Race Promotions Years of service Date of inception Level within the company Job title
Data Gathering	LPCAT scores obtained through assessing all candidates over a period of 1 year. LPCAT was administered for development purposes	Job performance promotions are earned when job knowledge examinations are passed. Job knowledge examinations are monitored by the Human Resource Development Department and approved and controlled by functional heads. Employee promotional histories drawn from SAP (R4) HR. The process is governed by documented policies and procedures and audited by various internal departments.	Downloaded from SAP (R4) HR and entered into Excel spreadsheets.
Data Processing	Learning Potential Scores entered into an Excel Spreadsheet Data analysed using STATISTICA package & EXCEL Data was analysed by mean of the following techniques: Descriptive Statistics, Correlations, ANOVA and Regression analysis	SAP (R4) HR downloaded into Excel spreadsheet CDP information entered entered into Excel spreadsheet. Data analysed using STATISTICA package & EXCEL Data was analysed by mean of the following techniques: Descriptive Statistics, Correlations, ANOVA and Regression analysis	SAP (R4) HR downloaded into Excel spreadsheet Data analysed using STATISTICA package & EXCEL Analysis of Variance (ANOVA) used to identify variances Data was analysed by mean of the following techniques: Descriptive Statistics, Correlations, ANOVA Regression analysis and *t*-test
Hypothesis	H0: There is no statistically significant relationship between the learning potential & job performance of technical employees. H1: There is a statistically significant relationship between the learning potential & job performance of technical employees.	H0: There is no statistically significant relationship between the learning potential & job performance of technical employees. H1: There is a statistically significant relationship between the learning potential & job performance of technical employees.	H0: There is no statistically significant relationship between the learning potential & job performance of technical employees. H1: There is a statistically significant relationship between the learning potential & job performance of technical employees.

Appendix 2 – Production progressional route

Time Scale	Grade	Job Title	Educational Qualification	In-house Training	Group Training
Probation 4 weeks	B2	Learner Process Controller	Std 10, Maths and / or Science	Basic module training (theory) – generic 100% Safety module per section – vessel entry	
6 months or pro-rata - 100% Attendance 6months – reasonable stage No formal warning for the 6 months	B2-B4	Process Controller B	Std 10, Maths and / or Science	Basic module (practical). 25% of specialized modules (theory and practical) 25% of part 2 (Plant Identification)	
6months or pro-rata - 90% Attendance Reasonable period + 9 mnths for B4 No formal warnings for last 6 mnths	B4-B6	Process Controller A	Std 10, Maths and / or Science	100% Specialized modules (theory and practical) 50% of part 2 (plant identification) Lockout	
6 mnths as a reasonable time	B6-B7	Process Operator	Std 10, Maths and / or Science	100% of specialized modules (theory and practical) 100% of part 2 (Plant identification) Azon# Lockout	
Acting at C2 (14 days) Reasonable time 12 – 14 months	B7-C2	Process Co-ordinator	Std 10, Maths and / or Science	HR-Pay-Time-Leave MM-PM-For end user PP-PI sheets SAP overview training Valid First Aid Certificate	Practical Supervision Labour relations in the work place Managing discipline Practical Loss Control
Minimum 12 months at C2 (reasonable time 18-24mnths)	C2-C5	Shift Leader Jnr	Std 10, Maths and / or Science	Cross Training will be advantageous	Conflict Management Legal Standards Situational Leadership
Reasonable time 18mnths	C5-D1	Shift Leader	Std 10, Maths and / or Science	Cross training in all modules of all areas	
Vacancy	D2	Production Overseer	Std 10, Maths and / or Science	Overseer Certificate and JMP	

APPENDIX 3 – Engineering progressional route for artisan

Carpenter (Phase 1 of 3)

Criteria	On the job tasks / Internal course		Off the job / External courses		
	No	Description	No	Module	Description
Must have a minimum of ABET level 3, with a suitable level of language, communication and literacy With numbers and measurement they should be able to solve realistic problems dealing with physical quantities e.g. length, mass, time, and money To be selected from Carpenter helper who have had not less than one year's experiences in the relevant trade Course and project work ABET level 4 will be considered an advantage	1	Safety - PMR orientation - Induction (Health and Safety) - First aid - ISO 9002	1	CBMT	Orientation
			2	IN-AO1	Introduction to the Building Industry
			3	IN-AO2	Safety
			4		Identify Carpenter hand tools
	2	Know the Safety aspects off the Job	5		Identify and safe use of measuring instruments
	3	Use the correct PPE	6	BM-AO1	Interpret basic Building drawings
	4	Identify Carpenter hand tools	7	BM-AO2	Determine and transfer levels
	5	Read measuring instruments and spirit level	8	BM-AO5	Erect and dismantle scaffolding
	6	Interpret basic Carpenter drawings			
	7	Read and understand Carpenter drawings	9		Use Carpenter hand tools
	8	Safe use of Carpenter hand tools	10		Identify and safe use of Carpenter Elec. Tools
	9	Safe use of Carpenter electric tools	11	CT-EO4	Fit & hang a single door to a steel door frame
	10	Fit and install door frames	12	CT-EO6	Prepare and install open shelving
	11	Fit and install door, hinges, handles and locks	13	CT-AO1	Set out and construct basic joints
	12	Install Dry Wall Partitioning	14		Make up a workpiece from a drawing-handtools
	13	Prepare and install shelving	15		Plan and Install Dry Wall Partitioning
	14	Joining by means of different joints	16		All work must be done to minimum tolerances
	15	Work to minimum tolerances			
	16	WI/ENG-17 Lock out procedures			
	17	WI/ENG-28 Eng.In-house orientation			Financial life skills
	18	WI/ENG-31 Working on moving machinery			
	19	WI/ENG-42 Safety prec. - flammable store			
	20	WI/ENG-52 Working on a high risk area			
	21	WI/ENG-55 Use&exam.lifting mach.& tack			
	22	WI/ENG-58 Use / inspect of safety belts			
	23	WI/ENG-59 Erection,use&inspect scaffolds			
	24	WI/ENG-66 Operate 5000kg&8000kg hoist			
	25	WI/ENG-78 Work with portable elect.equip.			

APPENDIX 4 – Laboratory progressional route for Junior Staff

CAREER DEVEOPMENT PATH FOR JUNIOR LABORATORY PERSONNEL

B1 ENTRY AND PROGRESSION MINIMUM REQUIREMENT: MATRIC WITH MATHS AND SCIENCE
(Other generic minimum requirement: English literate)

POSITION		REQUIREMENTS		
	CODE	MODULES	NOTES	MINIMUM REQUIREMENTS
		ALL TRAINEES	ENTRY VACANCY DRIVEN	
1. LABORATORY ATTENDANT	LAB 01/01	Introduction Course	1. MODULE TESTS	
B1	LAB 01/02	Laboratory Glassware	(Theory + Practical)	
		ALL TRAINEES		Succesful Completion of Modules done as B1
	LAB 01/03	General Chemical Principles		
	LAB 01/04	Redox Reaction		
	LAB 01/05	pH Measurements		
	LAB 01/06	Use of Analytical Balance		
	LAB 01/07	Atomic Absorption Spectroscopy		
		METAL ACCOUNTING LABORATORY		
	LAB 01/08	Working with Muffles and Ovens	1. MODULE TESTS	
2. JUNIOR LABORATORY	LAB 01/09	Use of HF	(Theory + Practical)	
ASSISSTANT	LAB 01/10	Fusion	2. CRITERION TEST	
		PROCESS CONTROL LABORATORY	3. INTERVIEW (Knowledge and	
B3	LAB 01/11	Preparation of 1N NaOH	Troubleshooting Skills)	
	LAB 01/12	Qualitative Tests		
	LAB 01/13	Ir Shake Test		
		FINAL METALS LABORATORY		
	LAB 01/14	The Use of the Carbon Analyser		
	LAB 01/15	Cutting and Pickling Grain Samples		
	LAB 01/16	Reduction of Metal Salts to Pure Metals		
		ALL TRAINEES		
	LAB 02/01	Atomic Absorption Spectroscopy	1. MODULE TESTS (Theory + Practical)	Succesful Completion of Modules done as B3
		(Maintenance and Calibration)	2. CRITERION TEST	
3. LABORATORY ASSISSTANT	3PMPCL02	Atomic Absorption Practical	3. INTERVIEW (Knowledge andTroubleshooting Skills)	
B5		ALL TRAINEES		
	LAB 03/01	Inductive Coupled Plasma		Succesful Completion of Modules done as B5
4. SENIOR LABORATORY	LAB 03/02	Atomic Absorption Spectroscopy	1. MODULE TESTS	
ASSISSTANT		(Slides or Softbook)	(Theory + Practical(2PMPCL02))	

B6	LAB 03/03 LAB 03/04	Standardisation of Standard Solution **<u>FINAL METALS LABORATORY</u>** Spark	2. CRITERION TEST 3. INTERVIEW (Knowledge and Troubleshooting Skills)	
5. LABORATORY TECHNICIAN **C1**	ADC	1. Practical Supervisory Course 2. Team Relations Course 3. Performance Review Training 4. Situational Leadership 1. Situational Leadership	VACANCY DRIVEN	Minimum 2 years experience as B6
6. SHIFT LABORATORY **TECHNICIAN** **C2**	ADC	2. Managing Conflict 3. Managing Discipline 4. Performance Review Training 5. Acting Opportunities to show: - Technical Capability - Ability to Maintain Discipline and control	VACANCY DRIVEN	Minimum 3 years experience as B6

Appendix 5 – Values assigned to non-numerical moderator variables

Race	Value
Black	1
White	-1
Job Level	Value
B2	-1
B3	-0.82
B4	-0.64
B5	-0.45
B6	-0.27
B7	-.0.09
C2	0.09
C2AR	0.27
C2CH	0.45
C5	0.64
D1	0.82
D2	1