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Abbreviations

A.P.S.O. - Association for Personnel Service Organisations

C.V.C. - Computer Users Council

N.I.P.R. - National Institute for Personnel Research

N.M.C. - National Manpower Commission

N.P.I. - National Productivity Institute

ABSTRACT

The shortage of skilled computer staff in South Africa has reached critical proportions. Not only is commerce unable to recruit enough manpower with the required experience and expertise, they are also posed with the problem of high turnover and remunerating a small number of people in excess of their market value. In contrast to this phenomena, South Africa has a vastly under-utilised "other than white" population of Matriculants and Technikon diplomates. It is hypothesised that the skilled shortage in computer programming could be overcome if more applicants out of this labour segment were given entry level jobs and trained to be productive and competent. This study attempts to address the difficulties of the under-utilised manpower resources by looking at the entry level requirements for computer programmers.

Since for industry as a whole, aptitude tests are used on applicants for entry level programmers, one of these tests, viz. the National Institute of Personnel Research General Aptitude Battery was investigated. It was hypothesised that the instrument was an unfair selection tool as most "other than white" applicants evaluated did not perform as well as the white applicants.

The sample comprised of technikon students who had passed at least their first year of the Computer Data Processing Diploma. Thirty five were selected and matched from a white and forty three from a so-called "coloured" institution. The results of this cross cultural research design in a field setting were statistically analysed and findings were that the "coloured" group scored far lower than that of the white group. Therefore, the researcher concluded that the test battery was not a good predictor of success and should not be used across population groups, as it could lead to an unfair labour practice. It was proposed instead that a biographical structured interview guide based on the accomplishments of applicants be used to supplement the test results. In so doing the researcher suggested that dimensions of success for a programmer be probed for, during the interview rather than concentrating purely on an aptitude test which could be seen as unfair.

CHAPTER ONE

INTRODUCTION

Barker (1984), under the auspices of the Human Sciences Research Council (HSRC), authored a publication entitled Manpower Shortages in South Africa, in which it was stated that the skilled shortage of manpower in the country could be considered to be one of the greatest constraints on economic growth in the country. The overall number of positions vacant in the non-agricultural sectors of the economy was given as 188 000 in 1981. When further analysed by occupation, 38 000 of these vacancies were in the professional and technical category and the balance of 150 000 was spread over management and other categories.

During the course of 1988 the National Manpower Commission Report of 1987 was published. Here it was stated that the total vacancies for 1983 were 190 106, of which 30 865 were in the professional and technical sector. Furthermore, the same report states that in 1985 a total vacancy figure of 167 958 was given, of which 28 338 were in the professional and technical sector. When one examines the total vacancy picture from 1981 to 1985 in Table 1 below, it can be seen that the number of vacant positions has dropped over a five year period from 38 000 to 28 338. However, the vacancy rate of more than five percent remains high over the stipulated period. The National Manpower Commission Report of 1988 suggests no improvement in more recent years, with a vacancy rate of 5,2 or 32 798 vacancies for 1987. Thus, over a period of seven years, there has been no improvement in real terms to the problem.

South Africa is therefore suffering from a skilled shortage of key positions in both the private and public sectors. Vacancies are however not necessarily an indication of manpower shortages. According to the National Manpower Commission (NMC) report of 1988, manpower shortages can be defined as vacancies filled with great difficulty. The NMC conducted a survey among a number of organizations in order for them to gain some idea of which positions are difficult to fill in the current labour market. Their findings indicated a number of jobs critically undersupplied, including Computer Personnel. A similar survey was conducted among recruitment agencies for the Association of Personnel Service Organisations (APSO). The result of this APSO survey more or less confirmed the findings of the NMC study. Future projections of demand for

Table 1 : Vacancies as an indication of skilled shortages in the professional and technical sector

Year	1981	1983	1985	*1986	**1987
Total vacancies	188 000	190 016	167 958	175 721	159 270
Professional & Technical vacancies	38 000	30 865	28 338	30 015	32 798
Vacancy rate	5,1	5,6	5	5,3	5,2

Adapted from: * Manpower Survey no. 16 Department of Manpower
26 September, 1986.

** National Manpower Commission Annual Report 1988.

skilled labour, as illustrated in Table 2 indicate that there will be a steady increase in demand for the already undersupplied skilled positions. The fact that these manpower shortages have existed for a number of years, has only served to aggravate the problem.

Background To The Problem

This study will address itself to a specific manpower segment within this occupational group, namely computer programmers. Training for this specific position is usually intensive, of a technical nature and tends to stretch over a period of time. Without properly trained computer programmers, no senior programmers or analysts will emerge and the manpower shortage in the computer sector and industry will persist (Botha, 1988; Calitz, 1984). The focus of the study is on the selection of the computer programmers, with special emphasis on the validity of aptitude tests prescribed by the industry for the selection of candidates. The point will be made that aptitude tests utilized for the selection, may only be valid for screening white applicants and may in fact discriminate against other applicants. The exclusion of other race groups is not only discriminatory but also deprives the industry of valuable human resources.

Fair selection within the recruitment process for entry level programmers will thus be investigated. The present study aims to suggest a fair selection model, which could assist in the equitable selection of prospective programmers from all walks of life and population groups in South Africa.

It can justifiably be asked, when reviewing the critical manpower shortages in South Africa, whether our current tertiary educational system is able to provide adequately for the future high level needs of the country.

Professor J.T. Steele (1989) of the University of Witwatersrand, when addressing the Annual Conference of the Insurance Institute of South Africa, stated that almost all the products of tertiary education to be employed between now and the year 2015 are already born. Their genetic make up is already determined. It should be noted that environmental factors, including the quality of their education will have a substantial affect on their abilities to perform successfully in their careers (Steele, 1989).

Table 2 : Anticipated demand for high level manpower projected growth in labour force

OCCUPATION	VACANCY TRENDS 1983 - 1985	PERCENTAGE GROWTH PER ANNUM IN DEMAND 1985 - 1995
Professional Engineers	4,88	3,0
Engineering Technologists	7,94	3,6
Architects: Quantity and Land Surveyors	3,23	3,0
Natural and Life Scientists	8,84	3,5
Doctors: Dentists, Vests	4,10	3,8
Para Medicals	11,66	3,8
Nurses	9,85	3,4
Educators	3,23	2,3
Lawyers	1,86	2,2
Accountants	2,23	3,6
Other Professionals	6,41	3,0
Managers and Administrators	5,96	3,0

Source: National Manpower Commission Report : 1987/88

Table 3 : Senior certificate results from 1970 - 1989

Senior certificate				
Population group	Year	With exemption	Without exemption	Total
Total	1970	16380	26341	42721
	1975	27062	29592	56654
	1980	34388	51201	85589
	1985	35637	70102	105739
	1986	38365	89580	127945
	1987	50229	89138	139367
	1988	58753	87740	146493
	1989	57379	121200	178579
Whites	1970	14412	22132	36544 (86%)
	1975	20850	22135	42985 (76%)
	1980	25523	22647	48170 (56%)
	1985	26546	29539	56085 (53%)
	1986	26669	33194	59863 (47%)
	1987	27508	34024	61532 (44%)
	1988	29126	37683	66809 (46%)
	1989	27886	38510	66396 (37%)
"Other than Whites"	1970	1968	4209	6177 (14%)
	1975	6212	7457	13669 (24%)
	1980	8865	28554	37419 (44%)
	1985	9091	40563	49654 (47%)
	1986	11696	56386	68082 (53%)
	1987	22721	55114	77835 (59%)
	1988	29627	50057	79684 (54%)
	1989	29493	82610	112183 (63%)

Source: 1970 - 1988 : National Manpower Commission Reports.

1989 : Business Day - 15th January 1990.

According to the NMC report of 1988 there has been a steady increase in the number of black and "Coloured" matriculants over the period from 1970 to 1988, as can be seen in Table 3. Unfortunately these figures do not include figures from the Independent Homelands. Statistics quoted from the University of Orange Free State's Economics Research Unit reported in Die Burger (19 June 1988) state that 84 320 Black students passed their matriculation exams in 1987. Furthermore, the Business Day reported on 22nd February 1989 in a Manpower Review that 50 000 Black students passed the matriculation examination with a University exemption pass in 1988. When consulting table 3 and adding the matriculation figures for 1989 it can be seen that of the 178 579 students who completed their schooling in 1989 that Black and other "non-white" groups made up 63 percent while 37 percent were White.

Based on existing figures, it is forecasted that within five years time 885 500 Black matriculants will have entered the labour force while by the year 2001 3,5 million Black matriculants will be seeking to enter the labour market (Steele, 1989). Therefore, South Africa has in theory, a huge pool of human resources to draw from when looking to overcome the skilled shortage in the future. The majority of the human resources will by necessity be Black or Non-white. The problem however is that this specific human resource pool is poorly educated, leaving a large section of the country's human resources unskilled and unemployed (Shaw and Human, 1989). Even though the policy of Black education is being upgraded, it will take generations to overcome the inadequacies (Steele, 1989). Presently the quality of Black education although improving is inadequate preparation for university. This fact can be confirmed by the Matriculation pass rates among the different race groups, as quoted by the Business Day dated 15th January 1990 for the 1989 school year. White Matriculants had a 96 percent pass rate, "Coloureds" a 73 percent pass rate and Blacks a 42 percent pass rate. Indications therefore are that for the present and near future with 17 Universities and a total population of some 267 608 University registrations and 119 000 students registered at Technikons, that more than fifty percent of this student population will be White (NMC 1988). However given Professor Steele's figures on the changing face of school and tertiary educations racial content, little will be accomplished in the face of solving the country's manpower shortages without utilisation of the "other than white" people, either Black, "Coloured" or Indian.

In conclusion to the background of the problem concerned, it can be said that the future of South Africa's economy depends on the success of how the emerging Black and "non-white" scholars are accepted and trained by organizations in order to meet the critical manpower shortages of the country. The future of South Africa's economy depends on the success of full and free participation of skilled educated Black workers and business (Shaw and Human, 1989).

Manpower Needs and Skills In The Computer Industry

The country's manpower skills shortage problem has been sketched. Examining the demographic trends of South Africa has served to illustrate that this problem will remain with us in the future. Now this problem will be examined in terms of its implications for the computer industry.

As can be seen from Table 1 the skill shortage in the technical and professional section has been a problem since at least 1981. No doubt organisations at that point of time were in pursuit of technical staff such as programmers and systems analysts. Table 4 below indicates that the growth of the Computer Industry from 1975 to 1980 increased by just under eight thousand people.

Enough employers shared a common problem, to warrant a request to the Computer Users Council (CUC) of South Africa to initiate an investigation into the problem. The CUC in turn requested the National Productivity Institute (NPI) to investigate the problem. The result was a document entitled "The Manpower Training and Development Needs of the South African Computer Society" (Riley, Otto and Coetzee, 1983). Some of the main findings of the investigation was that the skill shortage in the industry could be ascribed to entry level requirements being inappropriate (Riley et al., 1983). As a result the NPI recommended that the CUC rationalise the design, develop and use aptitude tests to determine entry into the industry. These recommendations were especially directed towards matriculants. A second major recommendation based on the findings of the investigation was that the CUC had to market the industry to a much wider human resource population of school leavers to ensure a steady in-flow of programmers and other staff members (Riley et al., 1983). In fact the second recommendation pointed to the increased usage and introduction of "other than white" employees into the industry to help solve the skilled shortage.

Table 4 : Growth of computer industry (1975 - 1980)

YEAR	NUMBER OF PEOPLE	VACANCIES	% VACANCIES TO TOTAL EMPLOYEES	RACE		% VACANCIES TO TOTAL EMPLOYED
				WHITE	NON- WHITE	
1975	14 251	1 171	8,22	11 601	2 650	18,60
1977	16 186	1 203	7,43	12 765	3 421	21,14
1979	20 416	1 360	6,66	15 962	4 454	21,82
1980	22 121	1 852	8,37	16 813	5 308	24,00

Source: Reily et al., (1983)

From official statistics, it would seem that the shortage of skilled computer staff has been addressed since the 1983 NPI investigation. When looking at the latest Manpower figures gained from the National Manpower Commission Annual report of 1988 and Mini Manpower Survey 16B September 1986, the vacancies figure given for the graduates and diplomats in the same year would imply that the demand has been met by the tertiary institutions in 1986, and no skilled shortage exists. (NMC report of 1988, Mini Manpower Survey no. 16B 1986).

Unfortunately the picture is nowhere near what the official statistics indicate, as both professional computer journals and placement agencies together with the CUC have commenced with a renewed outcry for the training of staff. Computer Week quotes a prominent placement agency as stating that there are currently approximately 3 500 vacancies for skilled computer staff, 70 percent (2 450) for traditional programmers with high level skills, 10 percent (350) for managers and 20 percent (700) for the new growing area of user support (Mayberry, 1989).

Furthermore figures from tertiary institutions such as technikons and universities producing computer trained graduates and diplomats have shown a very small growth in numbers produced. Again Computer Week of August 1989 stated that only 24 percent (246) of diplomats who commenced the computer data processing diploma will complete their studies in 1989.

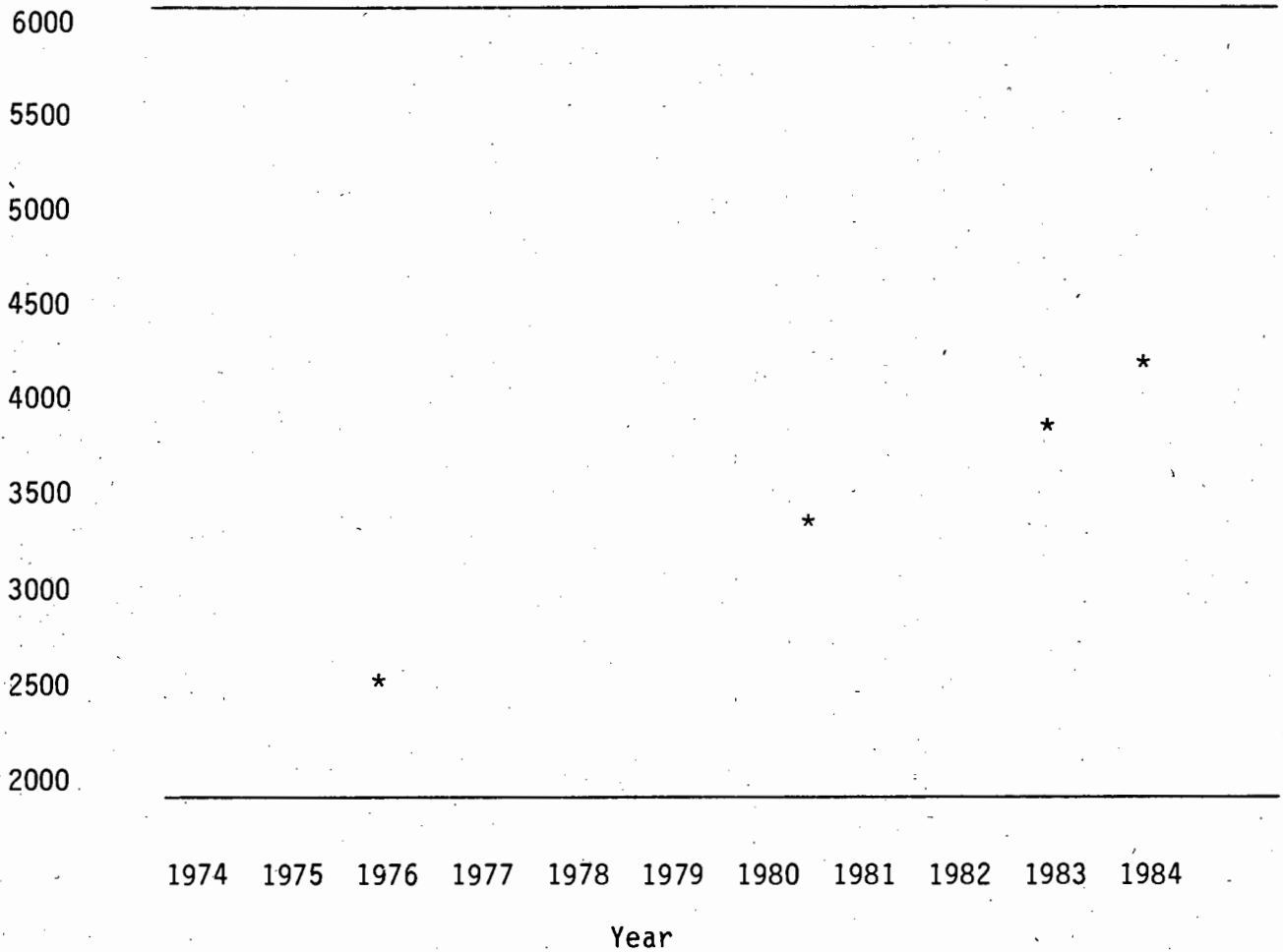
On going back to the NPI investigation and findings of 1983 it appears that the study focused on the late eighties and now use it to ascertain whether their forecasts were in fact correct. Starting with the information in Table 4 we see how it was used to forecast the future needs of the industry illustrated in Tables 5 and 6 below.

The data suggests that the computer industry is growing steadily with the number of vacancies increasing. In fact, the vacancy rate is alarmingly high, as can be inferred from the 34 percent turnover in the industry in 1988. (Busin, 1989)

Already in 1983 it was estimated that the computer industry would need to recruit 8 000 new employees by 1987, an estimated growth of 36 per cent (Riley, et al., 1983).

Table 5 : Assessment of growth of programmers

Number of programmers



Source: Reily et al., (1983)

This figure excluded those people who needed to be replaced as a result of leaving the industry. When focussing on the specific job category of programmers (refer Table 5) it was estimated that with a growth rate of 320 per annum (Table 6), approximately 6 371 programmers were required by 1987. Therefore the estimation of the CUC and personnel placement companies are more accurate in estimating vacancies than the official statistic (Mayberry 1989, NMC 1989)

Another trend that has been observed in the computer industry is an increase of admission of employees from a variety of racial sectors. Of the 22 121 people employed in the industry in 1980, 5 308 or 24 percent were "other than white", even though a large number of them were not computer programmers and therefore did not really alleviate the skilled shortage problem in this job category (refer to Table 4).

Following the trend of using Black employees, it seems that when comparing this population group as a total of employees in the industry (refer to Table 7) there was a steady growth of blacks from 18,6% in 1975 to 24% in 1980.

In the programmer category alone, there has been an increase in the use of Black programmers over the same period. In fact, there has been an increase of approximately five per cent more programmers in this category, viz. from 76 in 1975 to 408 in 1980, or from 2,85 to 7,68 percent of the industry.

Given this scenario of linear growth within the period of 1975 to 1980, when the South African economy was experiencing an economic depression, the figures provide a basis for considering employment trends beyond 1980. Based on these findings and the fact that 50 percent of programmers change jobs within the first nineteen months of service, suggestions by the N.P.I. were that the industry needed an intake of at least 894 new recruits for training in 1983 (Riley et al., 1983). Following that, the training at entry level had to be maintained if the skill shortage was to be overcome. Obviously this figure for 1983 could not have been met, as when we look at the N.M.C. report of 1988, only 874 degrees and diplomas were issued in computer science and data processing at universities and technikons in 1985. During 1986 this total figure moved to 912 and 1 024 in 1987. Therefore it appears that educational institutions cannot keep up with the growth of the computer industry, resulting in a skills shortage.

Table 6 : Computer Industry Vacancies

Estimates of people needed by occupational category

<u>1. Operations</u>		<u>2. Programmers</u>	
Number employed	5 584	Number employed	4 468
Number promoted	<u>797</u>	Number promoted	<u>596</u>
Growth	430	Growth	320
Vacancies	472	Vacancies	894
Lost of system	279	Lost of system	<u>238</u>
Total 1 (Incl. vacancies)	<u>1 978</u>	Total 1 (Incl. vacancies)	<u>2 048</u>
Total 2 (Exl. vacancies)	<u>1 506</u>	Total 2 (Excl. vacancies)	<u>1 154</u>
 <u>3. Data Base staff</u>		 <u>4. Systems analysts</u>	
Number employed	232	Number employed	1 800
Number promoted	<u>46</u>	Number promoted	<u>225</u>
Growth	18	Growth	120
Vacancies	75	Vacancies	407
Lost of system	12	Lost of system	90
Total 1 (Incl. vacancies)	<u>151</u>	Total 1 (Incl. vacancies)	<u>842</u>
Total 2 (Exl. vacancies)	<u>76</u>	Total 2 (Excl. vacancies)	<u>435</u>
 <u>5. Managers</u>			
Number employed	1 400		
Number promoted	<u>93</u>		
Growth	110		
Vacancies	35		
Lost of system	70		
Total 1 (Incl. vacancies)	<u>308</u>		
Total 2 (Exl. vacancies)	<u>273</u>		

Source: Reiley et al., (1983).

Table 7 : "Non Whites" as a percentage of total Computer Industry

No	Occupational Groupings	1975	1977	1979	1980
1	Operations	26,88	33,50	32,98	35,60
2	Data Preparation	21,43	24,08	24,85	29,56
3	Data Control	18,54	31,19	30,33	32,90
4	Programming	2,85	5,59	6,85	7,68
5	Systems Analyst	0,95	0,77	1,35	1,52
6	Data Base	-	4,48	9,00	2,90
7	Operators of ancillary equipment	85,42	82,20	76,94	79,39
8	Management staff not included above	1,39	0,46	1,60	0,66
9	Technical Maintenance	3,65	1,42	6,91	9,09
10	Other Computer Staff	24,48	18,69	27,41	22,70
11	Average	18,60	21,14	21,82	24,00

Source: Reiley et al., (1983).

Black integration is therefore critical for the skilled shortage in the Computer Industry. However, in order to do so, certain obstacles have to be removed so that these other population groups get a fair opportunity to enter the computer industry.

Given the fact that there are insufficient "whites" to be employed in the industry as programmers, commerce has to turn its attention to alternative human resource segments out of the entire labour pool (Botha, 1988; Riley et al., 1983). It is therefore recommended that more use should be made of "other than white" school leavers, to alleviate the skilled shortage concerned.

Black or "other than White" integration is therefore critical for the skilled shortage crises in the Computer Industry. Again Computer Week of November 1988 addressed the problem of integrating the Industry as well as using computer skills as a forum for change. The conclusions formed by representatives of most companies leading the field in bringing blacks into the computer industry was that no real progress was being made. In fact placement agencies maintained that the placement of Black Personnel had decreased from 30 percent in 1985 to that of 21 percent in 1988. The agencies blamed wrong attitude of employers as far as employment practices were concerned and maintained that more training should be emphasized. Other problems that organizational representatives had in this regard was mainly in the form of prejudice, inferior education, communication skills and cultural differences (Cockburn, 1988).

However, from a business point of view taking the future demographic forecasting into consideration, most South African organizations will be forced to employ more and more "other than white people" in the computer industry to alleviate the skilled shortage. Successes to date inside organisations have been heartening when practices and selection methods are carefully considered as was noted in the Infogold report (Botha, 1988). Both computer placement agencies and computer managers inside organisations concluded however that no matter what the problems were in bringing about the integration, be it entry level standards, inferior education, or cultural differences when imposing new technology on third world population groups, there is no other solution to the problem. The conclusion was that unless "other than whites" were brought into the computer industry on a large scale, the year 2000 - only eleven years away - will dawn with severe skilled shortage problems (Cockburn, 1988).

The problem, however, is not as straightforward as it sounds. The requirements needed for "white" entry level programmers cannot be simply applied to the selection of other population groups. Should this be done it could quite easily be construed as an unfair labour practice under the Labour Relations Act against an employee using aptitude tests that have not been validated cross-culturally (Taylor & Radford, 1986). It is against this background that the study reviews the whole concept of selection fairness with emphasis on aptitude tests used to select entry level computer programmers.

CHAPTER TWO

SELECTION TOOLS CURRENTLY USED IN THE COMPUTER INDUSTRY

This chapter reviews the tools used in the selection of entry level computer programmers. Firstly, the merits of the employment test will be discussed. Secondly, aptitude tests will be defined and commented on, thereafter tests used in the computer industry will be looked at. Finally, an evaluation of tests and the computer aptitude test in question will be discussed.

A psychological test can be defined as "a standardised measure of aptitude, knowledge, ability, personality or performance with fixed rules for administering or scoring" (Reilly & Chao, 1982, p. 2). If an employment or psychological test is used as part of the selection process it must be seen as a measurement of the applicant's ability and motivation to perform the job applied for (Nunns & Kruger, 1986).

Employment tests are therefore used to assess the suitability of job applicants against specifications outlined by a job description. Employment or selection tests are made up of certain categories, the most relevant for this study being aptitude tests which measure the testee's ability, knowledge or skill (Nunns & Kruger, 1986). Such tests are vital for entry level positions, as no other measuring means exist whereby the applicant can prove whether he/she has the potential to do the job. In this respect tests of cognitive ability measuring abilities or aptitudes such as mental alertness, arithmetic ability, verbal comprehension, inductive reasoning among others would or should be a good indicator of trainability (Nunns & Kruger, 1986).

Aptitude Tests

The concept aptitude is a general term which refers to an individual's capacity or potential for giving certain types of responses. Aptitude tests came about as a result of intelligence tests being too limited in what they measured (Anastasi, 1982). They assessed verbal ability and to a lesser degree the ability to conceptualise numerical problems and abstract symbolic relations.

Therefore, a number of tests which originally would have been named intelligence tests, came to be known as scholastic aptitude tests. These tests were developed for use in counselling and selection of staff in industry and military settings. With the development of the factor analysis statistical method, multiple aptitude batteries were developed. This provided a measure of an individual's ability with respect to a number of different traits. (Anastasi, 1982)

Anastasi (1982) further clarified the difference between aptitude and intelligence tests by specifying what they measured. Intelligence tests refer to heterogeneous tests with a single overall score, viz. Intelligence Quotient, while aptitude tests measure clearly defined segments of ability. Certain forms of these tests are special aptitude tests measuring a single aptitude, while multiple aptitude batteries measure a number of aptitudes and provide a profile of scores for each aptitude. Aptitude tests therefore could help to determine differential ability in industry as a guide to the training and placement of employees or potential employees.

Originally, aptitudes referred to innate, hereditary abilities and "achievement" as opposed to learnt performance (Anastasi, 1982). The term aptitude can therefore best be explained by comparing the concepts achievement and ability. The former measures an individual's competence on completion of training, while the latter also measures acquired skills but these skills are not taught in formal education. Aptitude tests do therefore not measure proficiency, rather they are used to predict whether an individual has the ability to successfully acquire new skills in the future (Anastasi, 1982). This is explained on a continuum of experiential specificity where achievement tests dominated the one end and "culture fair" tests the other, with aptitude tests overlapping in the centre (Anastasi, 1982).

In conclusion, it has been realised that such a distinction is impossible in practice, for it is impossible to measure any aptitude independently of any general or incidental learning experience (Anastasi, 1982). Furthermore, when differentiating between aptitude and achievement tests, the tester should guard against the naive assumption that achievement tests measure the effects of learning while aptitude tests measure "innate capacity" (Tyler, 1984) independent of learning.

In South Africa at present there are various tests being administered to measure programming ability. One of the tests used is the National Institute of Personnel Research's Computer Aptitude Battery. It consists of the following subtests:

- Mental Alertness
- Abstract Reasoning
- Logical Reasoning
- Comprehension and Problem Solving

Calitz (1984), in his assessment of aptitude tests for computer programmers, reviewed all the test batteries available to programmers in South Africa. He found that certain factors were important for computer programming work, viz. ability to think logically, a preference for detail, accuracy, ability to work under pressure, ability to work with people, a fairly retentive memory, ability to adjust to changes, ability to see a problem through and mathematical ability.

It is doubtful whether any of the specific aptitude tests for programmers actually measure all the dimensions of a successful programmer mentioned above, as no evidence of a correlation between these performance criteria and the aptitude tests was evident in the research (Calitz, 1984).

Furthermore, there was a difference in the types of aptitude tests administered by various computer companies, such as IBM and Burroughs. These seemed to emphasise speed and power tests and were not found to be good predictors of programming ability (Calitz, 1984). In a speed test items have uniformly low level of difficulty, so that all subjects could complete all items if they were given enough time; however, the time limit under which they have to answer the questions makes it well nigh impossible for all the items to be answered correctly (Anastasi, 1982). What is in fact being tested is the person's speed, not the ability to solve the problems. A power test contains items that are steeply graded in terms of difficulty and includes items too difficult for all but the ablest subjects to complete; a time limit is set long enough that all subjects can attempt all items.

If the findings of the reviews of these tests used in the computer industry are so questionable, what then is the rationale for using them in the first place? The solution to this quandry must be seen from two perspectives, firstly, that of the computer industry themselves and, secondly, from a

psychometric perspective. In the first instance the computer industry via the Computer Users Council believe that to become a programmer certain specifications are required. How to measure the specifications for the job is beyond their capabilities as can be seen with the findings by Reilly et al. (1983). Also, there seem to be great confusion in understanding the difference between intelligence, aptitude and achievement tests (Hamilton 1988, Malherbe 1988). The best reasoning given to justify the use of tests however comes from Hovy (1980) who maintained that career success requires a sound match between organizational needs and the abilities, personality and values of the individual. Subsequently career suitability predictions is possible if the individuals measured suit the needs of the organization. This match is improved with the use of psychometric tests. Secondly from a psychometric point of view if aptitude tests are able to measure whether individuals possess the ability to be trained, they should be a good predictor of success in entry level jobs (Nunns & Kruger, 1986).

An Evaluation of Aptitude Tests

Having briefly summarised what employment and aptitude tests are and which are used in the computer industry, a review of these measurement tools is now given.

Employment tests should have strict conditions under which they should be used. This includes, separate norm tables for different age groups, genders and racial groups. The norms should be standardised in the country it is being used in and care should be taken when these tests are used across cultures with different educational standards (Nunns & Kruger, 1986; Radford & Taylor, 1986).

Ghiselli (1973) reviewed the validity of aptitude tests. His conclusions were that when looking at the predictive power of aptitude tests, the validity coefficients were good enough for training purposes (.39), however less reliable for proficiency criteria (.22). Reilly and Chao (1982) performed similar research and arrived at similar conclusions to that of Ghiselli (1973).

With respect to the N.I.P.R battery, its validity was examined by Steyn (1969), who expressed doubts as to whether these subtests were in fact an indicator of

success as a programmer. He noted that borderline cases of testees who just managed to become entry level programmers, after actual work experience developed the necessary skills quite easily and quickly. Other studies using these sub-tests of the N.I.P.R. battery by Steyn and Latti (1974) seem to suggest the same doubt regarding the battery as an indicator of success. However, in the absence of any other data the test was used in that study with specific cut-off points for the categories of programmer and computer analyst.

Reilly et al., (1983) also surveyed the aptitude testing of entry level programmers. Their findings were that there were thirteen aptitude test batteries being used in South Africa and that failure in the aptitude test almost always resulted in a failed job application. However, success in such a test does not necessarily lead to an appointment in the industry itself. Their conclusions were that each aptitude test had a different purpose.

In conclusion to this chapter, it can be said that tests have definite limitations, the N.I.P.R. Battery being no exception. Tyler (1984) outlined that tests do not measure an individual's worth or value, as each person functions in a unique manner. Furthermore, test users should not assume that aptitude tests measure innate characteristics of individuals. Also, individual test scores should not be used to make group comparisons. Finally Tyler (1984) warned against interpreting aptitude scores as measuring the ability or potential to learn, as this was only partly true.

Given these limitations selection decisions, should not be made on test scores only. Neither should tests be disposed of. The tests used are only an indication of an individual's ability of how he/she measures against certain job specifications. It should therefore serve as one of the indicators in a selection process, wherein individual abilities and organizational needs are matched.

CHAPTER THREE

PROBLEMS OF SELECTION IN A CROSS CULTURAL SETTING

According to Anastasi (1982), Du Preez (1986) and Barret and Bass (1975) the testing of persons with highly dissimilar cultural backgrounds has received increasing attention since the 1950s. Most of the conclusions reached from this type of assessment have been adverse, which brings into question why this practice is continued. The answer lies in the validity of tests. Tests are needed for the maximum utilization of human resources in the newly developing nations of Africa and other third world nations. This problem was recognised as early as 1910 as a result of large scale immigration into America. The applicability of available tests was then already a cause for widespread concern when testing individuals of minority groups or sub-cultures, since each culture fosters its own development of behaviour applicable to acceptable norms and value systems (Du Preez, 1986).

When an individual has to adjust to and compete within a culture other than that in which he or she was reared, the cultural difference is likely to become a cultural disadvantage (Anastasi, 1982). Traditionally, cross cultural tests have attempted to rule out one or more parameters wherein cultures differ, e.g. language differences, educational backgrounds and differing literacy levels. Another factor related to the examples given is that of different perceptions of time across cultures (Du Preez, 1986).

Furthermore, according to Anastasi (1982), cultural differences can operate in a number of ways to bring about group differences in behaviour. Cultural differentials vary from being superficial and temporary to being permanent and far reaching. Cultural factors that affect test responses are also likely to influence the broader behaviour domain that the test is designed to sample. Going back to the cultural differentials, language differences could be seen to be a superficial impediment, if the language of the test is foreign to the testee. } P

Because language is not hereditary it can affect performance on a test administered as well as affect the individual's educational and social activities in a culture using an unfamiliar language. Therefore, as a basis to testing the test content, constructs and language have to be known to all groups tested if the results are to be compared (Du Preez, 1986).

A continuum of cultural differentials could be drawn. In the middle range of cultural differentials, cognitive differences could be highlighted where disabilities, ineffective strategies for solving abstract problems, lack of interest in intellectual activities, hostility toward authority figures, low achievement drive and poor self-concept can be seen as examples. All of these are apt to affect test performance (Anastasi, 1982). Therefore, another vital factor playing a role in cognitive development is that of education or schooling.

Research by Grant (1969) indicated that schooling affects individuals' level of performance and structure of intellect. By implication, therefore, when testing across cultures, one should expect differences in results and recognise that tests serve a purpose by indicating where an applicant is placed with respect to cognitive development at a specific moment in time. Also, the tester should accept that selection procedures are never 'objectively neutral' and therefore controversies will surround test results.

Lastly, since schooling is the most significant mode of acculturation to industrial society, if equivalent school standards are not offered to the different population groups tested, differences in test results will always occur (Du Preez, 1986; Radford and Taylor, 1986).

On the extreme end of the cultural differentials, again Anastasi (1982) states that the longer an environmental condition has operated in an individual's lifetime, the more difficult it becomes to reverse its effects. Maternal nutrition and other conditions related to low socio-economic status have a higher frequency among blacks than among whites (Anastasi, 1982).

Also, cultural differentials usually have a long term effect which cannot be reversed within the lifetime of the affected individual. Usually it requires more than one generation for the elimination of these organic disorders affecting behavioural deficiencies.

Barret and Bass (1975) point out that individuals differ significantly in their tested aptitudes for different kinds of work. Similarly, different ethnic, racial and national groups will and have always shown consistent differences in their mean scores on most aptitude tests. This does not, however, justify selection practices which implies working in the same job as one's parents, thereby limiting attempts at breaking down vocational discrimination.

Since no racial group or nationality can monopolise intellectual ability needed for success in any occupation, the quest was to assess aptitudes independent of race, ethnic group or gender. This was an attempt to control the generalisation of stereotypes of certain population groups, when it came to specific types of work individuals were supposed to aspire to. However, selection across cultures will remain difficult mainly as a result of certain perceptual processes in the underdeveloped countries being quite different from first world countries (Barret & Bass, 1975).

Du Preez (1986) sums up this area by stating that because differences exist between societies and inside cultures within societies, differences should always be noted. Therefore, test scores on aptitude tests will differ not only between different cultures but also between men and women and different language groups. Subsequently, different scores can be expected between different cultures and direct comparisons of these results should never be made until we are able to define what we are attempting to assess.

Human Resources problems in a cross cultural setting

Cross cultural selection is plagued by insufficient research and the complexity of the problem. Although there has been declining interest in American research into the issue of cultural bias during the 1970's, it has become an issue in Israel as well as South Africa in the late 1980's (Zeidner, 1987; Moerdyk, 1989).

Research trends in America elicited two schools of argument. The one camp, backed by researchers such as Jensen (1980) and Reynolds (1982), suggests that properly constructed standardized aptitude tests fail to support the theory that measuring instruments are culturally biased. Other researchers such as Cleary (1975) and Linn (1973) found little evidence for cultural bias in the prediction of scholastic achievement. Jensen (1980) maintained that scholastic scores are generally homogenous across a wide variety of socio-cultural groups. However, black psychologists in America still believe that tests are biased in content, procedure and usage against disadvantaged groups. They therefore have taken up the anti-test stance and have formed a strong lobby group to oust psychometric testing, which they believe it is a tool of discrimination (Jensen, 1980).

A study by Zeidner (1987) in Israel seems to support the theory that no test bias exists between scores of different ethnic groups on their scholastic performance. Likewise a study by Drasgow (1987) emphasised that anti-test court rulings prescribed by New York State legislation has no scientific justification. Subsequently it can only be justified on political grounds.

In the South African situation research by Birkenbach and Allan (1988), Du Preez (1986), Moerdyk (1989) and Radford and Taylor (1986) all warn of the danger of using test results across different ethnic groups and the consequences in an Industrial Court should a claim of an unfair labour practice be lodged by the disadvantaged groups.

The problem, however, with selection of potential black employees is that they usually perform poorly on entry-level aptitude tests. The question arising as a result of this is how fair these tests are. Therefore, the central challenge in South Africa confronting organisations building a non-racial workforce and profile, is the development of fair methods of selection (Human & Human, 1989).

Approaches to cross-cultural testing

When psychologists started developing instruments for cross-cultural testing around 1925, they thought that it would be possible to measure 'hereditary intellectual ability' without the influence of culture having an impact.

The hypothesis behind it was that individual behaviour was covered by a cultural veneer which could be penetrated with so called 'culture-free tests'. Developments in genetics and psychology have proven this to be a fallacy as hereditary and environmental factors operate together at all stages of human development (Anastasi, 1982; Du Preez, 1986; Barret and Bass, 1975).

In human behaviour, culture is influenced by environmental effects. Therefore, all behaviour is affected by culture and since tests are samples of behaviour, cultural influences will always be reflected in test performance. Therefore, Anastasi (1982) concludes that it is futile to attempt to devise a test free from cultural influences. Also, the objective of cross-cultural testing is to elicit experiences common to different cultures by means of tests. Therefore, culture free tests are not possible and should be replaced by terms such as 'culture common' or 'culture fair'. However, no single test can be equally 'fair' to all cultures. Therefore, although cross-cultural tests are not interchangeable they are useful in cross-cultural comparisons. To illustrate this point an aptitude test may be fair to one cultural group but not to the other. If the cultures compared are quite dissimilar then it is unlikely that any one test would be 'fair' to more than one of the cultures compared (Du Preez, 1986).

Therefore cultural differences become cultural handicaps when an individual moves out of the culture or subculture in which he/she was reared and attempts to function, compete or succeed within another culture (Anastasi, 1982; Barret & Bass, 1975).

Several approaches to the problem have been proposed by researchers such as Anastasi, Du Preez and Bass and Barret. Some of these will be discussed. Du Preez (1986) initially discusses cultural comparability with the assumption that it is possible to have culture free tests. This, however, he concludes is unlikely. Therefore, he defines a term called cultural uncertainty by which is suggested that tests are neither culture free or neutral. This much overlaps with the Barret and Bass (1975) approaches of nature or nurture. Here the nurture approach is that test differences are true or natural, that certain groups are better off cognitively. The nature approach is that differences occur as a result of bias so that aptitude and ability tests favour one group.

In conclusion then, the culture free or fair testing debate will linger on in South Africa until all environmental and other forms of discrimination at the work place are resolved (Moerdyk, 1989; Retief, 1988). In the interim, industrial psychologists will have to take a stance and identify their role especially in testing.

The role of the psychologist with respect to test fairness

Abdi (1975), an African psychologist, expressed the need for research of a practical and applied nature to be conducted in the field of psychological testing in Africa. He believed that because of the condition that the continent is in, the 'pure theory' approach - such as applying standardised intelligence tests which are American or European oriented - would be of very little value to Africans. In contrast, little is known about how mental traits or any other psychological characteristics can be measured in Africa.

Generally, research activities in Africa were handicapped by inadequate theoretical constructs and a lack of proper methodological designs. With respect to methodology, the question asked was, 'Can one use the same Western orientated techniques in Africa?'. Inside the continent itself there are great cultural differences and subsequently a wide heterogeneity of people is present, ranging from highly literate populations to illiterates, as well as rich and poor nations. While researchers may benefit from such diversity they should be careful not to generalise their findings to the whole population of Africa. The problems facing psychology in Africa will remain a daunting challenge. However, Evans (1970) and Du Preez (1986) offered the following guidelines when doing research in African communities. Researchers should be aware of the cultural values, attitudes and socio-economic conditions of the African population they are studying. Secondly, their educational and cultural settings should be known and the pitfalls inherent in methodologies should be noted when analysing psychological principles.

Thirdly, the goals, methods and criteria for evaluating psychology in Africa should be operationally stated. Lastly and most importantly with respect to test fairness, care should be taken when using foreign orientated tests and principles in an African context.

In conclusion to this Abdi (1975) appeals for an immediate need in Africa for the development of human resources. Therefore psychology should be given priority so that the talents and potential of African children can be identified. Jahoda (1973) suggests that psychologists should focus immediately on relatively limited and specific applied problems. Test fairness in an African context would fall into this category. Abdi's plea has subsequently been supported by Fullagar and Paizis (1986) who stated that research in psychology was not relevant to Africa. Therefore psychologists should note that when working with two different population groups, that test results should be compared in a fair manner.

Test fairness as part of the ethical responsibility of a psychologist

Marais (1988) stated that industrial psychologists have the individual in the workplace as his/her first responsibility. This implies fair treatment for all and subsequently the profession should be guided by scientific psychometric rules. However, he maintains that when using tests that have not been standardised for South Africa in the selection process, we should question whether we are being fair to the individual and our profession.

Secondly, when using unstandardised tests on members of a racial group for which it was not intended or for whom no norms exist, psychologists at most times are not sure what the data generated mean. Especially, when results of Blacks are compared with those of whites, the psychologists must be responsible for the interpretation of the results.

Thirdly, Marais (1988) suggests that we, as industrial psychologists adopt an ethical point of view and re-examine our entire approach to testing and research from that viewpoint. This is necessary as a result of psychometric instruments being such powerful instruments, that most organisations use the results in an over-dependent manner. Therefore, recommendations made by psychologists to line managers, based on results of psychometric tests, have to be responsible, based on acceptance of the ethical code and must be deemed to be fair.

Radford (1988) also addressed the problem of how test score differences influence fair selection. He concluded that when psychologists use the same test for different ethnic or racial groups with only one set of norms they place the future fairness of psychometric tests in danger. The quest for psychologists in South Africa is to strive for test fairness in the selection process, an area which will now be covered.

CHAPTER FOUR

FAIRNESS IN SELECTION

This section outlines the concept fairness and further related concepts. Following on to it a review of different approaches and models of test fairness will be discussed in order to find the appropriate model for the present research, and for computer programmers in South Africa.

What is Fairness in Selection Testing?

Recent research conducted by the N.I.P.R. indicates that there are problems with respect to constructing a framework within which cross-cultural assessment could be scientifically compared (Retief, 1988; Verster, 1987). Recent publications by Wood (1988), Retief (1988) and Taylor and Radford (1986) have thrown light on to the difficult and contentious topic of selection fairness. The early cross cultural research of Rivers (1905), Biesheuvel (1952) and Berk (1982) has highlighted the incomparability of test scores of different cultural groups. This led to the debate on intergroup comparability of test results which brought to the fore related concepts such as bias, fairness and utility (Taylor & Radford, 1986). Therefore included in the discussion of fairness these related concepts will also be mentioned.

Apart from the common use of the word "fairness" usually pertaining to equity, two other usages of the concept are applicable within the domain of psychology, especially in the field of psychometry. Firstly, as used in "culture-fair testing" fairness refers to a special case of bias, with the objective to reduce or eliminate unwanted score effects associated with cultural differences. In essence, fairness in this sense is an attempt to create tests with no cultural bias - a task which is believed to be impossible (Retief, 1988). The second meaning of fairness in psychometry is concerned with the quality of the decision rule used for selecting one person over another based on their scores test scores.

Important at this juncture is to note that fairness can be distinguished from bias on the basis of when test data are used. That is, fairness concerns the use of test scores after the test has been completed, whereas bias refers to influences on scores during testing itself.

Verster (1987) notes that "fairness" has to do with the characteristics of the decision rule or model adopted in selecting one job applicant over another. Further, no relationship exists between measurement bias and fairness in test use, as what is of importance is the model of fairness used in the selection process (Verster, 1987). The salient issue behind "fairness" is that disadvantaged groups get fewer opportunities of enjoying the social benefit of employment and occupational advancement (Verster, 1987).

Therefore, the answer to "fairness" does not lie within a statistical approach, but rather a social judgement should be made by decision makers in providing guidelines for employment opportunities (Taylor & Radford, 1986).

Wood (1988) on the other hand suggests that in order to distinguish between a narrowly defined meaning of fairness and other interpretations of the term, one should consider fairness as "authoritative selection". She argues that the term, authoritative selection, should be used to indicate that selection models that are perceived as being fair, should not only be evaluated on a philosophical level (Wood, 1988). Therefore, if "selection fairness" were to be considered an absolute quality then the word fairness would not be appropriate. Consequently, a philosophy or value judgement regarding the acceptance and rejection of potentially successful candidates in different ethnic groups is inherent in each decision rule. An example of this is the affirmative action programmes undertaken by multinational companies and the application of a racially mixed manpower profile with respect to disadvantaged groups in the South African company context, that is, the introduction of more Blacks into supervisory, technical or management positions.

This philosophy of affirmative action maintains that the poor test scores of certain ethnic groups are due to their being disadvantaged. This gap in their disadvantaged backgrounds can only be overcome by introducing educational enrichment programmes and special efforts to recruit the disadvantaged. In so doing, this would allow far more opportunity educationally and socially for them (Human & Human, 1989; Shaw & Human 1989).

Bias

A clear distinction has to be made between bias at the conceptual level where the differences between groups are made before the tests are selected and the subsequent comparability of data after test administration. This study will focus on the latter. According to Taylor & Radford (1980), "a test is said to be biased if group differences in test scores are too large or too small when compared with group differences on the same criterion measure for which the test is used as a predictor". Sources of bias may reside within test items, in the tester, in the testing context or interactions of these with other sources (Retief, 1988; Taylor, 1987). In practice, bias means the unjustifiable suppression or lowering of test scores of disadvantaged groups. However, the term generally implies the under or over estimation of true ability of any group of testees.

Bias can be demonstrated, but the absence of bias can never be proven. Hence at all times its possibility must be acknowledged (Retief, 1988; Verster, 1987). Therefore bias can never be eliminated by the researcher but steps can be taken to minimize the effects of bias. For example, conceptual bias can be detected by asking experts to evaluate the test items. This is of course a judgemental method relying on a person's subjective evaluation. Wood (1988) indicates that judgemental methods are important with regard to the public acceptance of tests based on their face validity. This is of particular importance when testing disadvantaged groups.

Comparability and Equivalence

This in essence is the method whereby subsequent to data collection statistical analyses are computed to detect differences between the different groups of testees. The main issue in the analysis of test score comparability is whether the same construct or dimension is being measured across different groups (Taylor & Radford, 1986) and whether the difference in test results contain any other variance besides what the test is designed to measure.

Poortinga (1971) used the term comparability to refer to the situation where, prior to the prediction test being administered to two cultural groups, the researcher has established that the test measures both qualitatively and quantitatively the same attributes of behavior in the two groups (Wood, 1988). In this respect Poortinga (1982) proposed four levels on which "psychological universals" can be represented on a scientific basis. These they called conceptual universals, functional equivalence, metric equivalence and scalar equivalence. This approach is analogous to the four widely recognised levels of measurement viz. nominal, ordinal, interval and ratio scales (Poortinga, 1982). these levels will now be addressed in turn.

Conceptual Universals Conceptual universals refer to construct validity at a high level of abstraction which is difficult to define operationally, since it is difficult to make empirical comparisons of universals across cultures. Retief (1988), however, notes that work by Irvine and Berry (1983) has indicated that dimensional identity can be demonstrated by the adoption of universals. These universals are characteristics common to all human beings such as language, norms and socialization. Different groups of people can be compared along these universals. However, as far as equivalence is concerned, demonstrating the validity of these dimensions is difficult.

Qualitative or Functional Equivalence According to Retief (1988) this concept exists when two or more behaviours, in two cultural systems, relate to functionally similar problems. This exists when certain behavioural patterns have developed in response to a problem that is shared by two or more cultural groups. A precondition for the existence of this type of equivalence is that response behaviours must be inherent and not as a result of prompting or manipulation. Techniques used to investigate this phenomenon are similar to those used for construct validation and in fact are often identified with the analysis of comparability.

Metric Equivalence Again, according to Retief (1988), this phenomenon exists when the psychometric properties of two or more sets of data from two or more cultural groups demonstrate essentially the same structure. The argument here is that co-variation among variables should be stable regardless of the source of variation. Simply put, test scores should represent the same unit of measurement across cultures but could have a different source of origin in each culture. If this is the case, that two variables measure the same construct, then this should be represented in a common regression line. This then indicates that the main scores of each variable are equivalent (Wood, 1988).

Lastly, a test is considered to be item equivalent if items of that test, taken as a separate measurement, satisfy the requirements of metric equivalence.

Scalar Equivalence Scalar equivalence implies in most cases distributional identity across cultures. Measures should therefore have the same unit of measurement or metric across cultures as well as the same point of origin. Examples of strict universals can be found for only a few concepts e.g. the speed of processing simple visual and auditory stimuli. However, even with these simple measurements there are doubts (Wood, 1988).

Utility

According to Taylor and Radford (1986), the term utility is sometimes confused with selection fairness. However, the term really has to do with the outcome of a particular selection decision in financial terms while fairness has to do with the outcome of a particular selection decision. The concept of utility has its derivation in industrial psychology and was used in measuring the practical effectiveness of tests in selection. Industrial psychologists of earlier years, such as Taylor and Russel (1939), based their test utility models on objective ideas i.e. incremental validity. For example, a test is useful to

an organisation if the performance of those candidates selected is acceptable. Therefore, the utility of a test lies in the extent to which the method of selection constitutes an actual gain to the organisation in performance over other selection methods (Wood, 1988).

Differential validity and Differential Prediction

According to Cascio (1987), administrators of tests should attempt, whenever it is feasible, to investigate differences in prediction systems, when working with testees of different racial, ethnic and sex subgroups. The investigations proposed should look for possible differences in subgroup validity or differential validity. Over and above this, other differences sought for should be those of standard errors of estimate, slopes as well as intercepts of subgroup regression lines. Both these phenomena, viz. differential validity and differential prediction occur in numerous forms. However, where studies are well controlled both should be minimized. Furthermore, job performance must be assessed in line with test performance i.e. establish criterion related validity. In the final analysis definitions of fairness will not rest on technical grounds only, other values will also have to be considered (Verster 1987; Wood 1988).

According to Anastasi (1982) the major consideration in the evaluation of a test battery is its differential validity against the separate criteria. The main objective of such a battery is to predict the difference in each person's performance in two or more jobs, or against other situational criteria. Tests chosen for such a battery should yield different validity coefficients for the separate criteria and for different groups. In a two criterion problem the ideal test would have a positive correlation with one criterion and a zero or negative correlation with the other. In a classification test, what is required, is a test that is a good predictor of one criterion and poor predictor of another, with another test which has the reverse relationship with the predictors.

Therefore differential validity appears in a variety of forms. In each

diagram a scatterplot of one person's score on both predictor and criterion is reflected in a bivariate scatterplot. The first (Figure 1 below) indicates that the shape of an eclipse occurs with the majority of dots appearing in quadrants 1 and 3 indicating positive validity.

Source: Cascio (1987).

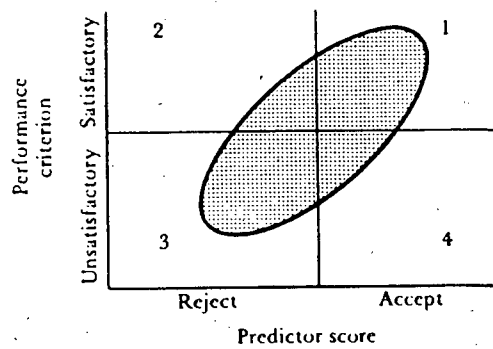
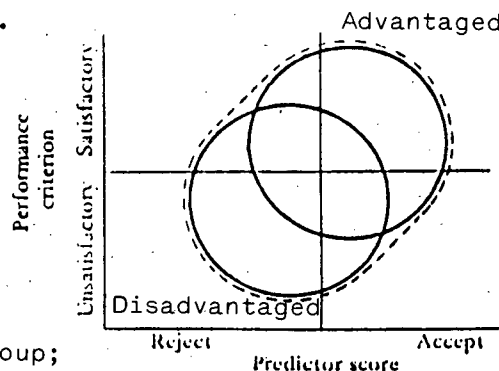


FIGURE 1 Positive validity.

Since the relationship is positive, people with high (low) predictor scores also tend to have high (low) criterion scores. In the instance of this case of differential validity the joint distribution of minority and non-minority groups is similar and the use of the predictor, be it a test battery or any other test, should be continued for both advantaged and disadvantaged groups. A negative validity will have the majority of dots in quadrants 2 and 4.

Other examples of this type of validity are not as straightforward, such as where the validity for the advantaged and disadvantaged groups is equivalent but the disadvantaged group scores lower on the predictor and hence performs poorer on the job. The point is that factors affecting performance on the criterion on the predictor may be the same ones affecting performance on the criterion and hence the adverse effect is defensible. A further illustration of differential validity is in Figure 2 below where a predictor is valid for a combined group, but invalid for each group separately.

Source: Cascio (1987).



(Figure 2

Valid predictor for entire group;
Invalid for each group separately.

This instance illustrates the fact that where no validity exists for either

group individually, errors in selection will occur. Apparently this is the most clear cut case of using selection measures to discriminate against disadvantaged sub-groups. A further instance of differential validity is illustrated in Figure 3 below, where the equal validity in two subgroups is demonstrated, yet each group has different predictor means or criterion means.

Source: Cascio (1987)

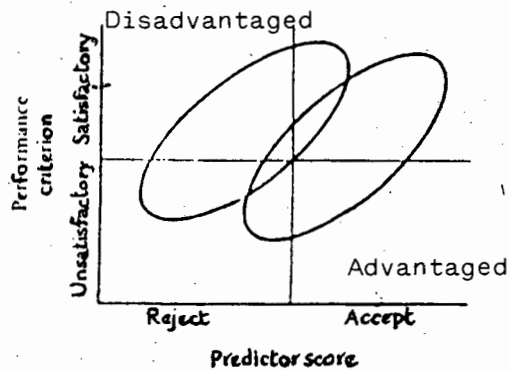


FIGURE 3 Equal validity, unequal predictor means.

In this instance the most appropriate strategy would be to use two separate regression lines or cuttings in each group based on their predictor performance, while expectancy of job performance remains equal.

A further instance of differential validity is illustrated in Figure 4 below, where lowered validity will result unless differential prediction is maintained. This is because advantaged group members tend to perform better on the job than do disadvantaged group members. If, however, predictions were based on the combined sample the results would be underprediction of minorities and overprediction of advantaged persons performance.

Source: Cascio (1987)

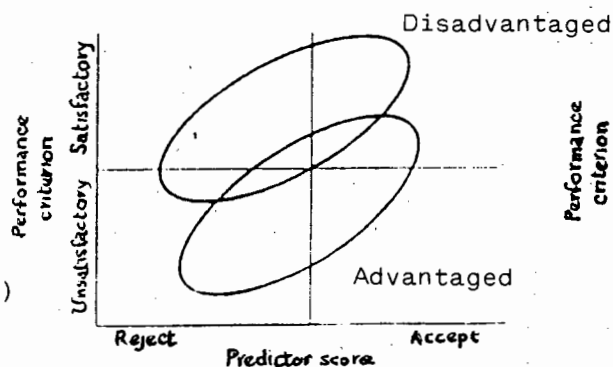


FIGURE 4 Equal validity, unequal criterion means.

A further case illustrated in Figure 5 below is that no differences between the groups exist on both predictor and criterion scores. However, the predictor has validity only for advantaged groups. Subsequently the selection measure or test should only be used for advantaged groups.

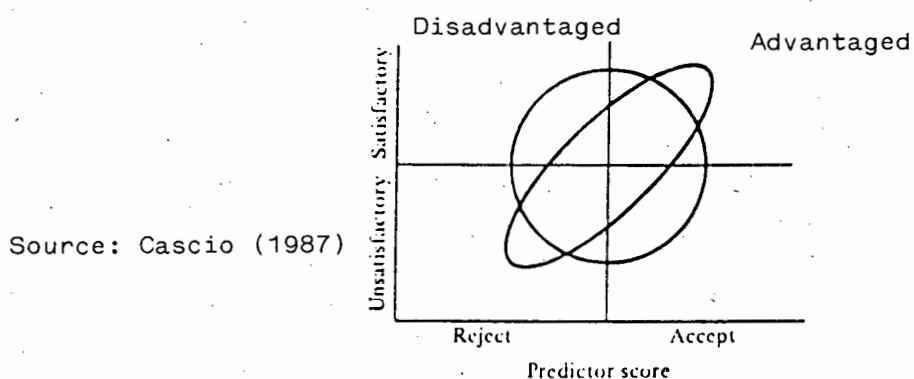


FIGURE 5 Equal predictor means, but validity only for non-minority groups.

In conclusion, Cascio (1987) states that when testing two groups with different socio-economic backgrounds, possibilities do exist to assist in making predictions. One of these is, where prior evidence shows a good probability of differential validity. Also, if as stated initially, it is feasible to test for differential validity, then better and fairer selection is likely to result by validating test separately for each identifiable sub-group.

Evidence of differential validity only provides information whether a selection device should be used to make comparisons between subgroups. With respect to differential prediction it was pointed out again by Cascio (1987) that differential prediction does not occur when subgroups are compared i.e. when equivalence or comparability does exist. The concern, however, is that the phenomena has been found often enough when a common regression line is used for selection.

Implications of these concepts in the South African Situation

Verster (1987) states that the question of predictive validity is the crux of the issue when fairness in testing is discussed. In this respect, if identical distributions exist on predictor and criterion variables for all

groups, selecting candidates could be done across groups on an equivalent basis. However, when reviewing literature on inter-ethnic comparisons of cognitive test performances, it indicates that significant mean differences exist, even though criterion performance scores were similar in each group. Therefore, although individuals tested had similar levels of formal education and are therefore matched, significant differences still appeared to be prevalent (Taylor and Radford, 1986).

According to Wood (1988) the implications of fairness indicates that research conducted in this area by industrial psychologists and psychometrists will be very valuable. In this respect tests should be subject to initial face validity to ensure that it is not offensive, and that it will not bring about negative influence. These reviews could eliminate the impression that tests discriminate against a particular group (Wood, 1988).

Models and Philosophies of Selection Fairness

According to researchers such as Peterson and Novick (1976), the evaluation of models for culture-fair selection will remain a major problem for institutions and organisations alike who rely on the use of psychometric test results as an objective means to selection. The crux of the problem is how to eliminate cultural or racial unfairness arising from the use of tests. Different definitions of what constitutes culture fair testing or selection each involve a different set of value judgements and subsequent implications. The purpose of this section of the research would be to find a suitable model, if any, for the South African situation. (The emphasis here should be on the strategy which is a rule for making decisions. Each selection model and philosophy presented, therefore represents a strategy with the intention of attempting to guarantee cultural fairness in the selection process).

The Regression Model

According to Taylor and Radford (1986), this model is the most accepted model for test fairness in America. The approach was initially proposed by Cleary (1968). He maintained that a test is biased if the criterion score predicted from the common regression line is consistently too high or low for members of a subgroup; the test could then be construed as biased. Therefore, the model assumes that fairness is achieved if separate regression equations are used in instances of differential validity between groups. This is the most widely used model of selection fairness and is based on the work of the researchers such as Anastasi (1982), Einhorn and Bass (1971) and Schmidt and Hunter (1974).

The Equal Risk Model

Einhorn and Bass (1971) proposed this model of culture-fair selection which takes into account the probability for success for each applicant's test score from each ethnic group, rather than the applicant's predicted criterion score as suggested by the regression model. Therefore, the same risk is taken in each group tested and hence the selection procedure is considered fair if those selected have the same risk of failure regardless of their group membership.

Subsequently separate cut-off scores i.e. minimum predictor scores, should be used if groups have different probabilities of success. Cascio (1987) indicates that what must be emphasised in this model is that the difference in the standard errors of estimate between different ethnic groups determines selection fairness. If the two groups had the same standard error of estimate and subsequently the same slope then the selection strategy of the regression model and equal risk model would be similar (Taylor & Radford 1986).

The Constant Ratio Model

Proposed by Thorndike (1971), the constant ratio model prescribes a strategy for considering proportions of applicants from each ethnic group, and the implications of within-subgroup regression lines. Basically the model is aimed at achieving equality of opportunity for all ethnic groups. Therefore a model is fair if for any given criterion of success it selects the same proportion of disadvantaged applicants that would be selected on the basis of the criterion itself. If in a given ethnic group 60% were successful and 50% in another group was successful in terms of the criterion, then a fair selection strategy that the model would propose is a 60 : 50 success ratio.

Conditions Probability Model

Similar to the constant ratio model this model aims at achieving fairness in proportions to composition. The basis of this model is that both advantaged and disadvantaged group members who achieve satisfactory criterion scores should have the same probability of selection regardless of ethnic group membership (Cole, 1973). Therefore all applicants capable of success should be guaranteed an equal or fair opportunity to be selected.

The Subjective Regression Model

Also known as the culture-modified criterion model (Peterson & Novick, 1976) and the modified criterion model (Taylor & Radford 1986), this model as proposed by Darlington (1971) has in addition to the criterion variable Y and predictor variable X, defined a third variable C. This denotes an applicant's group membership e.g. sex, race and socio-economic status. Cascio (1987) states that this model first makes a value judgement about the desired ability of special selection of members of a particular group defined by race or ethnically. Following this, if special selection of certain groups is desired, then different criterion scores for the groups is adopted, resulting in applicants being selected from each group.

Therefore, Darlington (1971), with his model, argued initially that a traditionally accepted criterion must be modified according to culture. Therefore, he formulated selection fairness based on the culture modified criterion model (Peterson & Novick, 1986; Taylor & Radford, 1986). This states that for fair selection, one must clearly distinguish between the use of a test to maximise criterion from the use of the test to give preferential treatment to disadvantaged groups (Darlington, 1971). Darlington (1971) maintained that if any differences arose between that of maximising validity and reducing discrimination against certain groups, then a subjective policy level decision needs to be made by the organisation concerned regarding the relative importance of the two goals.

The Threshold Utility Model

This model was proposed by Gross and Su (1975) and Peterson (1976) where an attempt was made to balance the social benefits of selecting from disadvantaged groups against the utility costs. The model requires the summing up of the utility of the four possible selection options, that is successful rejections and acceptances and unsuccessful rejections and acceptances for all identified groups. The approach assumes that there is no one best model for achieving fairness in selection. The model underlines the importance of utility or economic worth of the strategy and can be negotiated between parties having a vested interest in this.

The Moratorium Philosophy

This philosophy is adopted by anti-test movements who state that test based decisions are unfair. However, it seems that there are more arguments for than against tests. In the South African situation, alternatives to an objective index are loaded with inequalities. For example, school and matriculation results are not reliable indicators of success as different standards for the different ethnic groups cause the advantaged pupils to do much better at school.

It would seem that structured interviews and biographical items such as application blanks could substitute tests in the interim. Utilising a fair selection method with test results and weighting this information lower than the biographical items, could be a suitable compromise (Wood 1988).

The Autonomy Philosophy

Models falling under this philosophy are largely as a result of research in cross-cultural psychology, so that skills not identified in Western civilisation can be identified. These include the use of group parity models with the quota and ratio models e.g. Thorndike's Constant Ratio model.

Unqualified Individualism versus Qualified Individualism

According to Wood (1988) for as long as norm referenced tests are used in decision-making, accurate prediction can only be made when all available information on candidates is taken into account. This includes evaluating the person tested against his/her correct norm groups. Therefore, Wood (1988) claims that research not as yet published indicates that cultural convergence between English and Afrikaans language groups and between certain ethnic groups in South Africa is occurring and socio-economic rather than language or ethnic groups should be used. This of course is a controversial issue, as it could mean that no cultural difference exists between certain disadvantaged groups and their advantaged counterparts. It could then also lead to a hypothesis that because no cultural difference exists, test performances can be measured against the appropriate norm. The disadvantaged group would, no doubt not benefit from this as their inadequate education and environmental circumstances would still make them score lower in performance tests. In so doing their selection chances for the position would be slimmer and the bias in the tests would be ignored.

Broad cultural environment is therefore not enough to ensure fairness. In this respect criterion related decisions and criterion referenced tests seem to be the best interim options. Some other options are proficiency testing i.e. non-normative mastery measurement and real life measures such as Mahler's Achievements or Accomplishment analysis for entry-level employment categories. None of these mentioned require the classification of subjects into groups as in the case of normative psychometric testing.

Finally, with regard to the future of cognitive assessment in South Africa, Taylor (1987) prescribes measures of learning potential as a new direction for assessment to take in future. This construct, also known as modifiability and zone of proximal development, is particularly relevant to education, as learning potential scores should be predictive of performance in an educational context.

Learning potential measures have three sections viz. an initial assessment of performance in the content area i.e. (pre-test), secondly an intervention or actual training in some of the core procedures required for effective performance in a given subject (treatment). Lastly, a second assessment or post-test of competence in the subject concerned. Taylor (1987) furthermore states that the learning potential measures add to and does not replace tests used for selection. This measure adds to and does not replace tests used for selection. This measure will enable the tester to obtain information about an individual who would not otherwise have been eligible for selection. The method is particularly relevant when selection is for occupational positions where a large amount of learning is necessary, e.g. computer programmers. In this regard Taylor also notes conventional testing as having a high correlation with socio-economic status (SES), therefore results of these tests can be misused.

In a sense, selection decisions made on the basis of these tests could and possibly do discriminate against disadvantaged people. Learning potential on the other hand may not have a strong correlation with SES and therefore could be of use in the development of equitable selection practices.

What remains in this section is to decide either for or against conventional testing in the South African situation. In this regard, Wood (1988) believes that unlike in the United States of America, dissatisfaction with tests has not come about as a result of using them to label groups or exclude disadvantaged groups on the basis of their results. Therefore, provided safeguards are built into the use of tests, which includes factors such as bias, comparability, the principle of inclusion and the application of appropriate models of fairness, tests should still be the basis of selection. However, non-normative tests should be given preference and the principle of unqualified individualism should be used. This entails getting as much information about an individual as possible and using it to make the most accurate prediction possible about criterion performance.

On the other hand, since entry-level programmers are to be evaluated, ability tests are still the best form of assessment for potential (Nunns & Kruger 1986).

Therefore the models of fairness initially proposed should be employed within the process of selection. Organisations have to employ an approach amounting to a philosophy on whether they are to test or not, and how test results will be used, for example to establish quota systems or to determine training potential.

Should they decide to go the former route, they then will have to employ one or a combination of the models proposed. The model chosen will have to bring about the perception, both within and outside the company, of equity or fairness in the process of cross cultural selection.

Conclusion

In conclusion to this chapter the hypothesis and aim of research to be described and discussed in later chapters will be stated as follows:

In order for a healthy supply of computer analysts to exist it is essential that a new intake of trainees be accepted into commerce each year. The lack of this has caused a skilled shortage to occur in the industry (Mayberry, 1989). The current study involved a large insurance company in Cape Town, who when faced with a skilled shortage in their computer department, decided to employ 'other than White' Technikon students.

The research problem based on the above aim was that testing should be conducted on two groups of Technikon students both White and 'other than White' as a wide variance will exist between the two groups predictor scores.

Given that this will be the result, the assumption underlying the study was that the N.I.P.R. aptitude test used for selecting programmers is an unfair test, when used for two different racial groups. It was alternatively proposed that a fair selection process for programmers should be followed. This meant that test scores of the N.I.P.R. battery should be given a lower weighting, while criterion scores of major subjects at the Technikon be considered more strongly and that dimensions of success with existing entry-level programmers be found. This was to be established by means of a verifiable biographical structured interview with successful entry-level programmers.

This process was proposed as an alternative to relying too heavily on the results of an aptitude test which could be unfair to one group over another. The process would also increase the opportunity for training and development to the programmer level and should be perceived as a more equitable process of selection.

CHAPTER FIVE

METHOD

Sample

Given the aim of the study to identify "other than white" programmers, it was necessary to select technikon students from both this group and the "white" group. This was to allow comparison of the aptitude test scores of each group and to assess the feasibility of the study.

According to Kerlinger (1973) the main technical function of research design is to maximise experimental variance, control extraneous variance and minimise error variance. The research in question has identified three methods by which to control extraneous variables. In the first instance it can be argued that the samples taken from each technikon will have had different standards with respect to education level and teaching. It is, of course, very difficult to eliminate twelve years of separate education wherein standards differ from one ethnic group to the other (Taylor & Radford, 1986) to be able to control for the effect of different educational opportunities. However, given the research proposal, the study tested students who had successfully passed the first year of study in the approved course and subsequently were either second or third year students. In addition, all students write an examination, the National Diploma in Computer Data Processing, and therefore in the final analysis different standards at the different technikons will be under control.

Secondly, students who were in the second and third year at respective technikons were selected on the basis of their performance. They were approached by letter requesting them to complete an aptitude test, with the view to possible employment and/or bursaries and co-operative education.

Thirdly, each technikon group consisted of different racial groups, i.e. either white or "other than white". Therefore the two samples were conveniently

different with respect to racial group, enabling a comparison of their scores. To test the feasibility of the study, a pilot study was embarked on involving fourteen students, seven from the white technikon and seven from the "other than white" institution. Both samples had been carefully selected on the basis of their performance at the technikon. They all agreed voluntarily to participate in the test itself and therefore the tester did not overstep his ethical responsibility towards the testees. Regarding the results of the test those tested were given their results in relation to the rest of the sample (stanines). Anonymity was maintained.

Once the pilot study confirmed the hypothesis of the study, an extension of the study was proposed whereby more students from both institutions were tested.

The total sample amounted to (N = 78) students who had completed at least one year successfully at a technikon, studying towards an approved computer course. The students were made up of two groups, one White (N = 35) of which twelve were Afrikaans speaking and twenty three English speaking. The other group consisted of students "other than white" (N = 43) of which thirty six were English speaking and the other seven Afrikaans. Furthermore in Group 1 (the White group) there were 17 males and 18 females whose ages ranged from 19 to 28. while the second group consisted of 33 males and 10 females whose ages varied from 20 to 24 years old. The total sample (N = 78) consisted of full time Computer students of which 50 (N = 50) were males and 28 (N = 28) were female. Of these 59 (N = 59) were English speaking and 19 (N = 19) were Afrikaans. The sample's age ranged for 19 to 28 with the mean age been 23.

Procedure

The full study was conducted in groups of ten, separately for each institution Test administrator and groups were matched in terms of racial group. Also the two groups were not to know that their test scores were to be compared. In addition a structured biographical type interview was used. This instrument, shaped after Mahler's (1976) Accomplishment Analysis, was utilised in the interview process. In conjunction with this information the specifications of the entry level programmer position, as well as dimensions needed for success in the job were obtained from line managers who trained

programmers. They were identified to be: application to programming as a subject, energy levels, ability to express ideas logically, leadership traits made up of assertiveness and enthusiasm and aspiration levels.

Measuring Instruments

The N.I.P.R. General Aptitude Battery

The measuring instruments consisted of the N.I.P.R. Aptitude Battery and an interview schedule. These are reviewed below:

The battery of tests consists of four subtests:

- Mental Alertness Test which is one of the subtests of the N.I.P.R.'s high level battery. The test contains 42 items and allocates subjects 45 minutes within which to complete the test. This is a test of general intelligence requiring a fairly high level of abstract ability, which includes reasoning tasks in the form of verbal analogies, classification of abstract concepts and figure and letter series. Norms exist mainly for white matriculants and first year university graduates. The test apparently proved to be one of the better predictors of success for computer programmers when Steyn (1969) conducted a validation study of the very battery under discussion for the Computer Society of South Africa. Furthermore in the Infogold study, norms for Computer programmers were developed for a racially mixed group of trainee programmers. The reported reliability scores for the sample (N = 61) was K-R 21 = ,885 (with Tucker correction (0,1) Distr = ,932) (Anglo American Corporation of SA, 1988).

- The Pattern Relations test - consists of 30 multiple-choice items wherein testees are given fifty minutes within which to complete the test. The purpose of the test is designed to measure abstract reasoning ability, or more specifically, inductive reasoning ability. It is assumed that inductive reasoning is a form of conceptual thinking and therefore a part of the creative thinking process. What should be noted is the fact that the author (Barker, 1968) stated that this was a high level test and most suitable for graduates. Consequently most university students will find the test too difficult. Norms were developed on white scientists of the C.S.I.R. KR 21 reliability coefficient for this sample was 0,86.

- Gottschald figures test consists of 45 items and in which the testee has twenty minutes to complete the test. It is an adaptation of the Embedded Figures test and is thought to measure perceptual analytical reasoning ability and speed of perception rather than reasoning ability. Once again norms have been established, for white matriculants (N = 149) with the K-R21 reliability coefficient ,81. On an Indian sample of engineering students (N = 369) K-R21 reliability coefficient ,62 was reported (N.I.P.R Norms 1981, 1982, 1983).

- Concept Attainment Test - the test has seven problems of which seven answers for each problem are to be found, having given the testee one correct answer. The time allocated for the test is fifty minutes. The object of the test is problem solving, and it tests the subject's ability to develop a system of reasoning in approaches to problem solving. The norms for this test were developed using white university students, by Scheepers (1970) on a sample (N = 70) where reliability coefficients of ,89; ,87; ,89 were reported for spatial, verbal and numerical ability respectively, using Kuder-Richardson formula 21 with Tucker's correction.

In summary then, the N.I.P.R. Aptitude Battery has a total raw score of 187 and a total time limit of 2 hours 45 minutes.

Cut-off Points of the N.I.P.R. General Aptitude Battery and its Implications

In addition to the battery which was obtainable from the N.I.P.R., the institution also supplied cut-off points for different occupational categories in the computer industry. These cut-off points were given in a raw score for all tests combined as can be seen in Table 6.

This implies that the higher the raw score, the better the chance of the applicant tested for an entry level programmer. Most of the tests had norm tables for the white ethnic group only and the validation of the test was conducted on white employees and students alone (Steyn, 1969). The test scores are then used as a predictor of success for all potential computer programmers. This implies that standards acquired for the white group on whom the battery was validated (Steyn, 1969) should also be applied to other ethnic groups who wish to be considered for entry level programmer status.

Table 8: Cut-off points of the N.I.P.R. Battery for Computer Programmers

CATEGORY	ACTUAL RAW SCORE	STANINES	MAX SCORE	OCCUPATIONAL CATEGORY
	< 76	4		unacceptable for programming
1	77 - 113	5	187	acceptable programmer
2	114 - 129	6	187	highly recommended programmer
3	130 - 141	7	187	recommended analyst
4	142 - 160	8	187	highly recommended analyst

The insurance company used in the research set their own cut off points at a score of 142 or more on the battery. The rationale for the use of this very high cut off point was an insistence by the computer line management that individuals scoring high on the N.I.P.R. battery usually perform very well in the work place, when measured against their appraisal rating.

Even though the test battery was one of the most reliable and proven tests in South Africa, the question was asked how sure can organizations be of its predictive validity. In fact even though it was validated by Steyn (1969) for the Computer Users Council, it was not enough reason to accept that the test battery was valid for the selection of entry level computer programmers in the said organization. It was for this reason that a validation study was done by the organisation.

Validation of test battery

For this purpose a sample of programmers (N = 34) with two years and less experience, regarded as successful performers by their line managers were used. Their test results on the N.I.P.R. battery were correlated with criterion data (a performance appraisal rating on a nine point scale). As a first phase of the analysis a correlation matrix between the different subtests was calculated. (This would indicate duplication of measurement and the degree to which the different sub-tests predict the criterion.) For this second phase of analysis a stepwise multiple regression analysis was carried out on the test and criterion data to establish to what degree the battery predicts the criterion (appraisal rating). The findings will be discussed in the next chapter under results. However, the validation study proved successful in its aim and line management's confidence was once again restored in the test. The problem however was that the sample on which the validation was executed was in essence all white. So while the test was regarded as a valid instrument in predicting programming ability and work performance, it was merely doing so for one population group.

The Interview

This process, is an essential if not the most important function of the selection process, yet is probably the most subjective aspect of the process.

This subjectivity can be countered by using certain approaches suggested by Matarazzo and Wolman (1965) and Bayne (1977), and if adhered to and conducted properly, the interview can be a predictor of success for potential employees. In this regard Forbes (1979) recommends ways of improving the reliability and validity of the selection interview. He suggested that by conducting a structured panel interview which has planned probing questions to elicit specific dimensions recognised as indicators of success by line managers interviewing bias will be minimised. This will therefore involve tailoring the selection interview to the job and according to Goodale (1976), unless the interview is subjected to these conditions it will have low predictive validity, resulting in low reliability of interview evaluations. The evaluation is therefore the main area over which the chairperson in the interview has to keep control.

Therefore, subjectivity can be reduced by structuring interviews, tailoring dimensions to a family of jobs and simplifying the process of evaluation and establishing its criterion related validity. Guideliness in this respect are: start with the job not the person to fill the job; specify information predictive of each area of performance; write specific questions for each job and evaluate potential to perform. The interviewer should plan for the selection interview, clarify questions and verify statements and achievements claimed by the person interviewed (Lattereel, 1976). Each interviewer on the panel should have a role to play and evaluation of the process should be conducted as soon as possible after the interview.

The Biographical Item Interview

The biographical approach to structured interviews has been found to be the most reliable. In this regard Asher (1972) stated that given the dimensions upon which to assess applicants in an interview, certain of these which are verifiable can be classified as biographical items or B-items. In this respect, most items on an application for employment form are verifiable e.g. matriculation symbols. However, to elicit dimensions such as interest in the career chosen would mean questions such as "Why did you decide to become a programmer?" Although a non-essential question in the prediction of success as

a committed person or one simply seeking a career with a quick means to a good salary, it is not a true B-item. However it is essential that items such as personality, motivation, aspiration, attitudes and values be regarded as an enlarged classification of B-items since it allows the interview panel to make a better decision. When comparing predictive power of biographical items with other predictors of success in decision-making in the selection process, research has proved it to be far more valid and reliable (Ghiselli 1966).

In this regard, Ghiselli (1966) published validity coefficients which indicated that biographical items exceeded intelligence tests by 2 to 1 and spatial relations by 18 to 1, when the cut-off validity was .5. From this research it can be said that biographical items seem to yield higher validity coefficients than any other predictors. Although research indicates that the interview as an instrument has lower validity, it still has to be utilised in the selection process, since no selection can be done without the interview (Hunter & Hunter, 1984). In fact, Asher (1972) suggests that the questions cover the following areas for fair evaluation:

What has the applicant done to date?

Where has the applicant been up to the present time?

Where does he/she want to be with regard to career aspirations?

What does he/she feel?

How is he/she apt to behave in certain situations?

What interests the applicant?

What relationships has he/she had with other people?

All these areas are covered in the Mahler approach and will now be discussed.

The Accomplishment Analysis Interview Questionnaire

This process is based on the structured interview concepts, which is one of the more reliable means of an otherwise subjective process. The technique was introduced by Walt Mahler (1976) who was assigned to find a process, other than psychometric testing, to enable senior managers to be appointed within organisations. This resulted in the accomplishment analysis interviewing

technique, which firstly focuses on obtaining the specifications for the position. This is obtained from the existing incumbent as well as his/her immediate supervisor which in turn gives the interviewer an idea of the specifications for the position on two levels, present and future. The interviewing process itself focuses on accomplishments in the present and past as well as the applicant's future aspirations. Embodied in the process are questions covering the applicant's ability to plan, make decisions, relate to people and behave in leadership roles. All the interviewee's claims as accomplishments must be verifiable with either the applicant's last employer (or reliable referees in the case of technikon students. With this information of the applicant's accomplishments), as well as future aspirations, this can be rated against the specifications for the vacant position. In this regard Walt Mahler also designed an accomplishment analysis for college or technikon leavers.

In order to find a reliable biographical type of structured interview which could be tailored to the need of entry level programmers it was decided to use the guide on the total sample tested (N = 78). This was done after using the interview guide to illicit dimensions of success as a programmer. Also the same interview dimensions were used for the pilot study and subsequently validated six months later using these incumbents appraisal ratings (N = 14) as a criterion score.

Specifications and Dimensions of Entry Level Programmers

The National Productivity Institute study (Riley et al., 1983) found from data processing managers that programmers should be logical thinkers, seeking exactness in their work, willing to work hard and have a high need for independence. It was also noted that the role of the programmer was changing from that of a technical expert to one of internal consultant. Therefore, verifiable evidence of good interpersonal skills was becoming more important.

With respect to the organisation concerned, interviews were conducted with the view to finding specifications for entry level programmers on thirteen programmers with two years experience or less and who were from both population groups, male and female. Furthermore, interviews were also conducted with team

leaders responsible for the entry level programmers as well as the training manager user support. It was found that the common specifications were: interest in the computer profession, ability to finish work and observe detail, ability to work in a team, ability to communicate, fair interpersonal skills and a practical more than theoretical flair. Using these specifications, the interviewer could also note which dimensions were necessary for success as a computer programmer in the organisation. The Accomplishment Analysis interview guide for technikon/college leavers was used on the 14 programmers in the form of a pilot study. The interview guide firstly probed application and consistency in studies. Secondly, the reason for the person's choice to study for a career in computers. Thirdly, extra curricular activities and recreation participated in throughout his/her student years. Fourthly, how change is handled in the individual's life and what things would have been done differently if given a second chance. Fifthly, the interview guide probed work experience during vacations. Sixthly, influence of parents and brothers on the applicant and lastly and lastly an indication of status of current health (refer Appendix 1).

Statistical Procedures

The research regarded the predictor scores on the N.I.P.R. test battery as the independent variables and the criterion scores of the students' average of their major subjects as the dependent variable. Seventy eight persons, students from the respective technikons were tested and interviewed using the structured interview guide. The samples were matched and the test data and interview guide scores were analysed as follows:

Firstly, descriptive statistical information such as the number tested in each group as well as the mean (\bar{x}) and standard deviation on both independent and dependent variables for each group as well as the combined sample was computed.

Secondly, a t-test was done to the difference between criterion and predictor scores of each group.

Thirdly, a t-test was also done on overall interview scores and predictor

scores as well as on overall interview scores and criterion scores. This was done for the sample as a whole and for each group individually. The purpose of this was again to measure unequal variance.

Furthermore, Pearson's product moment correlations were calculated between all variables, including the interview score, for each group separately and for the whole sample. The pilot study using the interview was also correlated against an appraisal score, to assess the validity of the interview guide.

Lastly, linear regression graphs on the criterion (dependent variable) and predictor (independent variable) was drawn so as to see the dispersion of scores of each group and the total population to assess the variances, (if any) within the constant ratio model. (See figure 6).

FIGURE 6

The Constant Ratio Model

Quadrant 2 Not selected but would have been successful	Quadrant 1 Selected and Successful
Quadrant 3 Not selected and would not have been successful	Quadrant 4 Selected and Unsuccessful

CHAPTER SIX

RESULTS AND DISCUSSIONS

The Validation Study

As was mentioned in the chapter on method, even though the N.I.P.R. General Aptitude Battery was a regularly used instrument with high reliability coefficients for each subtest, this however was not reason enough for acceptance that the test battery was valid for the selection of computer programmers. A validation study was initiated whereby (N = 34) programmers test scores, obtained when they were entry level programmers were correlated with their appraisal ratings (criterion score). Since the average service of the programmers was in excess of three years, the criterion score used was therefore regarded as reliable and averaged for consistency over the same period. This was correlated with the subtests and total score.

The results of the study are, firstly the intercorrelations as indicated in Table 9. A low intercorrelation between subtests was observed. Thus the constructs measured seem to be pure and duplication of measurement between the different tests of the battery is limited.

Secondly, three of the four tests viz. Mental Alertness, Gottschald and Concept Attainment correlated significantly in the positive direction with the criterion data. This finding indicated that the three tests predict performance to a satisfactory level.

Thirdly, negative correlations between the test totals and the subtests were found in all cases. (refer Table 9).

With respect to the results of the step-wise multiple regression between the tests (as independent predictors) and the criterion (as dependent variable), the results of this analysis are indicated in Table 10. The main findings were that Mental Alertness plays the largest role and Pattern Relations the smallest role as predictors. This could be viewed as a more than acceptable predictor coefficient seeing that the test battery on its own can predict 50% of

Table 9 : Intercorrelations between the different subtests of the N.I.P.R. battery and a criterion score of performance (appraisal rating)

	1	2	3	4	5	6
1 Pattern	1,00	,27	,10	,15	-,13	,30
2 Mental		1,00	,26	,34	-,19	,56 **
3 Gott			1,00	,17	-,01	,35 *
4 Concept				1,00	-,40	,51 **
5 Total					1,00	-,50 **
6 Appraisal						1,00

* $p < ,05$

** $p < ,001$

Pattern = Pattern Relation
 Mental = Mental Alertness
 Gott = Gottschaldfigure
 Concept = Concept Attainment

TABLE 10 : Results of the multiple regression analysis between the test battery and criterion score

Variables	Multiple Correlation (R ²)	Single Correlation (R)	B-Weight
Mental Alertness	,56	,58	,08
Concept Attainment	,65	,51	,04
Gottschild Figures	,67	,35	,03
Pattern Relations	,68	,30	,04
			-2,4

the variance in appraisal ratings. All the tests were furthermore found to be in the regression format and this indicated that the test battery could therefore be kept in its present format and used as a valid predictive tool.

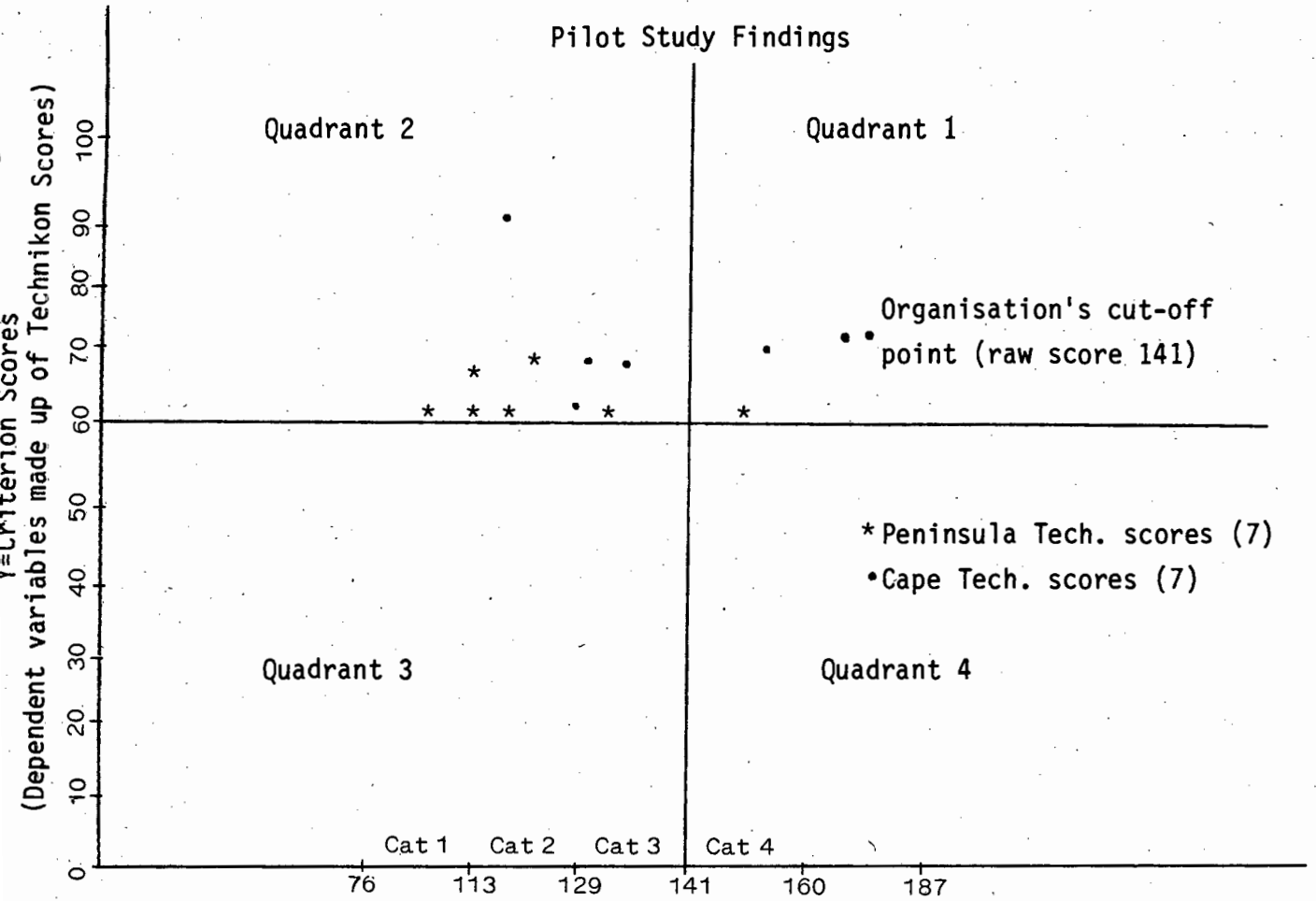
Results of the Pilot Study

The researcher approached each technikon for students currently completing their third year or second year of study in the computer and data processing department. Initially for the pilot study seven students were selected from each technikon. They were interested in becoming either entry level programmers or they wanted bursaries and co-operative work experience during their studies. The results indicated that most of the students from each technikon scored between 60% - 70% in their major subjects viz. Commercial Programming and Information Systems. However, the dispersion of scores on the N.I.P.R. Battery were so wide that no real relationship existed between predictor and criterion scores. In essence, should the standards of the company concerned have been taken into consideration (select only those with raw scores higher than 141), only four out of fourteen students would have qualified for selection (see Figure 7 below). Of the four, one was from the so-called "other than white" group (group 2) and three from the white group (group 1). When referring back to the models of fairness specifically to that of the constant ratio model, it was seen in the scatter diagram (Figure 7) indicated that most of the students, ten out of fourteen, were in the second quadrant or not selected but would have been successful, while four were in the first quadrant, selected and successful.

Furthermore, all those participating (N = 14) in the pilot study were put through the structured interview process, based on the identified dimensions for success as an entry level programmer (refer Table 11). Of the fourteen tested some were granted bursaries, but all of them were employed by the company on a co-operative education basis, over a period of one year. Thereafter they were appraised according to their performance and offered permanent positions should they have met with the standards of the company.

The conclusion was therefore that a model of Fairness such as the constant ratio approach, was acceptable to the organisation's manpower profile strategy. This could be used in conjunction with the predictor and criterion score of the student.

FIGURE 7



X = Predictor Scores

(Independent variable made up of total raw scores of N.I.P.R. subtests)

- Cat 1 = acceptable programmer
- Cat 2 = highly recommended programmer
- Cat 3 = recommended Analyst
- Cat 4 = highly recommended Analyst

TABLE 11 Correlation between predictor, criterion and interview variables of pilot study (N = 14)

VARIABLE	1	2	3	4	5	6	7	8	9
1 Appraisal rating	1.00								
2 Technikon results	-0.06	1.00							
3 Aptitude	-0.32	-0.09	1.00						
4 Application	0.03	0.45	0.08	1.00					
5 Energy	0.19	0.05	-0.62**	0.11	1.00				
6 Logic	0.69 **	-0.04	-0.53	0.04	0.21	1.00			
7 Assertiveness	0.53	-0.02	-0.63**	0.24	0.64 *	0.80 **	1.00		
8 Aspiration level	0.04	0.13	-0.40	0.47	0.47	0.46	0.64	1.00	
9 Interview score	0.38	0.11	-0.59*	0.48	0.69 **	0.69 **	0.92 **	0.81 **	1.00

* p < ,05

** p < ,01

Lastly, in order to validate the interview guide the scores of the pilot study sample were correlated with a performance appraisal point given to them after their period of co-operative education. (refer Table 11).

The matrix reports correlations between the appraisal rating, Technikon results, aptitude test scores, interview dimensions (five in total) plus the overall interview score. Results indicated that the appraisal ratings given by line managers did not correlate significantly with eight of the nine variables and therefore a question mark should be placed over the validity strategy and the study conducted earlier giving credence to the test battery. As suspected the interview scores did not have a significantly positive correlation with either the predictor (test scores) or the criterion (technikon scores). However the correlation of $r = ,38$ with the variable appraisal rating was low but in line with meta-analysis findings of validity indicators for structured interviews and therefore acceptable (Hunter & Hunter, 1984). Scores out of ten for each variable were computed and recorded in Appendix 2.

Follow-up Study Results

For the sample ($N = 78$) of technikon students, criterion scores made up of the major subjects, Commercial Programming and Information Science as well as an average for both was computed. Similarly, for each sample of technikon population predictor scores for the N.I.P.R. battery was computed. This entailed scores for the sub-tests of the battery, which were: the Mental Alertness test, the Pattern Relations, the Gottschald and the Concept Attainment test. In addition to this a total score of the predictor test was computed, and a further variable namely the interview score was built in. Nine variables, five independent and four dependent, both for Group 1 ($N = 35$) white group and Group 2 ($N = 43$) "other than white" group were covered.

Descriptive statistics for the predictor and criterion variables were obtained for each sample of technikon students as well as for the combined group (refer to Table 12). The results were used to gain an idea of the amount of

TABLE 12 : DESCRIPTIVE STATISTICS

PREDICTOR/CRITERION	M (n = 78)	SD	M (n = 35)	SD	M (n = 43)	SD
Commercial Programming	63,9	10,4	65,3	8,9	62,8	11,4
Information Systems	66,1	10,5	65,7	9,6	66,4	11,4
Average	65,2	9,5	65,6	9,1	64,8	9,8
Mental Alertness	25,6	8,3	32,7	5,2	19,9	5,5
Pattern Relations	13,6	5,0	15,7	5,0	12,0	4,5
Gottschald	22,6	10,0	26,4	10,8	19,6	8,3
Concept Attainment	47,0	15,2	55,0	12,8	40,5	14,0
Total	108,9	29,8	129,4	22,5	92,2	24,0

variance existing in each variable. A high variance, indicates that dispersion varied widely. It can therefore be confidently said that the variance, especially those on the predictor scores, differed widely from each other when the two groups were compared. In this respect the total mean score on the predictor for each group indicates that the mean score for each sub-test in the battery exceeds the mean of group 2 (white sample $M = 129$; "other than white" sample $M = 92$). The total population mean on the predictor was 108. Similar predictor score variances exist in the statistical analysis and can be seen in range scores for each sample. Group 1 range equals 79, Group 2 range equals 63 and the total group range equals 127,00. Standard deviations reported in the same order as above were 22,5; 24,0 and 29,8 respectively.

Intercorrelations and levels of significance

The statistical relationship between the test predictors, criterion scores and interview were assessed for groups 1 and 2 individually (refer Table 12) and thereafter for the whole sample (refer Table 14). A computerised statistical package called Application System was used to do the correlation studies employing the Pearson correlation method. Levels of significance for the correlations in the different groups were noted and calculated at the ,05 and ,01 levels (or 95% and 99% points of significance) for the predictor scores against that of the criterion marks and interview score. The intercorrelation trends in Group 1 and 2 were markedly different.

For Group 1 - the White Technikon sample - the predictor subtests Pattern Relations and the Gottschald test was correlated significant by ($p < ,01$) with the criterion scores. The Mental Alertness predictor subtest did not correlate significantly with either of the criterion scores, or with any of the other subtests of the predictors. While the Concept Attainment subtest correlated significantly with one criterion score, Commercial Programming ($p < ,01$) it did not correlate significantly with the other criterion score viz. Information Science. The interview guide on the other hand correlated significantly ($p < ,01$) with all the variables, both predictors and criterion, with the exception of Mental Alertness. Similarly the total predictor score correlates significantly ($P < ,01$) with all the variables other than mental alertness.

TABLE 13 : CORRELATIONS BETWEEN PREDICTORS, CRITERION VARIABLES AND THE INTERVIEW GUIDE FOR GROUP 1 AND 2

VARIABLES	1	2	3	4	5	6	7	8	9
1 Commercial pro.	1,00	,32*	,77**	,10	,22	,13	,14	,24	,66**
2 Info systems	,93**	1,00	,84**	,01	,01	,09	,08	,02	,49**
3 Average	,97**	,99*	1,00	,07	,15	,16	,08	,17	,68**
4 Mental Alert.	,02	,06	,05	1,00	,53**	,54**	,38*	,73**	,10
5 Pattern Relat.	,46**	,45**	,47**	,11	1,00	,42**	,27	,59**	,04
6 Gottschald	,49**	,53**	,53**	,16	,59**	1,00	,33*	,72**	,28
7 Concept Attainm.	,43**	,26	,33	,27	,38*	,13	1,00	,83**	,13
8 Total	,60**	,52**	,56**	,16	,73**	,69**	,72**	1,00	,22
9 Interview score	,64**	,69**	,69**	,05	,45**	,21	,48**	,52**	1,00

* p < ,05

** p < ,01

Note: Coefficients above diagonal based on Group 1 and those below the diagonal on Group 2

TABLE 14 : CORRELATIONS BETWEEN PREDICTORS, CRITERION VARIABLES AND THE INTERVIEW GUIDE FOR THE WHOLE SAMPLE

VARIABLES	1	2	3	4	5	6	7	8	9
1. Commercial pro.	1,00								
2. Info systems	,1	1,00							
3. Average	,84**	,88**	1,00						
4. Mental alert.	,12	,03	,05	1,00					
5. Pattern Relat.	,32 **	,15	,28 *	,44**	1,00				
6. Gottschald	,13	,24**	,33**	,45	,56**	1,00			
7. Concept Attainm.	,26*	,01	,16	,43**	,43**	,34**	1,00		
8. Total	,34**	,10	,26*	,73**	,69**	,71**	,83**	1,00	
9. Interview score	,64**	,54**	,66**	,03	,15	,21	,19	,22	1,00

* p < ,05
 ** p < ,01

For Group 2, none of the predictor subtests correlated significantly with the criterion scores, Commercial Programming and Information Systems. Regarding the intercorrelations of the subtests, the Pattern Relations ($p < .01$) Gottschald ($p < .01$) and Concept Attainment ($p < .05$) correlated significantly with that of the Mental Alertness test. Similarly the Gottschald Test was significantly correlated with Pattern Relations ($p < .01$) and Concept Attainment ($p < .05$). Also the Concept Attainment test was significantly correlated with the Mental Alertness, Pattern Relations and Gottschald subtests at the 95 percentage levels ($p < .05$). What must be noted is the low correlation and level of significance between the criterion score Information Systems and Commercial Programming ($p < .05$) when compared with the high correlation the criterion scores in Group 1. The interview also correlated significantly ($p < .05$) with the criterion scores but not with the predictor scores.

In the total sample ($N=78$) the correlation is significant between criterion and predictor scores ($p < .05$) barring the Mental Alertness test which was not significant. In fact in the criterion scores Commercial Programming had a significant correlation ($p < .05$) with all the variables except Mental Alertness. Secondly, information science showed a significant relationship with the interview guide and Gottschald figures ($p < .01$) as well as with pattern relations at the 95 percent level ($p < .05$). Regarding the Interview guide, it showed a significant relationship ($p < .01$) with the criterion but not with predictor scores.

Tests of significance were also carried out on each variable of the criterion and predictor for each group, to find out whether there was a significant difference between the results of each group's technikon scores (criterion) and test scores (predictors).

The results indicated (refer Table 15) that while there was no significant difference between the two groups of criterion scores, there existed significant differences ($p < .01$) between the scores of the predictor subtests as can be seen from the t-values.

Similarly t-tests were conducted for each group separately and on the whole sample to test difference between the interview scores and the predictor

TABLE 15 : COMPARISONS OF PREDICTOR AND CRITERION MEASURES FOR GROUPS 1 & 2

PREDICTOR/CRITERION	GROUP 1 (N = 35)		GROUP 2 (N = 43)		t VALUE	PROB.	
	M	SD	M	SD			
Commercial Programming	65,3	8,91	62,8	11,4	1,16	0,250	
Information Systems	65,7	9,6	66,4	11,4	-0,28	0,782	
Mental Alertness	32,7	5,2	19,9	5,5	11,67**	0.0001	
Pattern Relations	15,7	5,0	12,0	4,5	3,89**	0.0002	
Gottschald	26,4	10,8	19,6	8,3	3,45**	0.0009	
Concept Attainment	55,0	12,8	40,5	14,0	5,22**	0.0001	
Total	35	129,4	22,5	92,2	24,0	7,75**	0.0001

* p < ,05
 ** p < ,01

TABLE 16 : COMPARISON OF INTERVIEW SCORES WITH PREDICTOR AND CRITERION SCORES

	INTERVIEW		PREDICTOR				CRITERION			
	MEAN	SD	MEAN	SD	t-SCORE	PROB.	MEAN	SD	t-SCORE	PROB.
Total group	5,60	0,11	5,65	0,16	-0,26	0,80	6,19	0,12	-3,58 **	,01
Group 1	5,57	0,12	6,51	0,24	-3,48**	,00	6,26	0,17	-3,30 **	,00
Group 2	5,63	0,19	5,63	0,19	2,78**	,01	5,63	0,12	-2,06 **	,04

t-Test for difference in means between Predictor and Interview/Criterion and Interview

* p < ,05

** p < ,01

and criterion variables. (refer Table 16). From the results gained, the interview scores were significantly different ($p < ,05$) for the group predictor and criterion score individually.

Similarly when the total sample scores for prediction and criterion variables are compared for significance, results indicated that there was a significant relationship ($p < ,05$) of interview score with criterion score but not with the predictor score.

Furthermore, B1 variate curve fitting linear regression graphs were computed on Groups 1 and 2 as well as on the entire sample (Table 17 and 18). The results of these graphs of linear regression for Group 1 firstly indicated that of the thirty-five students tested only six incumbents had scores in the first quadrant which was the one that the organisation preferred. However, when adding those in quadrant 2 (17) this indicated that those in quadrants one and two represent 23 of the 35 students who could possibly be considered for employment in Group 1. The correlation coefficient recorded between the total score of the predictor and average score of the criterion was ,62.

In group 2 only one student had scores in the preferred quadrant one, while 29 had scores in quadrant two. This in fact allowed 30 of the 43 students tested to be considered for employment in Group 2. The correlation coefficient recorded between the predictor and criterion scores was ,09. The total sample scores is indicated in Table 18 and had a ,27 correlation.

Results of the Biographical Questionnaire Approach

The Constant Ratio model of fair selection was shown to allow 69% (53) of the total sample population (78) to be possible candidates for employment. According to this model it follows also that the percentage of each individual sample population is also 69% for each total sample population tested. (In this case 30 candidates from the coloured technikon and 23 candidates from the white Technikon). All 78 students were interviewed against certain job specifications and dimensions of successful entry-level programmers. Thereafter, by means of the Accomplishment Analysis Biographical interview, students were rated and the final decisions were based on consensus among interviewing panel with

TABLE 17 - LINEAR BIVARIATE CURVE GROUP 1 N=35

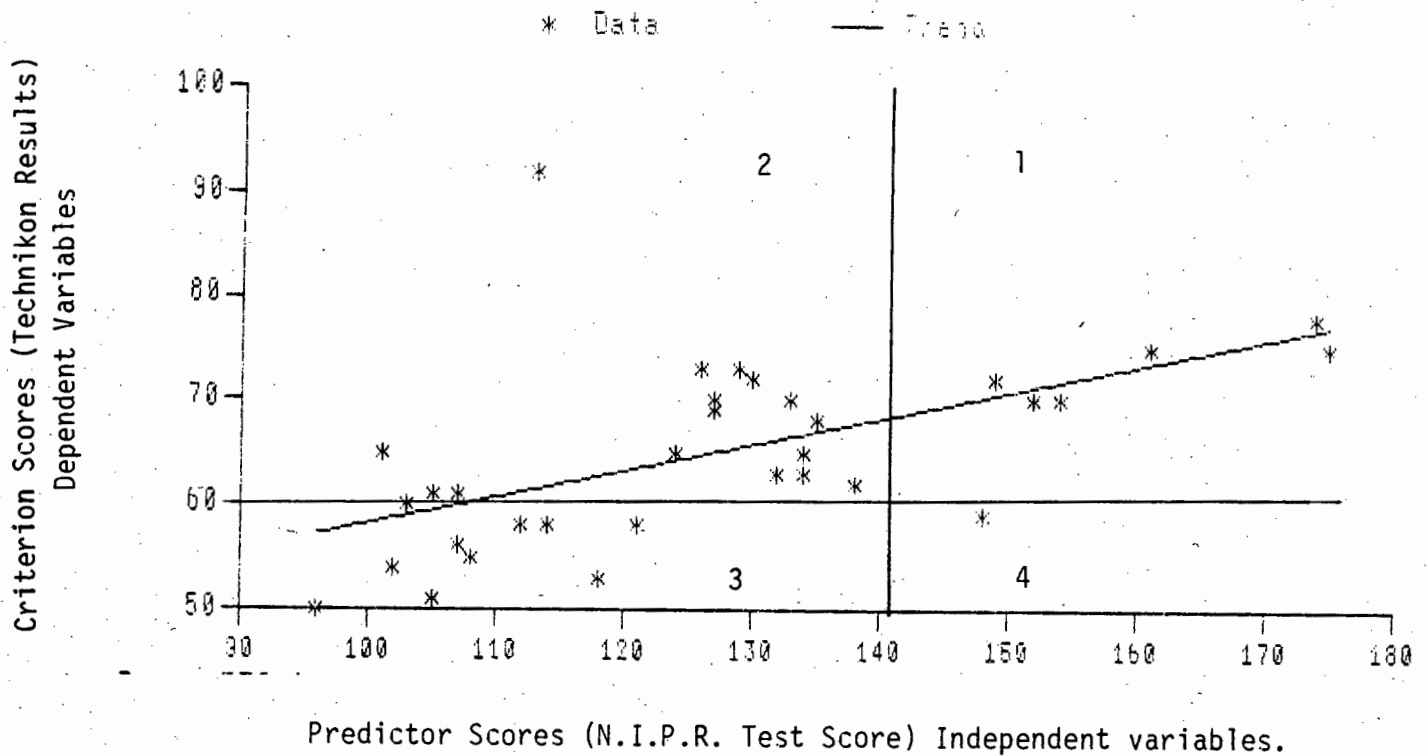


TABLE 17 - LINEAR BIVARIATE CURVE GROUP 2 N=43

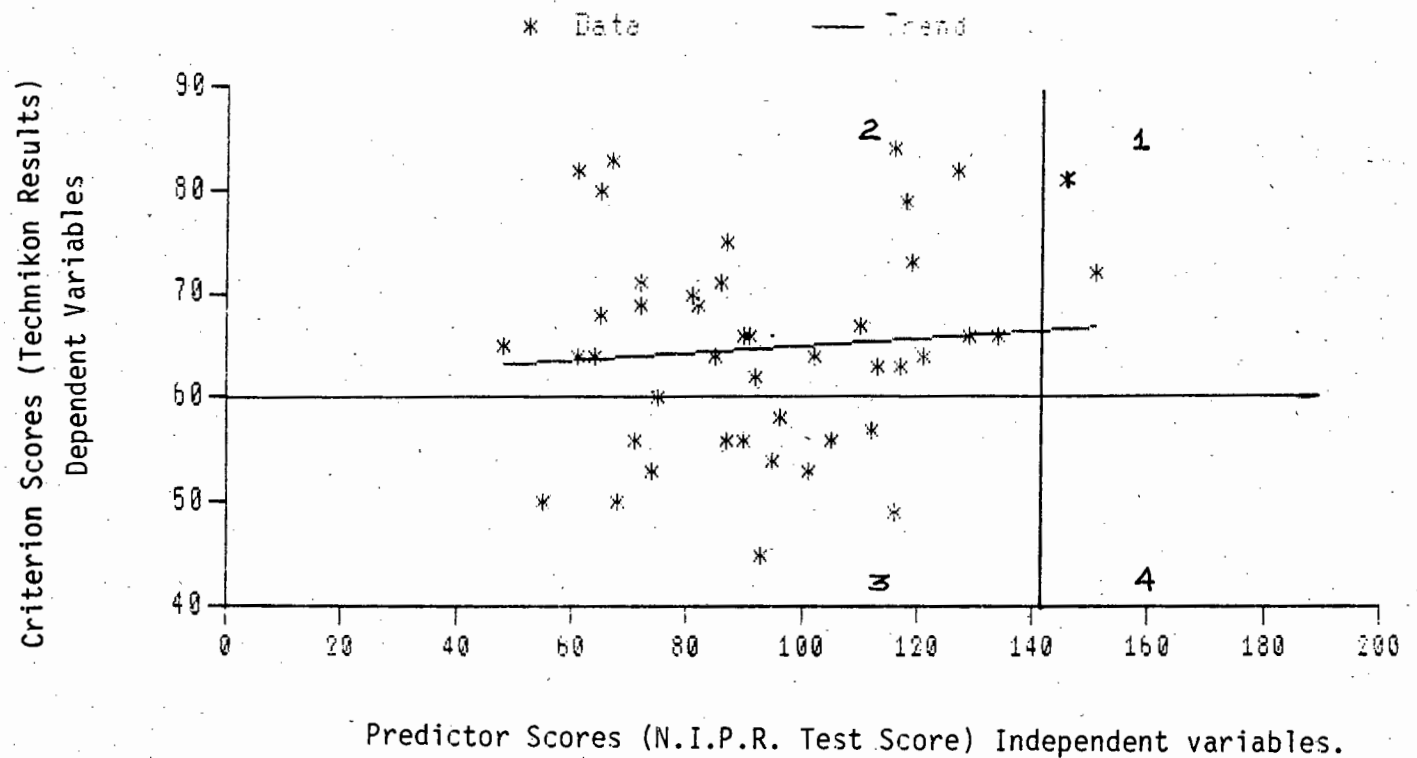
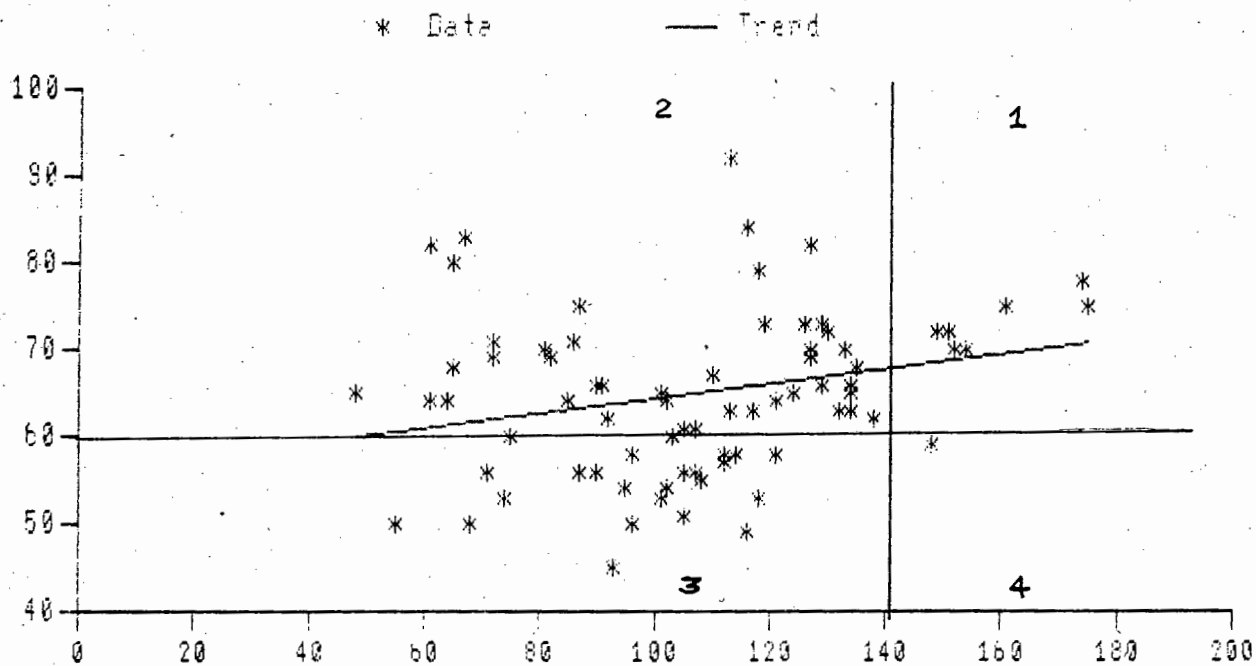


TABLE 18 - LINEAR BIVARIATE CURVE TOTAL SAMPLE N=78

Criterion Scores (Technikon Results)



Predictor Scores (Independent Variables)

regard to the required dimensions. The process of the selection of entry-level programmers was therefore perceived as fair by the computer line management of the organisation. This was done to select a valid fair selection model, viz. the Constant Ratio Model and finally, by including the Biographical Interview Guide. Furthermore, attention was concentrated on specifications and dimensions for success of the position and it was merged with that of verifiable accomplishments of the job applicants.

Discussion of the Results

Given the aim of the study to investigate the feasibility of employing "other than white" programmers to alleviate the skill shortage problem, the problem of this study was as follows: the research proposed that in order to grant this group an equal opportunity, the measuring instrument used in the study should be fair. Given that the N.I.P.R. General Aptitude Battery was used for the purpose of selection, the hypothesis was that it was an unfair test and should be used with caution when testing for programmers.

The main findings of the study were that the overall results are significantly different for the two groups tested.

The fact that significant differences were found in the means of the predictor scores of the two groups indicates that in fact the research hypothesis that the test was unfair to disadvantaged groups was correct. (Refer to Table 15). Results show that no significant difference occurred between either the interview or criterion scores. However, significant differences were noted on every predictor subtest between the two groups. In essence, the test underpredicted the score of Group 2 and overpredicted the score of group 1.

Table 16 indicates that a significant difference occurred in interview scores for both predictor and criterion for both groups. In the total sample only the criterion score (Technikon results) was significantly different, but not the predictor score. The result in essence indicates that the interview score was to some extent not contaminated by the score that individuals obtained

in their Technikon scores (Criterion). However the probability of the interview score and predictor score were both at the ,8 level. The negative t-score however further indicates that an inverse relationship occurred, meaning that the lower the test scores the higher the interview scores (refer Table 16). Again this gives the predictor (test scores) very little utility in predicting success as a programmer. In Table 15 in which significant differences between the groups on predictor tests were recorded, this information can be used to test the degree of test fairness in predictors. Test fairness can be regarded as having not occurred if a significant difference in the means for the respective predictor sub-tests is noted.

The question now arises against which group did these tests discriminate? Given the company's requirements to consider only applicants with a raw score of 141, when consulting Table 17, the bivariate linear curves within the constant ratio quadrants indicate the following: Firstly, for group 1 only 6 would have qualified before the interview stage while for group 2 only 2 applicants would have been considered. When applying the constant ratio theory of fairness by extending the quota system, group 2 the "other than white" group would have been treated unfairly.

Correlations in the pilot study indicated firstly that no real significant correlations were found between appraisal ratings and the interview guide ($r = ,381$). However this was expected, as similar research indicated similar low correlations (Hunter and Hunter, 1984). Therefore enough confidence was placed into the structured interview guide to carry on with the follow-up study. Another feature of this correlation was the negative relationship of the criterion and predictor scores, when correlated with appraisal ratings. This indicated that an inverse relationship occurred between the three variables. Therefore appraisal ratings were better when both Technikon and aptitude scores were not reliable predictors of performance, making the test battery and technikon scores invalid. In fact the interview with its low correlation ($r = ,381$) was a more reliable predictor. It was this fact that also encouraged the study to continue.

It was also found that the predictor and criterion scores were more significantly correlated within the white sample (Group 1) than that of the "other than white" sample (Group 2). Also greater intercorrelational

significance existed between subtests of the predictors (with the exception of mental alertness) in Group 1 than did in Group 2. This would indicate that the Test battery was a more valid measuring instrument for indication of success as an entry level programmer in the white group than in the "other than white" group.

Theoretical and practical implications of the findings

This battery of test was never validated on any other population group other than white. This in essence means that the tests should not have been used on any other group besides whites and any selection decision based on the predictors or test results for such a group could be construed as unfair. However, given the fact that the N.I.P.R. stipulated cut-off points, if adhered to very few applicants would have been successful. In fact, when the Bivariate Curve fitting graphs are scrutinised, (Tables 17 & 18), then of the total sample population tested only seven applicants would have been successful in satisfying the company's conditions. In fact, if the Regression Model of Cleary (1968) was utilised for the combined sample population, then few or no candidates of the "other than white" group would have qualified. In this respect the Constant Ratio Model of fair selection as proposed by Thorndike (1971) and using the fact that differential validity does exist, applicants in quadrants 1 and 2 (see Figure 6) gave a larger proportion of applicants from both samples a fairer opportunity. In fact, from the bivariate Regression Graph it can be seen that in the quadrants 1 and 2 a total of 53 applicants out of 78 could be considered eligible. Of this number, 30 were other than white and 23 white. Having stated this it would seem more feasible to now consider reducing this figure further by applying the Accomplishment Analysis interview guide for students. This identifies dimensions of success in the job specifications of the entry level programmer and is based on interviews with existing high performance programmers who have less than two years experience. This approach would be seen to be one of fairness as it considers not only the aptitude test results, but also the manner in which the person will fit into the organization.

When comparing the findings of this research with other similar studies by Radford and Taylor (1986), Birkenbach (1988) and Moerdyk (1989) then it can be said that results are similar in that, psychometric tests must not be used across cultures or racial groups haphazardly, applying the same norms or cut off points of raw scores to all racial groups. If this is done the psychologist or personnel practitioner will be committing an unfair labour practice.

With regard to limitations of the study, the sample size was limited by the number of students who were studying for the Computer Diploma at the two Technikons in question. Possibly the sample could be increased by testing throughout the country to ascertain whether the same results would be yielded.

With respect to the research design it was almost impossible to match and randomise subjects from such a small sample. Given a larger sample size would probably control error variance to a greater degree. As far as shortcomings in the statistical issues such as analysis used, it can be argued that the statistics used are too simple. However, Lawshe (1983) and Birkenbach (1988) proposed an even simpler statistical approach to assess whether a psychometric test is unfair or not. Thus, the statistical analysis here should be adequate.

Finally the largest area for development is to design a follow-up study after a year or two to correlate appraisal ratings of the entry level programmers selected by means of this approach.

Conclusions

It should be noted from the research conducted that at times psychometric tests are not fair selection tools. Given the evidence of this research and others (Taylor & Radford, 1986) the whole area of skilled shortage in the computer profession should be reviewed. Also, given the demographic projections and the predicted 186000 African matriculants in the Year 2000 (Cape Argus, 1988) the question of utilising the "non-white" human resource should be reassessed as a solution. Further, the fact that the future of cognitive testing based on cognitive ability for admission to professions such as computer programming should be reassessed.

Should this not be possible and a test battery be used to admit applicants, then a model of fairness or philosophy of selection fairness should be employed to ensure that no applicants are disqualified on the basis of low test scores. In essence, whatever route is taken to employ entry level computer programmers, an interview is inevitable and will be used no matter how informal. It is therefore recommend to determine the dimensions and specifications for the job and employ them in a structured biographical interview to evaluate the candidates. The whole selection process will therefore take on a far more meaningful purpose as the applicants appointed will only have the ability to do the job, but also will have the personal dimensions to fit the organisational requirements.

Finally, it is hoped that this research will stimulate similar projects, especially at the level of the disadvantaged school leaver to clarify the necessary specifications and dimensions required to be a successful computer student at institutions like Technikons.

While concluding the writing up of this research mention should be made that the N.I.P.R. has launched a Programmers Aptitude Battery (P.A.B.) specifically designed for entry level trainees. The battery has been validated across racial groups and used with great success in projects such as Infogold. (Botha 1988). Since this study discourages the use of the N.I.P.R. General Aptitude Battery for programmers, the P.A.B. should be experimented with using the same research design as this research including the structured interview.

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ACCOMPLISHMENT ANALYSIS INTERVIEW GUIDE
FOR TECHNIKON DIPLOMATES

A. ACADEMIC EXPERIENCES

1. LET'S BEGIN BY REVIEWING YOUR TECHNIKON EXPERIENCES TO DATE. I WILL BE INTERESTED IN HEARING ABOUT WHICH SUBJECTS YOU HAVE ENJOYED THE MOST, AND WHY? ALSO WHICH SUBJECTS YOU HAVE ENJOYED THE LEAST, AND WHY? IN WHICH SUBJECTS HAVE YOU RECEIVED YOUR HIGHEST GRADES, AND IN WHICH ONES YOUR LOWEST, AND THE REASON FOR YOUR PERFORMANCE BEING WHAT IT WAS

(If not clear from preceding) How would you compare your performance in elective versus major courses?

(If not clear) What have you found to be the influence of your Lecturers on your performance in various courses?

Would you clarify a point for me? Do you feel your abilities or your effort has contributed more to your highest grades?

(Where not evident from academic progress reports) Where do you estimate your class standing has been over the last several years? (..... in a class of how many?)

2. WOULD YOU TELL ME HOW YOU WENT ABOUT MAKING YOUR DECISION TO STUDY FOR A PROGRAMMER, WHAT INFLUENCED YOUR DECISION THE MOST?

(If not clear) Would you tell me about any other career options you considered or started and your reasons for not pursuing them?

How does your choice of course tie in with your prospective career in Business?

B. EXTRA-CURRICULAR ACTIVITIES

1. THE ACADEMIC IS ONE SIDE OF STUDIES. NOW LET'S TALK ABOUT THE EXTRA-CURRICULAR SIDE. WOULD YOU TELL ME ABOUT YOUR EXTRA-CURRICULAR ACTIVITIES. START WITH YOUR FIRST YEAR AT TECHNIKON. WHAT ACTIVITIES YOU TOOK PART IN, THEN GO ON TO YOUR SECOND YEAR, AND SO ON.

(If a change in pattern occurred) As you progressed through college your activities changed, apparently. What influenced this change?

How would you describe your participation in these groups in comparison with the participation of others?

(If history shows offices held) I note you were an officer in Tell me your reaction to this position?

2. THAT'S FINE. NOW TELL ME ABOUT SOME OF THE THINGS YOU HAVE DONE FOR FUN AND RECREATION - YOUR INTERESTS AND HOBBIES, BOTH IN HIGH SCHOOL AND IN COLLEGE.
3. I WOULD ALSO BE INTERESTED IN YOUR TELLING ME ABOUT ANY EFFORTS YOU HAVE MADE OVER THE PAST SEVERAL YEARS TO TRY AND CHANGE OR INFLUENCE SOMETHING, EITHER ACADEMICALLY OR OUTSIDE OF CLASS.
4. LOOKING BACK OVER YOUR TECHNIKON EXPERIENCE, BOTH ACADEMIC AND NON-ACADEMIC, IF YOU HAD IT TO DO OVER AGAIN, ARE THERE ANY THING WHICH YOU WOULD DO DIFFERENTLY?

C. WORK EXPERIENCE

1. HAVE YOU HELD ANY PART TIME JOBS DURING HIGH SCHOOL OR TECHNIKON?

(IF YES, GO ON HERE, IF NO, GO ON TO QUESTION 2)

SUPPOSE YOU TELL ME ABOUT EACH OF YOUR JOBS, STARTING WITH THE FIRST ONE YOU HAD AND WORKING UP TO THE PRESENT. I WOULD BE INTERESTED IN EXACTLY WHAT YOU DID ON EACH JOB, ANY SPECIAL RESPONSIBILITIES YOU HANDLED, YOUR LEVEL OF EARNINGS, THE DUTIES YOU PARTICULARLY LIKED AND THOSE YOU LEAST CARED FOR, AND ANYTHING ELSE YOU CAN REMEMBER THAT WOULD GIVE ME A GOOD PICTURE OF YOUR WORK EXPERIENCE.

(If not clear) Could you clarify for me which jobs you most enjoyed, and why?

(If not clear) Could you clarify for me which jobs you least enjoyed, and why?

(If numerous jobs held) You certainly have tried your hand at a number of different jobs. Did you ever consider continuing one of these jobs for a longer time?

2. (If record shows some vacation, not work) YOU HAVE HAD SOME VACATION TIME, THEN. WHAT HAVE YOU DONE WITH YOUR LONGER VACATIONS?

FAMILY BACKGROUND

I THINK YOU WILL AGREE WITH ME THAT AS ADULTS WE ARE WHAT WE ARE IN PART BECAUSE OF WHAT HAPPENED TO US AS WE WERE GROWING UP. THAT IS WHEN WE DEVELOP MANY OF OUR LIKES AND DISLIKES, OUR INTERESTS, AND OUR PERSONALITIES. SUPPOSE THEN, YOU TELL ME ANYTHING YOU CAN REMEMBER ABOUT YOUR EARLY HOME BACKGROUND AND CHILDHOOD, SUCH THINGS AS YOUR FATHER'S OCCUPATION, HIS INTERESTS, WHAT HE WAS LIKE AS A PERSON, YOUR MOTHER'S INTERESTS AND OTHER CHARACTERISTICS, THE NUMBER OF CHILDREN IN THE FAMILY, HOW YOU WERE BROUGHT UP, AND ANYTHING ELSE YOU THINK MIGHT HAVE HAD AN INFLUENCE ON YOU.

Could you describe for me the influence of your parents on your choice of institution to study and your career choice?

In a sentence or two could you give me a feel for the kind of academic and personal standards which your parents expected you to live up to?

(If the individual has older brothers and sisters.) How would you compare your performance academically and non-academically to date, with that of your older

E. HEALTH

WHAT ABOUT YOUR HEALTH? ARE THERE ANY HEALTH FACTORS THAT SHOULD BE CONSIDERED IN CONNECTION WITH YOUR CHOICE OF A CAREER?

APPENDIX 2

PILOT STUDY N=14

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Appraisal Ratings	6	6	8	6	5	6	6	8	6	6	6	5	6	6
Technikon Results	9	7	6	6	6	7	6	7	6	7	7	7	7	7
Aptitude Test (Raw Scores)	(113)	(175)	(129)	(85)	(151)	(118)	(117)	(110)	(90)	(129)	(126)	(154)	(130)	(174)
Application	8	7	7	8	7	7	6	7	5	7	6	7	7	7
Energy Level	7	7	6	8	6	6	6	7	7	8	7	5	6	5
Ability To Express Ideas Logically	7	6	7	7	5	6	7	8	7	5	5	5	6	6
Assertiveness/ Enthusiasm	7	6	6	8	5	5	7	8	6	6	5	4	5	5
Aspiration Level	8	7	6	9	7	6	6	8	7	6	6	7	6	6
OVERALL INTERVIEW SCORE	7,4	6,6	6,5	8	6	6	6,4	7,2	6,4	6,4	5,8	5,6	6	5,8

Appendix 3

INTERVIEW SUMMARY

NAME:

A. Academic experiences (Application /10; Aspiration level /10)

B. Extra Mural Activities (Assertiveness & Enthusiasm /10)

C. Work Experience : (Energy level /10)

D. Family Background (Influence /10)

E. Ability to express ideas logically? (/10)

APPENDIX 4

GROUP I N = 24

	1	2	3	4	5	6	7	8	9	10	11	12
Technikon Results	7	6	6	6	6	6	6	7	7	7	6	6
Aptitude Test	6	5	7	6	6	6	8	9	9	9	8	7
Application	7	6	6	6	5	5	6	6	7	7	6	6
Energy Level	6	7	5	5	5	5	6	4	6	6	7	5
Ability To Express Ideas Logically	5	5	5	5	6	6	6	5	6	6	7	5
Assertiveness/ Enthusiasm	5	4	4	4	6	4	4	6	5	5	5	4
Aspiration Level	6	5	5	6	5	5	6	6	6	6	6	6
OVERALL INTERVIEW SCORE/10	5,8	5,4	5	5,2	5,8	5	5,6	5,4	6	6	6,2	5,2

APPENDIX 4

GROUP I N = 24

RATING BY LINE MANAGERS AND HUMAN RESOURCES MANAGEMENT

	13	14	15	16	17	18	19	20	21	22	23	24
Technikon Results	7	7	9	7	7	7	7	7	6	7	6	6
Aptitude Test	6	6	5	7	8	8	8	7	7	9	7	5
Application	6	7	8	7	7	7	7	7	6	7	6	6
Energy Level	7	8	7	6	6	6	5	6	6	7	7	5
Ability To Express Ideas Logically	5	5	7	6	5	5	5	5	5	6	6	5
Assertiveness/ Enthusiasm	5	6	7	5	5	6	4	5	6	6	6	6
Aspiration Level	6	6	8	6	7	7	7	7	6	7	6	6
OVERALL INTERVIEW SCORE/10	5,8	6,4	7,4	6	6	6,2	5,6	6	5,8	6,6	6,2	5,6

APPENDIX 4

GROUP 2 N = 30
RATING BY LINE MANAGERS AND HUMAN RESOURCES MANAGEMENT

	1	2	3	4	5	6	7	8	9	10
School Results	8	7	6	6	7	8	8	6	6	7
Technikon Results	4	4	5	6	6	4	5	5	4	4
Aptitude Test	-	-	-	-						
Application	8	7	6	6	7	7	7	5	5	7
Energy Level	5	5	7	5	6	4	4	6	6	3
Ability To Express Ideas Logically	7	6	7	5	5	6	6	5	5	5
Assertiveness/ Enthusiasm	6	5	8	5	4	5	5	5	6	4
Aspiration Level	8	7	6	6	7	7	7	6	5	7
OVERALL INTERVIEW SCORE/10	6,8	6	6,8	5,4	5,8	5,8	5,8	5,4	5,4	5,2

APPENDIX 4

GROUP 2 N = 30
"OTHER THAN WHITE"

RATING BY LINE MANAGERS AND HUMAN RESOURCES MANAGEMENT

	11	12	13	14	15	16	17	18	19	20
School Results										
Technikon Results	8	6	6	7	7,5	6	8	6	6	6,5
Aptitude Test	6	5	6	5	5	7	4	5	5	7
Application	7	5	6	7	7	5	9	8	8	7
Energy Level	7	7	6	7	7	7	8	8	8	6
Ability To Express Ideas Logically	8	7	7	8	8	8	7	7	7	7
Assertiveness/ Enthusiasm	5	6	7	8	8	6	6	8	6	6
Aspiration Level	8	7	6	8	8	8	8	9	9	6
OVERALL INTERVIEW SCORE/10	7	6,4	6,4	7,2	7,6	6,8	7,6	8	7,6	6,5

APPENDIX 4

RATING BY LINE MANAGERS AND HUMAN RESOURCES MANAGEMENT

	21	22	23	24	25	26	27	28	29	30
Technikon Results	6	6	7	6	6	6	6	7	6	6
Aptitude Test	4	3	5	5	5	5	8	6	6	5
Application	6	5	7	6	6	6	7	7	6	5
Energy Level	6	6	7	7	7	5	6	6	5	7
Ability To Express Ideas Logically	6	5	5	5	6	5	5	6	5	7
Assertiveness/ Enthusiasm	4	4	4	7	5	4	5	5	5	7
Aspiration Level	5	5	5	6	6	6	7	6	6	6
OVERALL INTERVIEW SCORE/10	5,4	5	5,6	6,2	6	5,2	6	6	5,4	6,4